United States Department of Agriculture

Monarch Butterfly Conservation Strategy for the Eastern Region of the USDA Forest Service

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Photo: Janet Kudell-Ekstrum, USDA Forest Service

Forest Service

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Executive Summary

Monarchs have experienced a severe decline over the past two decades. Important factors contributing to this decline include loss of breeding habitat including milkweed and nectar resources, increased use of pesticides, including herbicides and loss or degradation of habitat at the remaining overwintering sites. Climate change, extreme weather, and disease are also contributing factors. Extirpation of the monarch butterfly is a very real possibility if current trends continue.

National forests/prairie in the Eastern Region of the Forest Service (Figure 1) play an important role in monarch conservation. This Region encompasses the heart of the monarch breeding range and has many opportunities for monarch habitat improvement. Modelling of monarch extinction risk has shown the need for about 1.6 billion milkweed stems to be added across the landscape to boost the eastern monarch population to a sustainable size (Pleasants 2016); many of these additions could be on national forests/prairie. The purpose of this plan is to provide readers with an understanding of the state of monarchs and the threats they face, and to identify specific goals and actions Eastern Region national forests/prairie can take to conserve monarchs. A table of goals, strategies, and recommended actions can be found beginning on page 29. This plan also provides resources that forests can utilize when implementing the strategy, including a list of information sources associated with each recommended action, and appendices with suggested funding sources and partners (Appendices 2 and 3). Appendix 1 includes best management practices specifically for the habitats and activities of Eastern Region national forests/prairie. These best management practices provide detailed guidance for activities such as mowing, prescribed burning, roadside and right-of-way management, special uses, and how to install and manage native plantings.

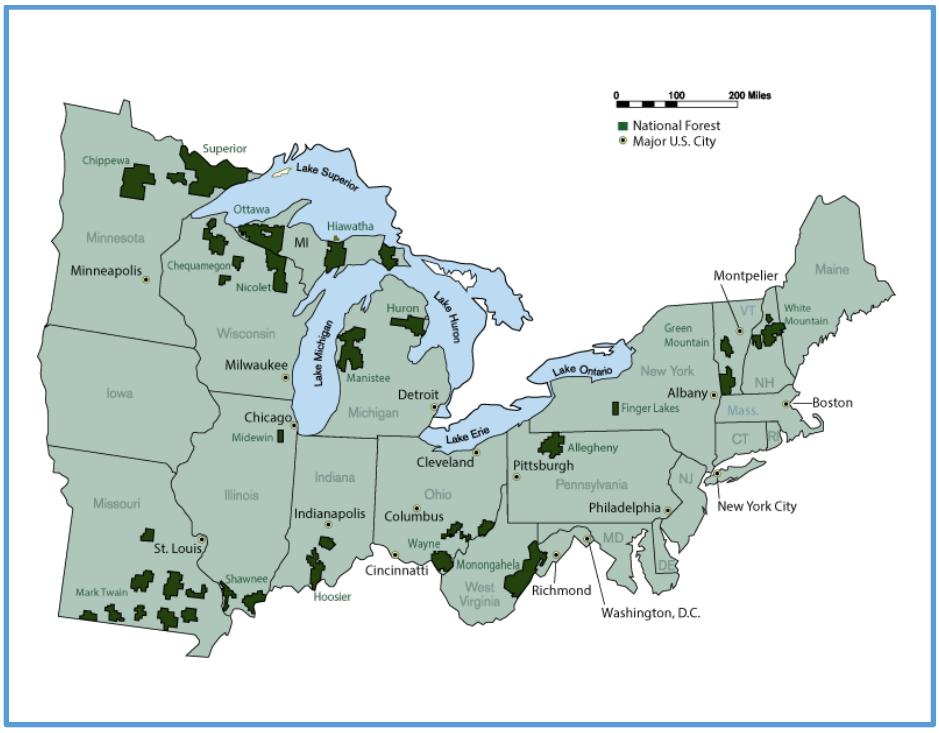

Figure 1. The Eastern Region of the U.S. Forest Service.

Introduction

Monarch butterflies (*Danaus plexippus*) are an iconic species on the North American landscape. For many generations, these large, brightly colored butterflies have been a common sight along roadsides, shorelines, and most other open habitats in both urban and rural areas. However, the North American population of monarch butterflies has declined significantly since robust annual monitoring first began in 1994. This population decline has prompted international concern for the long-term viability of monarch populations and for the continuation of their unique multi-generational migration. A recent analysis found that the risk of quasi-extinction of monarchs (defined as loss of a viable migratory population) over the next 20 years, was between 11% and 57% (Semmens et al. 2016).

In 2008, an international Commission developed the North American Monarch Conservation Plan, which outlined broad strategies for monarch conservation, listed known threats, and recommended conservation actions (Commission for Environmental Cooperation 2008). Implementation of U.S. efforts in this continental-scale plan is coordinated by the Monarch Joint Venture through partners, including the USDA Forest Service.

In June of 2014, the White House released the "Presidential Memorandum—Creating a Federal Strategy to Promote the Health of Honey Bees and Other Pollinators," which established a National Pollinator Health Task force, and directed federal agencies to take specific measures to substantially expand pollinator habitat on federal lands.

The Pollinator Health Task Force released the "National Strategy to Promote the Health of Honey Bees and Other Pollinators" in May 2015. This document provided three overarching goals, including one specific to monarch butterflies: *"Increase the Eastern population of the monarch butterfly to 225 million butterflies occupying an area of approximately 15 acres (6 hectares) in the overwintering grounds in Mexico through domestic/international actions and public-private partnerships, by 2020."*

In the August of 2014, a coalition of groups petitioned the U.S. Fish & Wildlife Service (USFWS) to list the monarch butterfly as threatened under the Endangered Species Act (Center for Biological Diversity et al. 2014). In December of 2014, the USFWS issued a 90-day finding that listing may be warranted. The species status assessment is underway, and a listing decision should be complete by June of 2019. Canada has classified monarchs as a species of Special Concern under the Species at Risk Act.

Meanwhile, a number of public agencies, including Natural Resources Conservation Service (NRCS), U.S. Geological Survey (USGS) and USFWS, and private and non-profit organizations have been working toward monarch conservation through monitoring, outreach, and habitat protection and improvement. Many of these organizations coordinate and collaborate under the umbrella of the Monarch Joint Venture. The wide range of organizations working toward monarch conservation has created many opportunities for partnerships and collaboration, some of which we identify in this plan. In 2014, a consortium of scientists and conservation professionals from government agencies, academia and non-profit organizations formed the Monarch Conservation Science Partnership (MCSP), which has worked on several projects to understand threats to monarch populations at the landscape level, model population trends, and develop conservation tools. Recently the MCSP has conducted an extinction risk analysis, and developed monarch conservation mapping tools that were used to prepare several of the maps in this plan.

In 2015, The Xerces Society for Invertebrate Conservation and NatureServe evaluated the level of imperilment for eastern and western monarch populations for the U.S. Forest Service. The resulting "Conservation Status and Ecology of the Monarch Butterfly in the United States" (Jepsen et al. 2015) identified the most important factors in the decline of eastern monarch populations, and provided a set of management recommendations. Using this status assessment, the Forest Service developed the document "*Conservation and Management of Monarch Butterflies: A Strategic Framework."* This framework provides broad strategies for using available resources and engaging public and private partners to take action for the conservation of monarchs.

Because the Eastern Region encompasses the heart of the monarch breeding range, national forests/prairie in this region have an opportunity to play an important role in monarch conservation. ***The purpose of this plan is to distill the broad strategies in the above multi-national, national, and agency-wide strategies into specific, prioritized goals, strategies, and resources that national forests/prairie in the Eastern Region can employ to conserve monarchs.*** Our intent is to combine the relevant information in existing broad-scale plans with region-specific data to provide a planning tool that can be used at the forest/prairie and regional level to identify and prioritize conservation actions that address the threats most relevant to monarch populations in the Eastern Region. Monarch conservation is an active area of research. Because new information regarding monarch ecology and threats becomes available regularly, this document is intended to be a living document, updated periodically to incorporate new knowledge and tools.

Monarch butterflies are one of many pollinator species facing population declines. While some aspects of monarch life history and habitat are unique to this species, many of the characteristics of high quality monarch habitat in the Eastern Region will also benefit many other pollinator species. Similarly, many of the threats facing monarchs also impact other pollinator species. In this way, monarchs are a familiar and charismatic species that can serve as a surrogate for other pollinator species, and conservation actions taken to conserve monarchs will also conserve a host of pollinator species.

Species Ecology and Status

This section provides a very brief overview of monarch ecology and population status, with a focus on the eastern monarch population. For a more thorough review of monarch ecology and life history, many references are available in books and online, including Conservation Status & Ecology of Monarchs in the United States (Jepsen et al. 2015), the North American Monarch Conservation Plan (Commission for Environmental Cooperation 2008), and the Monarch Joint Venture website (http://monarchjointventure.org/). Helpful information sources can also be found in the Recommendations section and Appendix 1. The following information is largely excerpted from these sources.

Monarch Biology

Monarch butterflies, *Danaus plexippus*, are large nymphalid butterflies with four life stages: egg, larva (caterpillar), pupa (chrysalis), and adult. Males and females are slightly different in appearance, with males having small pouches on the hind wings to store pheromones and females having thicker black veining. Eggs are laid, usually on milkweed leaves, and hatch in 3-6 days into a tiny striped caterpillar. The larva feeds exclusively on milkweed, and grows with molts through five instars for about 2 weeks. It then forms into a chrysalis, where it undergoes metamorphosis to an adult. That process takes about 10

days. The adult emerges and spends a few hours drying its wings and expanding its body. Then, it is ready to fly off and feed on nectar, mate and, if female, lay eggs.

Figure 2. A monarch dries its wings after emerging from a chrysalis. (Photo credit: Matthew Bushman, USDA Forest Service)

Distribution

The range of monarch butterflies in the Americas stretches from southern Canada to northern South America. The core of this range is in North America. In the United States, monarchs occur in two main populations with limited mixing between the two. The western population is located primarily in California, with smaller numbers occurring throughout the western states and British Columbia. The eastern population breeds east of the Rocky Mountains and winters in central Mexico. Small non-migratory populations of monarchs also occur in southern Florida, in Mexico, and on some Caribbean islands.

Migration

North American monarchs complete an extraordinary multi-generational migration each year. This section will focus on the migration of the eastern population only.

The eastern population of monarch butterflies overwinters in about 20 hectares (50 ac) of high-elevation oyamel fir (*Abies religiosa*) forest in central Mexico (Michoacan and Mexico states). Each spring, in late February or early March, they begin migrating north (Figure 2). When they reach areas with milkweed in northern Mexico and the southern U.S., they begin mating and laying eggs as they continue their migration. Survival of this first generation of offspring is very important, as this generation begins the rebuilding of population after winter losses. The first generation of offspring from the overwintering population continues the journey from the southern U.S. to recolonize the eastern breeding grounds. Second, third, and fourth generations reproduce in the northern breeding grounds throughout the summer, inhabiting most of the eastern U.S. up to southern Canada by June or July. The summer breeding range for monarchs includes most of the central and eastern U.S., with the core of breeding range in the "corn belt" of the midwestern U.S. (i.e., Kansas, Nebraska, Iowa, Missouri, Wisconsin, Illinois, Michigan, Indiana, and Ohio; see Figure 3).

Summer generations of adult monarchs begin breeding within a few days of emerging from the chrysalis, and live two to five weeks. Most monarchs that emerge after mid-August in the eastern U.S. become part of the migratory generation. This last generation of summer adults does not breed after emerging. Instead, they enter reproductive diapause and begin migrating south, a journey that can span thousands of miles. As this generation migrates, they feed on nectar plants along the way, both to fuel their flight and to build fat stores that they will live on over the winter. The migratory generation ends their journey back at the wintering grounds in central Mexico. This final migratory generation can live up to nine months, overwintering and beginning the migration north again to breed in early spring.

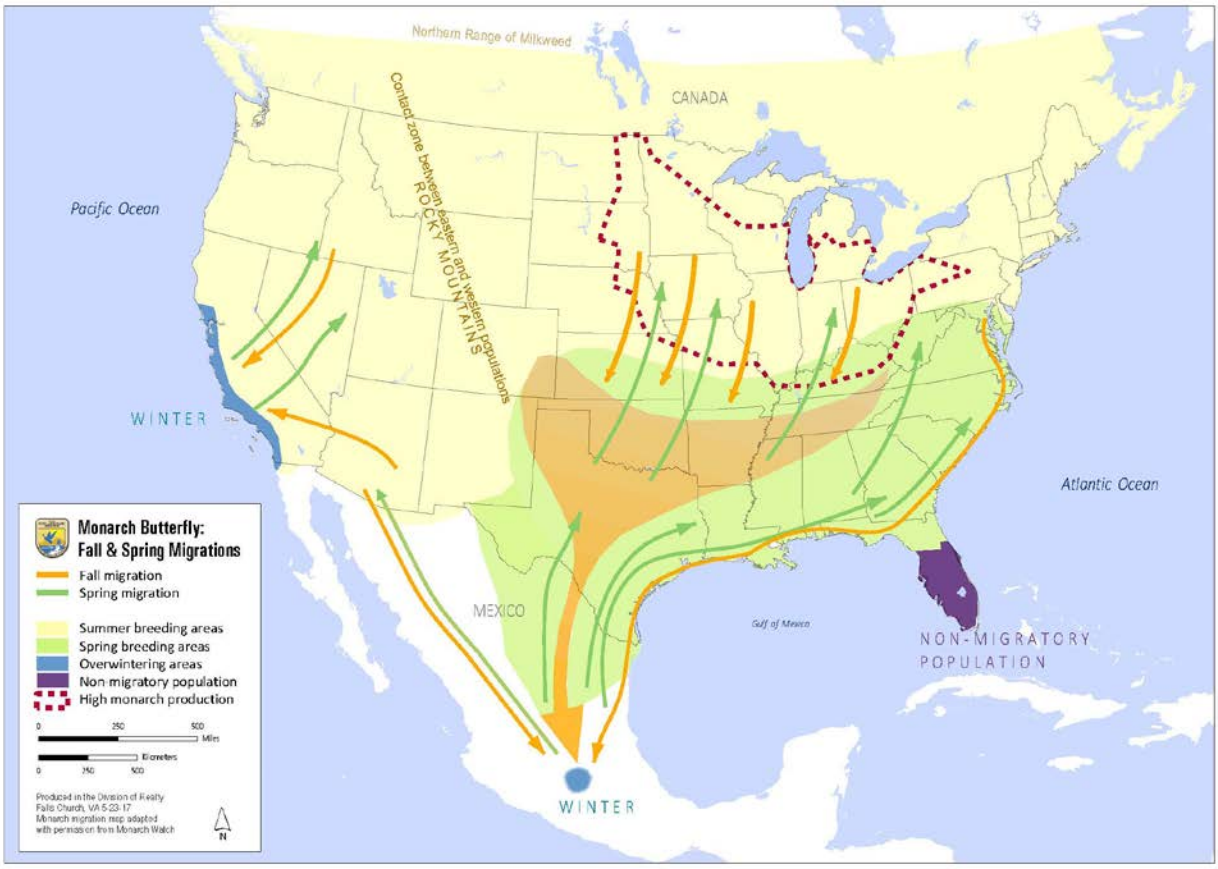

Figure 3. Monarch butterfly fall and spring migration routes, breeding areas and overwintering areas. Source: U.S. Fish & Wildlife Service.

The migration of monarchs is tracked each year by citizen scientists and researchers, and the northward and southward migration can be viewed in real time at the Journey North website. The northward migration is relatively diffuse, spreading out across about 247 million acres of the eastern U.S. north of Texas. The southward migration happens throughout the breeding grounds and funnels into a "central flyway" from southern Ontario, Canada, through Kansas, Missouri, Arkansas, and Oklahoma, then south through Texas and central Mexico. There is a second flyway along the east coast; however, many of these butterflies may migrate through Florida and on southward, with few reaching Mexico (Flockhart et al. 2017). Because migrating monarchs follow topographic features such as shorelines of large lakes, there are a few known stopover sites, where monarchs can be observed congregating every year. This includes Peninsula Point on the Hiawatha National Forest, where southward-migrating monarchs congregate before crossing Lake Michigan, (see pages 4-5 of Conservation and Management of Monarch Butterflies: A Strategic Framework for description of the Peninsula Point congregation area and work being done there). Similarly, congregations of monarchs are regularly observed along the Wisconsin and Lower Michigan shorelines of Lake Michigan. Monarchs also form transient congregations during migration at locations with abundant nectar plants and roost trees. Such congregations have been observed at the Midewin National Tallgrass Prairie and the Wayne National Forest.

Habitat Requirements

Along their migration routes and in their summer breeding areas, monarch butterflies require two types of plants: host plants for monarch caterpillars, which are almost exclusively milkweeds (*Asclepias* spp.), and flowering plants that provide nectar for adult butterflies. Having both host and nectar plants available throughout the times when monarchs are present is critical.

Monarch caterpillars require milkweeds as host plants. Milkweeds provide both nutrition and toxins that protect the caterpillars and adults from predation. While monarchs can use a variety of milkweeds as host plants, the four priority milkweed species for habitat restoration in the Eastern Region are common milkweed (*Asclepias syriaca*), swamp milkweed (*A. incarnata*), whorled milkweed (*A. verticillata*), and butterfly weed (*A. tuberosa*). It has been estimated that over 90% of the monarchs wintering in Mexico fed on common milkweed as larvae (Malcolm et al. 1993). The age and density of milkweed as well as patch size affect use by monarchs. For example, more eggs are laid per plant on milkweed in smaller patches (Oberhauser et al. 2001; Zalucki and Lammers 2010), and younger leaves tend to support higher densities of monarch eggs (Oyeyele and Zalucki 1990; Agrawal et al. 2012), but higher densities of eggs do not always lead to more adult monarchs (Nail et al. 2015; Stenoien et al. 2015).

Figure 4. Monarch butterfly (Photo credit: Melissa Simpson, USDA Forest Service)

While important throughout the breeding season, nectar sources are particularly critical during migration. During the fall migration, monarchs need carbohydrates to fuel their flight and to build up fat reserves for the winter, when they feed very little or not at all. A variety of flowering plants are used during the fall migration. Some important late-flowering nectar sources include goldenrods (*Solidago* spp.), asters (*Aster*, *Symphyotrichum* and *Eurybia* spp.), blazing stars (*Liatris* spp.), and coneflowers (*Echinacea* spp.). Agricultural crops including alfalfa, clover, legumes, and sunflowers are also important nectar sources for monarchs particularly along the migration pathway. Generally, butterflies prefer nectar plants that provide clustered florets, short corolla tubes, and have colors including pink, yellow, white, red and purple. Adult monarchs are not picky: in a study in Illinois, they were found to feed on 61 different nectar plants while many butterflies in the study fed on an average of 9-18 species (Tooker et al. 2002).

During migration, monarchs make frequent stops to rest and refuel. At these stopovers, they form communal roosts, which are usually in trees. An analysis of citizen science observations of these roosts found that 90% of roosts were in trees; conifers and maples were used most often in northern flyway regions, while pecans and oaks were more frequently used in southern regions. The authors did not find strong associations with any landscape attributes and concluded that monarchs are highly adaptable in terms of roost selection (Davis et al. 2012).

Eastern monarchs spend the winter in dense clusters on oyamel fir trees in cool, high-elevation forests of central Mexico. These dense forests provide a narrow range of temperature and precipitation conditions that monarchs favor. There are fewer than 20 known overwintering sites (in the states of Michoacan and Mexico), and many of these are considered inactive. In recent winter surveys, the majority of monarchs were concentrated in just two winter colonies (Vidal and Rendon-Salinas 2014). The Monarch Butterfly Biosphere Reserve (MBBR) was established in 1980 to protect the integrity of monarch overwintering sites, primarily by preventing logging. This reserve encompasses eight of the winter colonies, and approximately 70% of the eastern monarch overwintering population. Interestingly, monarchs tagged at Peninsula Point, on the Hiawatha National Forest, have all been found at the El Rosario sanctuary, which contained 43% of all overwintering monarchs during the winter of 2010-2011 (Janet Ekstrum, personal communication, 2016).

Population Status

The North American monarch population shows high annual variability, but a clear downward trend since monitoring began in 1994 (Figure 5). Annual surveys of the western monarch population overwintering on the California coast have also seen a nearly 90 percent decline during the past decade.

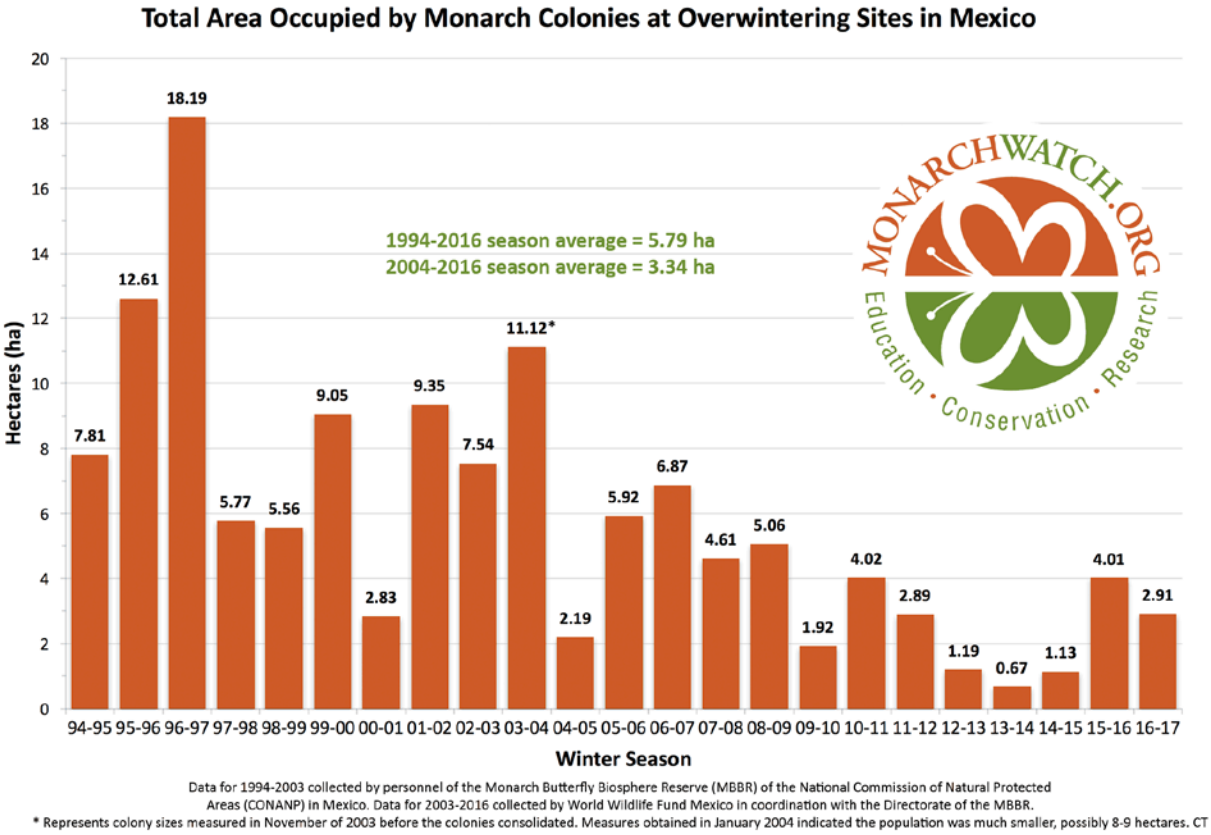

Figure 5. Total area occupied by overwintering monarch populations since monitoring began in 1994. Source: Monarch Watch, 2016 (http://monarchwatch.org/)

The best available estimate for the eastern monarch population is the number of individuals at the overwintering sites. This estimate is calculated by multiplying the area covered by monarchs by a density, which is estimated to be 30-50 million monarchs per hectare. In 2013, the annual estimate

reached a new low of approximately 33.5 million individuals, covering just 0.67 hectares (1.66 acres). The population has rebounded modestly since then, to approximately 200 million monarchs (4.01 ha, 9.9 ac) during the winter of 2015-2016.

A recent analysis found that the risk of quasi-extinction of monarchs over the next 20 years was between 11% and 57% (Semmens et al. 2016). In this study, quasi-extinction was defined as loss of a viable migratory population of monarchs in eastern North America. The same study estimated that in order to halve this risk, the monarch population would need to increase approximately 5-fold (relative to the winter of 2014–15). The U.S. Fish and Wildlife Service has recommended monarch conservation work focusing on geographic priorities, opportunity areas, and threats to be avoided (Figure 6).

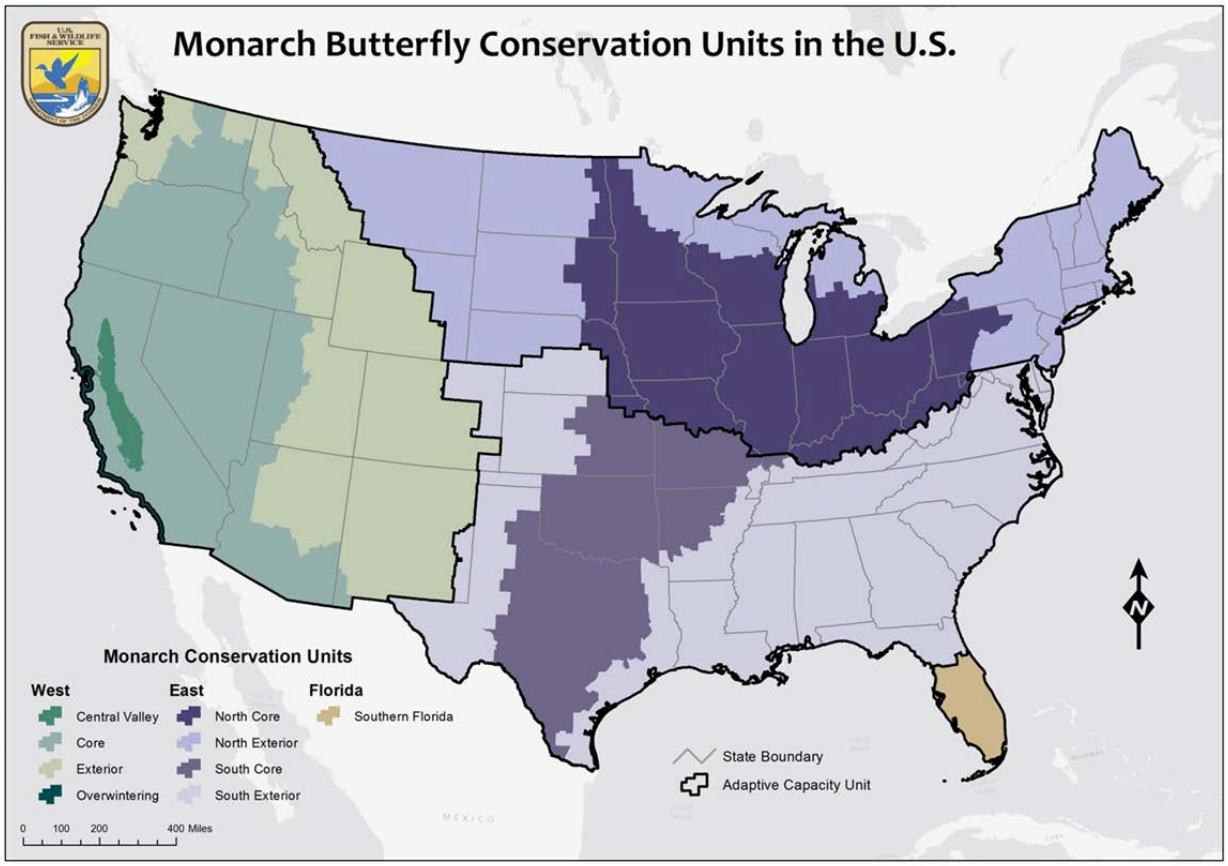

Figure 6. Monarch butterfly conservation units as defined by the U.S. Fish & Wildlife Service. The dark purple "North Core" unit constitutes the primary breeding range of monarchs in the eastern U.S., with secondary breeding habitat found in the "North Exterior" unit. The "South Core" represents the core of the migratory corridor for monarchs.

The Role of Lands within the Eastern Region of the Forest Service

The national forests/prairie of the Eastern Region all lie within the breeding range of monarch butterflies, and all provide migratory habitat during spring and fall migration (Figure 3). Tagging and isotope studies of the overwintering butterflies indicate that 18-58% (depending on the year) of the monarchs wintering in Mexico were born in the midwestern United States (Wassenaar and Hobson 1998; Flockhart et al. 2013; Flockhart et al. 2017). These studies indicate that there is annual variation in the productivity and importance of portions of the monarch breeding range, but the studies agree

that the midwestern (mean annual 38%), north central (mean annual 17%), and northeastern United States (mean annual 15%; Flockhart et al. 2017), areas encompassed by the Eastern Region, provide critical breeding habitat for monarch butterflies. As such, the Forests within the Eastern Region can play an important role in the conservation of monarchs.

The following map (Figure 7) shows the national forests/prairie within the Eastern Region, overlaid with the breeding range of monarchs in the United States. Based on previous isotope analysis, approximately 50% of all monarchs at the overwintering sites were found to originate from the area in blue, an additional 45% from the area in yellow, and an additional 5% from the area in green. (The yellow and green areas extend into Canada, although this is not displayed on the map.) More recent analyses have demonstrated that this is a simplified model, and there is substantial annual variability in the productivity of sub-regions within the monarch breeding range (Flockhart et al. 2017). Nonetheless, this map suggests that monarch breeding is occurring throughout the Eastern Region, and forests in the heart of the breeding range, including the Mark Twain, Shawnee, Hoosier, Wayne, Monongahela and Allegheny, may have higher densities of breeding monarchs. Northern Eastern Region forests in the yellow area may have increasingly important roles to play as climate change forces shifts in monarch and milkweed ranges. Lemoine (2015) found that the range of milkweed is likely to expand northward into Canada with the southern U.S. becoming less suitable. Note that, other than for Peninsula Point, Forest-specific data on monarch occurrence is very limited, and was not included in the mapping.

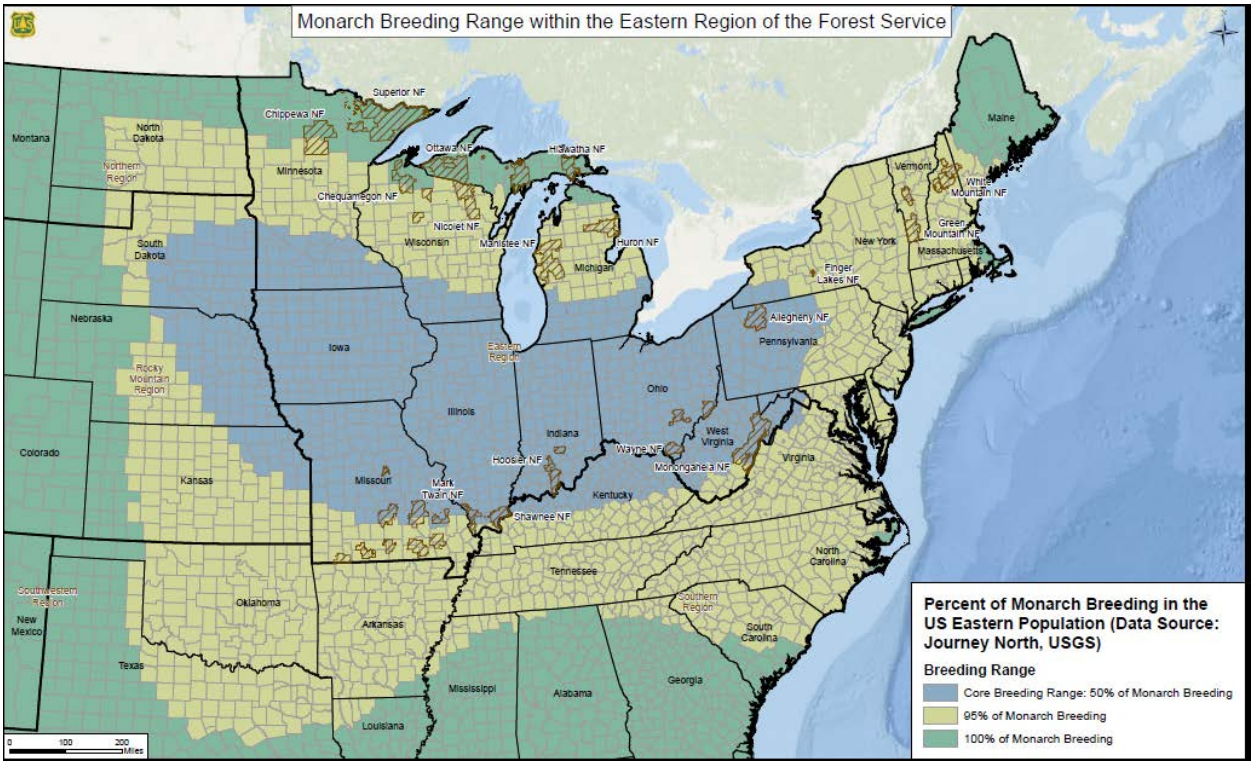

Figure 7. Forests within the Eastern Region of the Forest Service overlaid with the breeding range of the monarch butterfly in eastern North America. The blue area represents the breeding range within which 50% of the wintering monarchs in Mexico are produced. The yellow area represents the area within which an additional 45% of wintering monarchs are produced. The green area represents the range within which an additional 5% of monarchs are produced. The yellow and green areas extend into

Canada, though this is not shown on the map. A full-size version of this map can be found on the R9 Renewable Resources Sharepoint site here.

Historically, milkweed in agricultural areas served as an important source for monarch production (Pleasants and Oberhauser 2012). However, non-agricultural areas such as roadsides, rights-of-way, gardens, old fields, and forest openings also provide important monarch breeding habitat, especially where other habitat is scarce and if wildlife-friendly management practices are employed (Kasten et al. 2016). While most units in the Eastern Region are dominated by forest, all units also manage suitable or potential monarch habitat in the form of openings, open woodlands, riparian areas, wet meadows, prairies, grasslands, rights-of-way, roadsides, and administrative sites. Collectively our greatest opportunity to improve habitat for monarchs may be in those areas not traditionally managed for wildlife habitat, such as roadsides and rights-of way.

The contribution of non-agricultural monarch habitat will be more important as agricultural fields are increasingly planted to genetically-modified crops that can be sprayed with pesticides, thereby eliminating milkweeds; as neonicotinoid use on agricultural lands increases; and as suitable habitat is made unsuitable due to development (see Threats section, below). From 1999 to 2012, there has been an estimated 64% decline in overall milkweed abundance, which has primarily occurred on croplands (Pleasants 2015). Milkweed in agricultural fields produces nearly four times as many monarchs as milkweeds elsewhere (Pleasants and Oberhauser 2012), suggesting there is a strong need to provide abundant replacement milkweed plants on other landscapes such as national forests.

The vegetation managed by National Forest System lands also supports nectar plants which provide the essential lipid stores as fuel for the monarchs' long migration. The following maps show migration through the Eastern Region as documented by the citizen science program Journey North. Eastern Region Forests/Prairie can support migrating monarchs by providing early- and late-blooming nectar plants for monarchs during the time migrating monarchs are passing through, particularly in the southern part of the region (Mark Twain, Shawnee, Hoosier, Wayne, and Monongahela). Because monarchs follow geographic features, national forests along the Great Lakes shorelines may also be part of important migratory pathways for monarchs. The spring and fall migration maps below (Figures 9 and 10) show the earliest dates monarchs are observed during spring migration, and the peak of fall migration. These dates can help guide plant species selection for supplemental planting, to ensure nectar plant availability during migration.

Figure 8. Chrysalis emerging as caterpillar skin splits. (Photo credit: Sue Trull, USDA Forest Service)

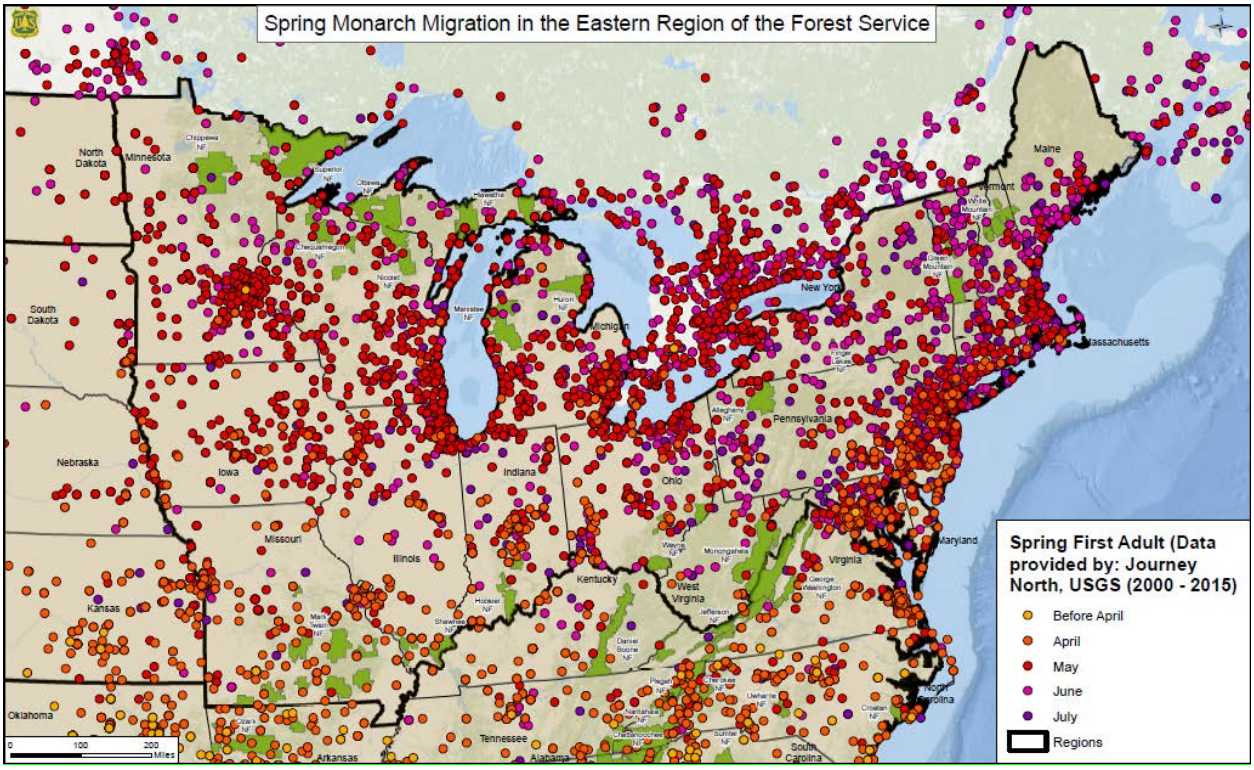

Figure 9. Map of first monarch observations during spring migration displayed by date. Data are citizen science observations collected by the Journey North program. Eastern Region units are displayed in solid green. A full-size version of this map can be found on the R9 Renewable Resources Sharepoint site here.

Monarchs stop often during migration, and form temporary communal roosts, particularly during the fall migration. These roosts are ephemeral, and may not be located in the same place each year. The large expanse of restored prairie at Midewin Tallgrass Prairie is a place monarchs rest and feed on their long flight south. Monarchs are regularly observed during migration, feeding during the day and roosting in nearby trees at night. Similarly, staff on the Wayne National Forest have observed monarchs congregating at Shawnee Grassland and Holmes Wetland during some years. There are also a few known locations where migrating monarchs congregate every year during migration. One such stopover site is Peninsula Point, on the Hiawatha National Forest. Migrating monarchs congregate on the white cedar trees of this peninsula before crossing Lake Michigan on their journey south. This location is both an important stopover and a location where population monitoring and tagging occurs annually. The Hiawatha National Forest thus has an important role in keeping roost trees and nectar forbs present at Peninsula Point.

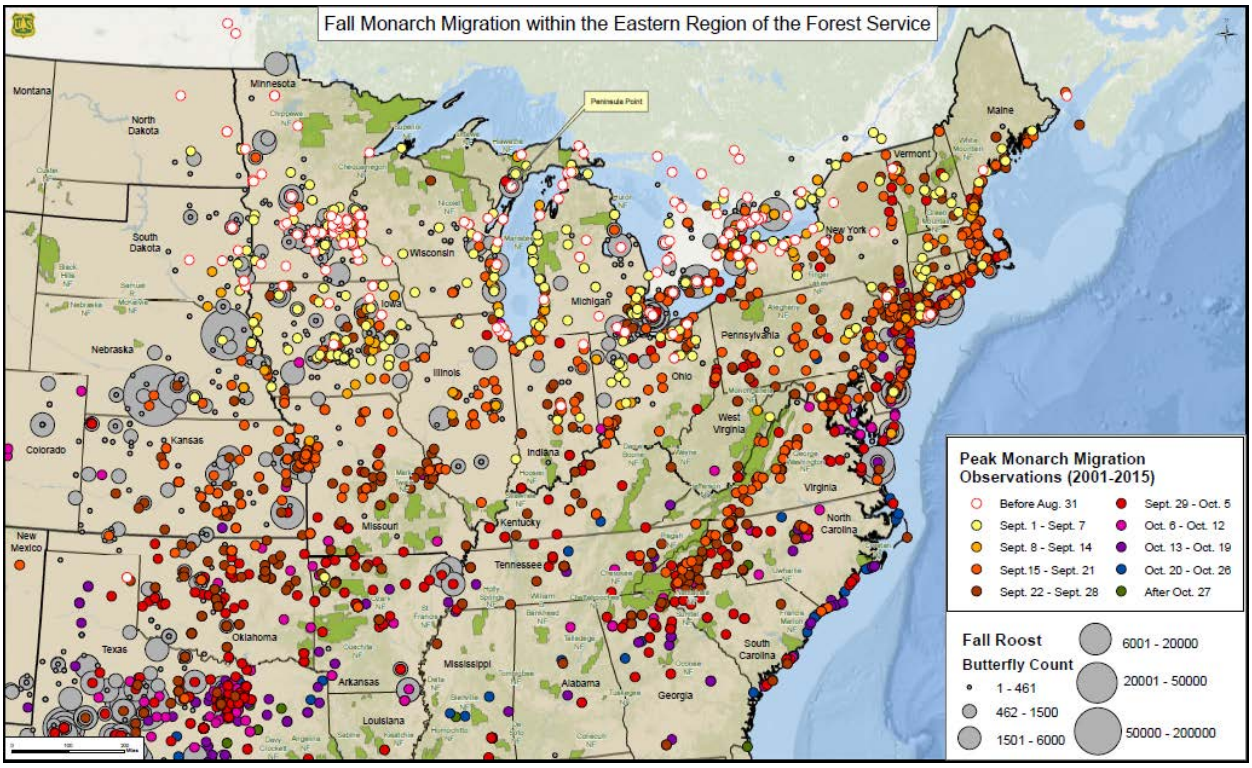

Figure 10. Map of estimated peak monarch migration dates during fall migration. Temporary communal roosts are displayed in grey circles with size indicating approximate number of monarchs observed. Data are citizen science observations collected by the Journey North program. Eastern Region units are displayed in solid green. A full-size version of this map can be found on the R9 Renewable Resources Sharepoint site here.

National forests/prairie in the Eastern Region consist of federal lands intermixed with other ownerships, including private, state, tribal, and county ownerships. This setting suggests both an opportunity and a need to work collaboratively with other agencies and landowners to address conservation needs such as monarch habitat management. Regardless of their geographic location relative to the monarch breeding range and migratory routes, Eastern Region national forests/prairie can serve as leaders for local entities in demonstrating application of best management practices (see Appendix 1), the use of native plants for gardens and restoration work, and education and outreach regarding monarch and pollinator conservation. See Appendix 3 for a list of partners that Eastern Region forests have worked with to conserve monarchs.

Threats to Monarch Survival and Reproduction

Several factors have been identified as contributing to monarch population declines, including loss and degradation of breeding habitat (particularly loss of milkweed); loss and degradation of winter habitat; pesticides, parasites and disease; climate change; extreme weather events; overutilization of monarch butterflies (commercial, recreational, educational, and scientific purposes); and inadequate existing regulatory mechanisms (Center for Biological Diversity et al. 2014). There is ongoing debate regarding the relative importance of these factors in causing the monarch population decline.

A NatureServe conservation assessment of monarch butterfly populations in the United States concluded that the three factors that appear most important to explaining the decline of eastern monarchs are loss of milkweed breeding habitat due to land conversion and increased use of herbicides on genetically modified crops; logging at overwintering sites; and climate change and extreme weather (Jepsen et al. 2015).

Figure 11. Common milkweed in meadow. (Photo credit: Scott Pearson, USDA Forest Service)

Flockhart et al. (2014) found that monarch population declines stem primarily from reductions in milkweed host plants on the breeding grounds rather than climate change or degradation of winter habitat. Similarly, Pleasants and Oberhauser (2012) correlated declines in winter monarch populations to declines in milkweed abundance in the midwestern United States and concluded that loss of agricultural milkweeds is a major contributor to the decline of monarch populations. Pleasant et al. (2016) concluded from their analysis that the main population loss is during the breeding season on agricultural fields treated with herbicides, which significantly reduce the amount of milkweed present. However, Inamine et al. (2016) analyzed long-term data from four citizen science monitoring programs to evaluate monarch population declines and concluded that lack of milkweed is unlikely to be driving the monarch population decline. In their view, fall migration and overwintering are the most critical times, and degradation at the overwintering sites, lack of nectar sources, and fragmentation along fall migration routes, or other threats to successful fall migration, are the limiting factors for monarchs. Clearly, these differing conclusions suggest different conservation priorities. However, there is no disagreement that creating additional habitat that includes both milkweed and nectar resources will benefit monarchs and other pollinators.

Researchers using different field data sets, assumptions, and models have reached different conclusions regarding the cause of the monarch population decline, resulting in an active, ongoing debate in the scientific community as to the types of data to use, methods to estimate monarch populations on the breeding grounds, and how to interpret this data (e.g. Pleasants 2016; Brower et al. 2012a and 2012b). However, most researchers agree that there is a decline in the overall population of monarchs. Evaluating the relative merits of the data sources, assumptions, and models is beyond the scope of this plan or the expertise of its authors. We recognize that there is ongoing scientific debate about the primary cause of the monarch population decline, and have attempted to build a strategy that will benefit monarchs even in light of this uncertainty. This strategy will briefly discuss all of the identified threats to monarch populations, and will focus on those that we can address within the geographic

boundaries of the Eastern Region, primarily threats on the breeding grounds and during migration. The following subsections describe the major threats contributing to monarch population declines. The information in these sections is adapted primarily from *Conservation Status & Ecology of Monarchs in United States.* (Jepsen et al. 2015), and supplemented with information from several other sources (see references).

Breeding & Migratory Habitat Loss and Degradation

Loss of milkweed and nectar plants: In the Eastern Region, milkweeds (*Asclepias* species) are the sole native host plants for monarch caterpillars, making them a critical component of breeding habitat. A variety of nectar-producing plants are also required in both migratory and breeding habitat to provide food for adult monarchs. Milkweed and many nectar plants are opportunistic species, flourishing in open habitats, including farm fields, roadsides, and other disturbed habitats. However, changes in management practices have reduced habitat for milkweed substantially in the central U.S (Hartzler 2010; Pleasants and Oberhauser 2012). This decline in milkweed has resulted primarily from widespread adoption of genetically modified, herbicide-tolerant (e.g. "Round-Up Ready") crops. These crops can withstand spraying with glyphosate, a broad-spectrum herbicide that kills most other plants, leaving treated agricultural fields barren of "weeds," including milkweed and other nectar plants. The following graph (Figure 12) shows the dramatic increase in glyphosate use on agricultural crops in the United States between 1992 and 2014 (Source: USGS 2016)

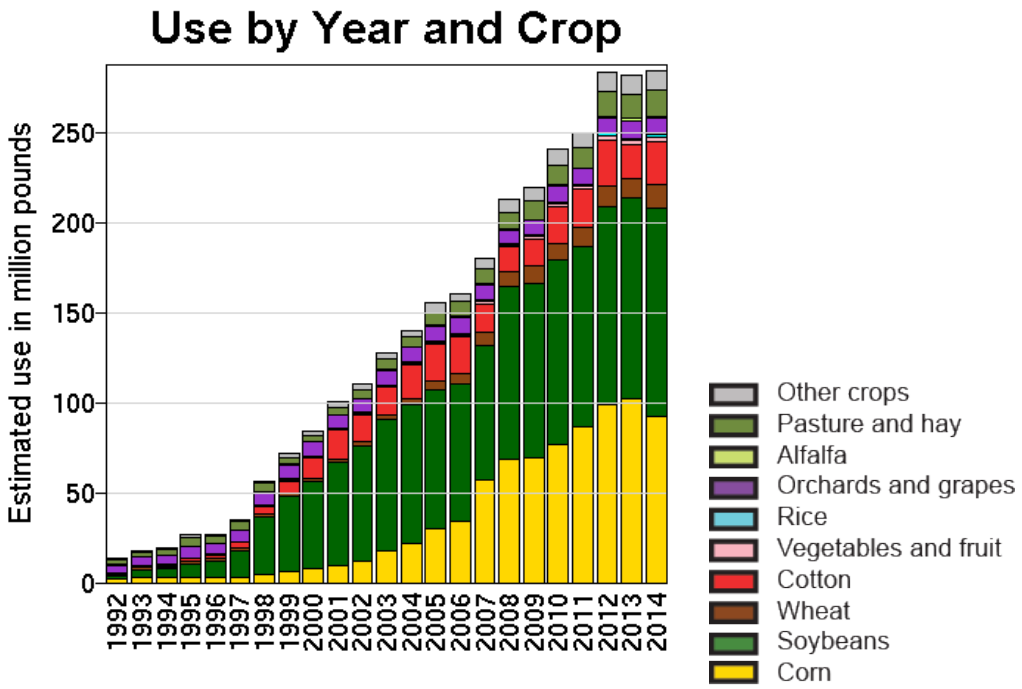

Figure 12. Use of glyphosate herbicide in the United States from 1992 to 2014. Graph shows a greater than 10-fold increase in glyphosate use, primarily on corn and soybean crops. Source: U.S. Geological Survey (2016).

This expanded use of herbicides in agricultural lands coincides with the core of the monarch breeding range. The following map shows the density of glyphosate use across the United States in 2013 (Figure 13, Source: USGS 2016)

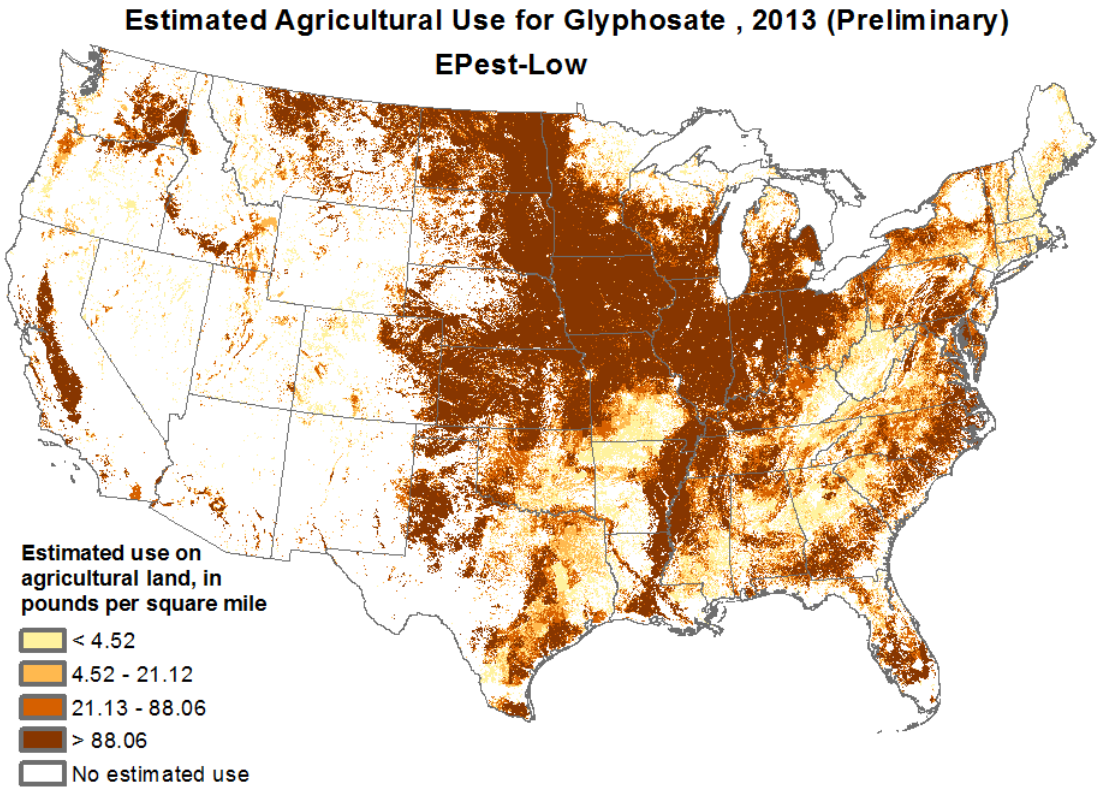

Figure 13. Map of the density of glyphosate use across the United States in 2013. The highest density of glyphosate application coincides with the core of the monarch breeding range. Source: U.S. Geological Survey (2016).

Pleasants and Oberhauser (2012) found an 81% decline in milkweeds in midwestern agricultural lands over a decade, coincident with the increase in the use of the herbicide glyphosate on genetically modified crops. Several studies have concluded that the decline of milkweed in agricultural areas of the monarch breeding range is the major contributor to the monarch population decline observed at overwintering sites (Pleasants and Oberhauser 2012; Flockhart et al. 2014), due in part to the disproportionately large role of agricultural milkweed in supporting monarchs (Pleasants and Oberhauser 2012). Crops engineered to be resistant to additional herbicides, such as dicamba, are under development (Mortensen et al. 2012), which may further decrease the availability of milkweed and nectar plants on crop lands.

The Monarch Conservation Science Partnership used multiple approaches to estimate the number of milkweed stems that would need to be added to the breeding landscape in order to substantially reduce the threat of extinction for monarchs. Their analysis indicates that 1.4 billion additional stems of milkweed would be needed. They then tested different conservation scenarios or 'storylines' where different land sectors or combinations of sectors added milkweed to the landscape. They found that

while participation from the agricultural sector is germane to meeting the 1.4 billion milkweed stems target, even with modest participation from the agricultural sector, if all other sectors participate, we can get close to an additional 1.0 billion stems on the U.S. landscape. Therefore, it is important that milkweed restoration occurs on non-agricultural lands in addition to addressing agricultural issues.

While most studies have focused on the loss of milkweed, the same changes in agricultural practices that have led to a loss of milkweed have had a similar effect on many nectar plants. Additional threats to milkweed and nectar plant habitat include pesticide drift, excessive or ill-timed roadside mowing, use of road salt (Snell-Rood et al. 2014), and development and reforestation (Oberhauser et al. 2006; Oberhauser et al. 2009).

A related issue is the loss of native habitats that support monarch breeding and migration. Between 2008 and 2011, approximately 23.6 million acres were converted from wetlands, rangelands and shrub-lands to crops, largely in the eastern U.S. (Taylor 2014). Lands that were in the conservation reserve program have been put into corn production as demand for biofuels has increased. An additional 2 million acres of potential habitat is lost to development each year. Taylor (2014) estimates the total monarch habitat loss to be 167 million acres since 1996. Conversion of native habitats to cropland or developed land reduces the availability of both milkweed and nectar plants for breeding and migrating monarchs. Development also brings additional risks to breeding and migrating monarchs, including increased risk of vehicle collisions and exposure to commercial and residential pesticide use.

Non-native invasive plants: Non-native invasive plant species compete with native plant species for space, light and water. Some are also allelopathic (toxic to other plants), further reducing the suitability of available habitat for native plants, including milkweeds and nectar plants. However, adult monarchs can and do use several non-native species for nectaring, such as Queen Anne's lace, forget-me-nots, exotic thistles, clovers, and alfalfa.

Two invasive European species in the genus *Vincetoxicum [Cynanchum]*, black swallow-wort and pale swallow-wort can, in some locations, attract female monarch butterflies to lay eggs on their stems and leaves. Monarch caterpillars cannot feed on black or pale swallow-wort plants. Caterpillars from eggs laid on these invasive plants will not survive. Therefore, swallow-worts in breeding habitat may act as a population "sink" for monarchs, enticing them to lay eggs that will not result in a new generation of monarchs. (Casagrande and Dacey 2007). Swallow-wort has been found at the Peninsula Point stopover site on the Hiawatha National Forest.

Figure 14. Monarch caterpillar on common milkweed. (Photo credit: Sue Trull, USDA Forest Service)

The cultivation of non-native tropical milkweed, also known as bloodflower (*Asclepias curassavica)* in the southern U.S. has allowed portions of the eastern monarch population to breed year-round rather than migrating. In Texas, coastal Alabama and other southern areas, bloodflower is thought to cause some southward-migrating monarchs to become reproductively active and either pause or end their migration. Some of these late reproducing monarchs can migrate to overwintering sites. However, non-native milkweeds that do not die back over winter can build up high concentrations

of OE (*Ophryocystis elektroscirrha*), a protozoan parasite that infects and weakens adult monarchs (see below).

Anthropogenic threats in breeding and migratory habitat: Management activities such as occasional mowing and prescribed burning can be important tools for improving and maintaining habitat for monarchs and other pollinators if implemented strategically. However, some management activities, or poorly timed management, can remove milkweed and nectar plants at critical times, or directly harm monarch eggs, larvae, pupae, or adults. Similarly, while roadsides can provide important monarch habitat, vehicle collision is a source of mortality for monarchs that use that roadside habitat, and larvae raised on milkweed that has taken up road salt show lower survival rates (Snell-Rood et al. 2014). Kasten et al. (2016) concluded that despite the potential hazards of roadside habitat, roadsides can contribute to the recovery of monarchs. Indeed, with loss of milkweed in crop fields, roadsides were estimated in 2014 to produce 35% of Midwest monarchs (based on Pleasants data, cited in Center for Biological Diversity et al. 2014).

Winter Habitat Loss and Degradation

Monarchs require dense and mature canopy cover from oyamel fir forests at their wintering sites, both as protection from extreme cold and storms and to maintain a cool temperature to conserve their stored lipids and maintain diapause. Logging, bark beetle outbreaks, and other forest alteration at or near the wintering sites can change the microclimate and reduce protection provided to wintering monarchs. Logging at the monarch wintering sites is largely banned now, though small amounts of legal and illegal logging continue.

Inamine et al. (2016) concluded that degradation of overwintering sites, along with threats to successful fall migration, are the primary causes of the overall monarch decline. Whether the primary cause of decline or simply a critical component of the monarchs' annual cycle, protecting and maintaining high quality habitat at overwintering sites is an important piece of monarch conservation.

Extreme weather events: Because eastern monarchs are concentrated in a very small geographic area (just 0.67 ha (1.6 ac) during the winter of 2013-2014), periodic winter storms can have big impacts on the overall population. Four extreme winter storms occurred between 2002 and 2016, bringing heavy rain, hail, high winds, floods, and freezing temperatures. These storms can both knock down trees and freeze and kill monarchs. Mortality from these events has ranged from 50-80%.

Atypical weather can also influence monarch survival and reproduction. Cool springs and wet cold summers can reduce egg laying and slow larval development, meaning the insects remain in the more vulnerable juvenile stages for a longer time, and fewer generations are produced. Cool and wet weather can also lead to increased fungal growth, resulting in a higher incidence of mortality in the chrysalis stage. Prolonged dry and hot spells can reduce the life span, size and fecundity of adults. Severe precipitation events can directly kill monarchs, particularly in unsheltered locations.

The availability of nectar plants along the flyways during spring and fall migration is also affected by weather. In drought years and cool springs, nectar plants may be limited or delayed. High spring precipitation in Texas is associated with the largest annual population growth of monarchs in Ohio (Zipkin et al. 2012), suggesting that spring droughts in Texas likely have a negative impact on the important, first generation of monarch butterflies born during spring migration.

Climate Change

It is difficult to predict how species will respond to climate change, particularly migratory species with a broad geographic range. Climate changes may result in a mismatch between the environmental cues that monarchs use to migrate and breed, and the availability of nectar and milkweed. On the other hand, the ability to migrate and move may increase monarchs' ability to adapt to changing habitat.

Changes in climate will impact the health, distribution and availability of plant species important to monarch populations. The high elevation oyamel firs on which monarchs overwinter are likely to experience stress from heat and drought, which is likely to make them more vulnerable to insects and disease. Climate change may also make some or all of the current winter habitats unsuitable (Oberhauser and Peterson 2003; Saenz-Romero et al. 2012), requiring monarchs to find new wintering locations either at higher elevations or further north. Current overwintering sites are already at high elevation, and presumably, less habitat will be available at higher elevations.

Many climate models predict increased summer mean temperatures in eastern North America, which could increase the suitability of northern latitudes for breeding in summer, especially if warming also allowed adults to reach these areas earlier than they do now. However, increased high temperatures in the southern, especially southwestern, part of the current breeding range could mean that region becomes less suitable due to higher temperatures or reduced availability of milkweed and nectar plants. According to Rawlins and Lederhouse (1981), constant temperatures between 88-96 °F are lethal for monarch larvae in the lab. They note that higher temperatures increase mortality, lengthen development time, and result in lighter weight adults.

With increasing temperatures, the range of milkweed is expected to shift north but this shift may not keep pace with monarch needs to shift north for temperature/development concerns. With more extreme weather, milkweed may be affected, since late frosts can kill milkweed (Brower 2009), meaning any monarch eggs already laid on the frosted milkweed will hatch and starve. The net impact of a potential shift of the primary breeding region northward is difficult to predict, although it would certainly lengthen an already long and hazardous migration and may require changes to migratory movements.

Lemoine (2015) modeled how distributions of both milkweed and monarchs would shift under high and moderate emissions scenarios (Figures 15 and 16). He concluded that current monarch summer breeding range will become slightly less suitable for milkweed and monarchs in the future. Both milkweed and monarch breeding ranges were predicted to expand northward, and suitability of habitat for monarchs during the northward migration is expected to decrease. The following maps display probability of monarch occurrence and milkweed occurrence within the Eastern Region under moderate (B1) and severe (A2) climate scenarios. They were produced using the Monarch Conservation Science Partnership planning tools, and are based on Lemoine (2015) models.

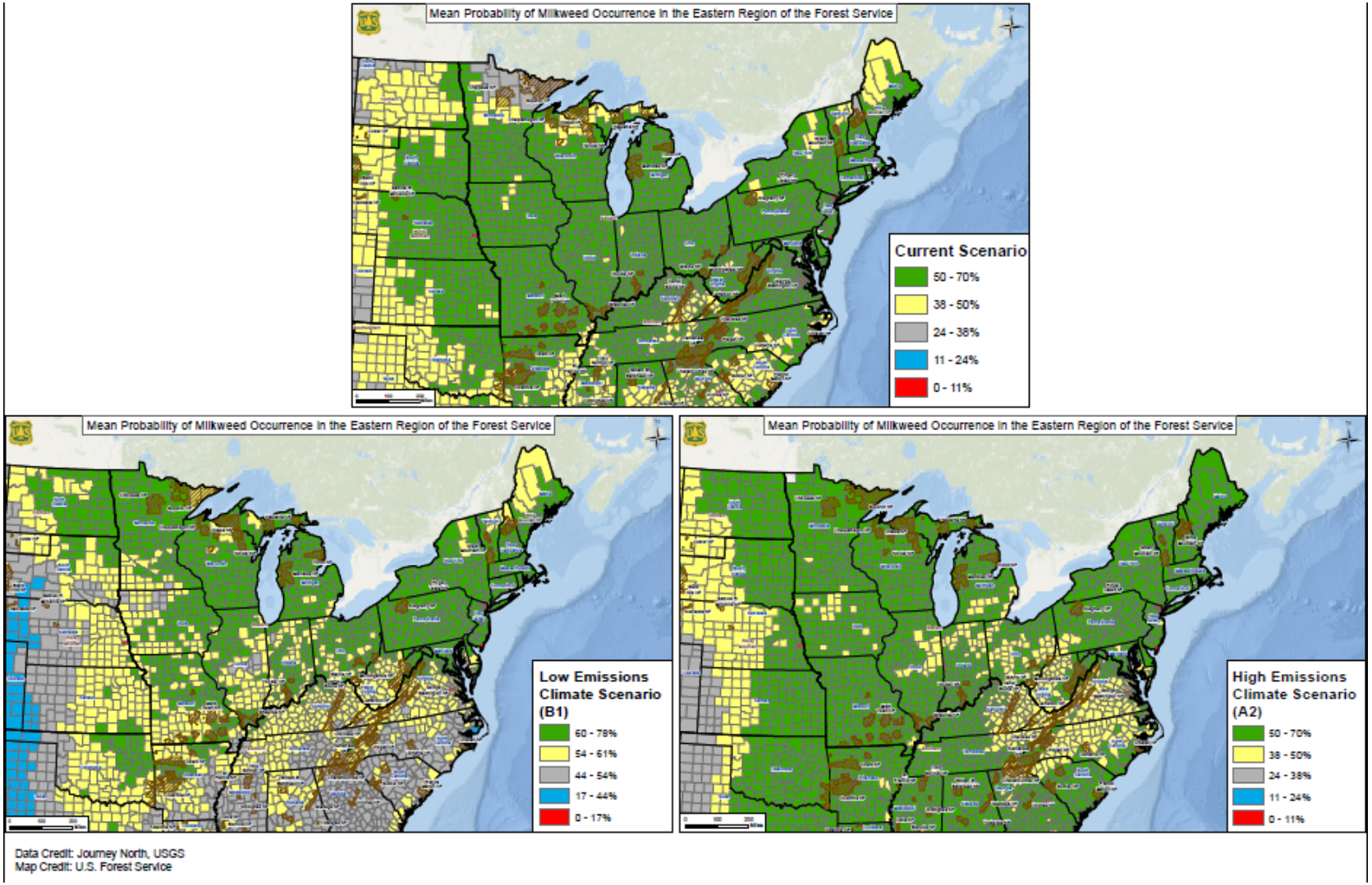

Figure 15. Probability of milkweed across the Eastern Region under current conditions, a moderate climate change scenario (B1) and a severe climate change scenario (A2). National Forests are represented by brown cross-hatching. Under both climate change scenarios, suitability for milkweed generally increases in the northern part of the region, and decreases in the southern part. A full-size version of this map can be found on the R9 Renewable Resources Sharepoint site here.

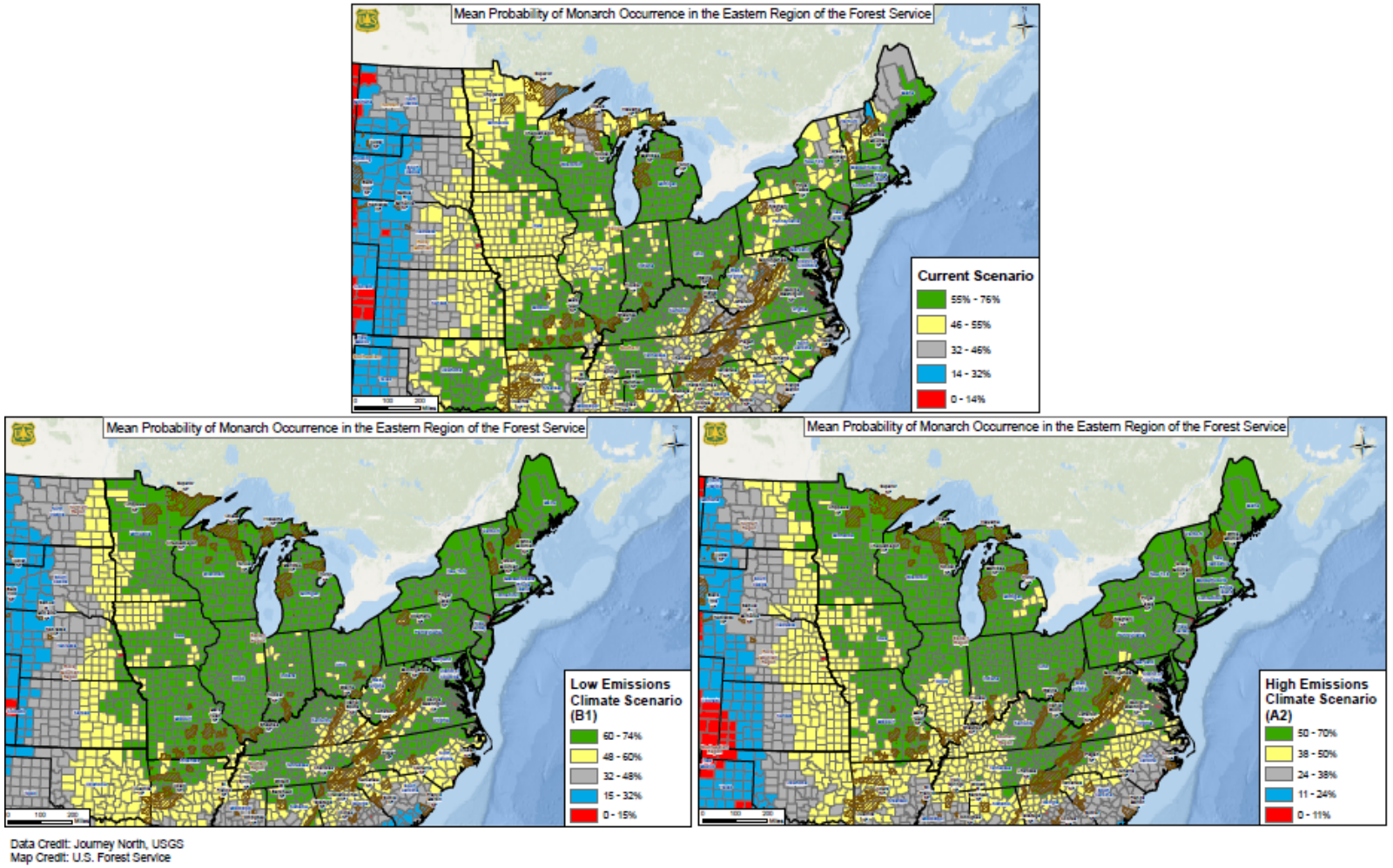

Figure 16. Probability of monarch occurrence across the Eastern Region under current conditions, a moderate climate change scenario (B1) and a severe climate change scenario (A2). National Forests are represented by brown cross-hatching. Under the moderate climate change scenario, probability of monarch occurrence increases throughout most of the Eastern Region. Under the severe climate change scenario, probability of monarch increases throughout the northern part of the Eastern Region, but suitability on some southern tier forests may decrease. A full-size version of this map can be found on the R9 Renewable Resources Sharepoint site here.

Monarchs are exposed to a variety of extreme weather and climatic events, including floods, strong winds, droughts, fires, severe rains, heat waves, and freezing temperatures, the frequency of which are expected to increase with climate change. Drought and fires in the southern part of the migratory pathway reduce nectar availability, which is particularly important during the southward migration. In 2012, near-record heat sped up the northward migration, skewed migratory patterns, and limited reproduction (Advani 2015). Drought affects milkweed as well, reducing germination, growth, seed production and lowering quality for larvae (Stevens and Frey 2010).

Extreme cold and wet weather can delay northward migration, and cause high mortality at the wintering site. A severe storm in 2002 killed 80% of the overwintering population (Advani 2015). Precipitation associated with winter storms may increase with climate change, and would likely increase mortality of monarchs (Oberhauser and Peterson 2003).

Predation, Parasites and Disease

Monarchs become toxic to predators by sequestering toxins from the milkweed they ingest as larvae, and are brightly colored in both the larval and adult stages to warn predators of this toxicity. Despite this protection, monarchs of all life stages are vulnerable to predation and disease, with the majority of predation occurring in the caterpillar stage. Like most moth and butterfly species, monarch eggs and small larvae face considerable dangers of predation; only about 10% of eggs and larvae complete metamorphosis. Ants can be a major egg predator, consuming 100% of the eggs at one Texas site (Calvert 1996). Spiders, crab spiders, true bugs, assassin bugs, beetles, wasps, flies and lacewing larvae are some known predators of monarch eggs and larvae. Tachinid flies and braconid wasps are parasitoids that attack monarchs. Black-backed orioles and black-headed grosbeaks are documented to consume large numbers of overwintering monarchs (Fink and Brower 1981), with bird-caused mortality ranging from 9 to 44% (Arellano et al. 1993). Mice also eat wintering monarchs.

Wild and reared populations can be affected by parasites and disease. The best studied monarch parasite is the specialist protozoan, *Ophryocystis elektroscirrha* (OE), whose spores are found on the scales of monarch adults and are spread from adults to larvae. The parasite can reduce larval survival, butterfly size, life span, mating success, and ability to fly. OE Infection is lower in migratory populations than non-migratory populations, with 8 percent of eastern monarch individuals heavily infected. The cultivation of non-native tropical milkweed in the southern U.S. has allowed portions of the eastern monarch population to breed year-round, increasing the likelihood that monarchs become infected with OE.

Reared monarchs that are released may increase the potential for wild populations to be exposed to the OE parasite. Commercial butterfly farms provide monarch butterflies for educational activities and for special events such as weddings. Although the USDA regulates the interstate shipment of live butterflies, existing permits do not track the number of butterflies transported nor do they require the butterflies to be screened for disease (Altizer and de Roode 2010).

In addition to parasitoids such as tachinid wasps, monarchs can become infected with pathogens, *Pseudomonas* bacteria and nuclear polyhedrosis virus (NPV); fungi such as *Cordyceps* and *Beauvaria bassiana* and protozoan parasites such as microsporidian species *Nosema.* Parasitoids, viruses, bacteria and protozoa most often affect the caterpillar stage of monarch butterflies. Additional information can

be found at the following websites: Parasites Affecting Monarchs and Disease of Monarchs and Other Butterflies.

Pesticides

Pesticide, including herbicide, use can reduce butterfly abundance and survival as well as affecting the availability and vigor of host and nectar plants. Many insecticides used in agriculture, urban areas, residential yards and gardens are detrimental, often lethal, to monarchs. Monarchs are exposed via overspray, drift, runoff, dust and ingesting food or water with pesticide residues. The increased use and spread of these insecticides within monarch breeding habitat likely impacts monarch survival and reproduction.

One group of insecticides that has raised concern is neonicotinoids, which have seen increased use in the last decade. These insecticides, including imidacloprid, clothianidin, thiamethoxam, acetamiprid, thiacloprid and dinotefuran, are extremely toxic to arthropods. They are systemic, meaning that when they are applied, plants absorb and distribute the compounds to all parts of the plant, making the leaves, nectar, pollen, and woody tissue toxic to insects and other arthropods that feed on them. The insecticides can remain in plants and soil longer than most compounds, so the resulting toxicity can also last for an extended period of time. Numerous studies and reviews have found neonicotinoid contamination in soil (Sanchez-Bayo 2014; Pisa et al. 2015) and water (Hladik et al. 2014) to be widespread, and not limited to the immediate vicinity of croplands. Milkweeds growing in contaminated soils may contain neonicotinoids, which may occur in sub-lethal or lethal concentrations for monarch caterpillars that eat them (Goulson 2013). Concern for monarchs has prompted many people to plant milkweed in yards and gardens. However, some of the commercially available milkweed has been found to be contaminated with neonicotinoids at levels sufficient to cause pollinator mortality (Brown et al. 2014).

In southern Florida, mosquito control activities were associated with declines of several butterfly species. Recent work indicates that butterflies are more susceptible than honeybees to insecticides used for mosquito control.

Bacillus thuringiensis (Bt) is a bacterium used for pest control such as for gypsy moth and European corn borer. Losey et al. (1999) found that pollen from corn that is genetically modified to contain a toxin from Bt has harmful effects on monarch larvae. However, this effect was found to be local and limited in scope (Oberhauser et al. 2001). Information provided by Eastern Region forests indicates that use of insecticides for mosquito control and Bt does occur on or near some national forest units.

Current Efforts to Address Threats to Monarchs in the Eastern Region

Habitat

Forest Service units in the Eastern Region are implementing a variety of activities that contribute to the conservation of monarchs, and pollinators in general. A few forests (e.g. Ottawa and Chequamegon-Nicolet) have developed forest-level pollinator action plans. Eastern region units are utilizing mowing and prescribed burning to maintain wildlife openings and other open lands, removing encroaching trees and shrubs to stimulate forb production. Restoration of native open habitats utilized by monarchs, such as prairies, glades, savannas and open woodlands is occurring on many Eastern Region units. The Midewin National Tallgrass Prairie has worked to convert over 3,000 acres to native vegetation, including planting seven species of milkweed, thus providing extensive breeding and foraging habitat for

monarchs. Many units are also augmenting open lands with milkweed and nectar species on a small scale.

Forests/prairie in the Eastern region are utilizing native seed mixes that often include milkweed seed, to seed new and temporary openings created by harvest activities (log landings, skid trails, temporary roads and harvested areas), and other soil disturbing activities.

Seed and plant availability are limiting factors for establishment of milkweeds and nectar plants. In order to address this, units have taken a variety of approaches including purchasing seed and seedlings (plugs) from native plant vendors, utilizing free milkweed plugs available from Monarch Watch, collecting and cleaning seed locally and growing it out on site, and utilizing partnerships with local schools to clean and grow out seed. Some forests have utilized Forest Service facilities including the Oconto River Seed Orchard and JW Toumey Nursery for cleaning and storing seed and for producing plants. The Monongahela National Forest has a native plant propagation partnership with Natural Resources Conservation Service's Appalachian Plant Material Center to propagate some native species.

Figure 18. Common milkweed seedlings shipped from Monarch Watch program. (Photo credit: Sue Trull, USDA Forest Service)

Non-native invasive plant species (NNIS) control is occurring across the Eastern region, and many units are working with local partners, individually or through cooperative weed management groups, to control NNIS across ownerships. Removal of NNIS allows native plants including milkweed and nectar plants to establish and grow in open habitats.

Most of the Eastern Region units have established multiple native plant and pollinator gardens at offices and other administrative sites. These gardens provide both habitat and outreach. Interpretive signs have been installed at these gardens, and monarchs have been documented using some of these sites.

Public education and outreach regarding monarchs or pollinators in general is being implemented on many units; several forests are presenting programs on pollinators and growing native plants at visitor centers and schools. On the Ottawa, wild-captured monarch larvae have been captured, raised, tagged and released, both as an educational activity and as a way to contribute to migration tracking data. The Chequamegon-Nicolet is working with two school groups to develop native plant gardens.

Eastern Region units have utilized a variety of partnerships and funding sources to implement monarch and pollinator inventory and habitat work. For example, the Shawnee National Forest participates in a Fish and Wildlife Service - Service First partnership to inventory pollinators. The Ottawa and other national forests have partnered with sportsmen's groups such as the National Wild Turkey Federation to conduct opening and other open lands maintenance, to benefit a suite of species, including monarchs. The Midewin National Tallgrass Prairie has partnered with regional non-profits and private charitable organizations to restore large areas of habitat. And many national forests partner with local schools, garden clubs, scouting groups, and individual volunteers to improve habitat and provide information and outreach.

Figure 19. Pollinator garden establishment on the Monongahela National Forest (Photo credit: USDA Forest Service)

Beyond the Forest Service, many entities and other agencies are working toward the conservation of monarchs. The Monarch Joint Venture is a collaborative conservation organization bringing partners from across the US together with the mission of conserving the monarch migration. Multiple states have convened monarch working groups, or held monarch summits, in which the Forest Service has participated. State natural resource agencies in many of the states in the Eastern Region have begun initiatives to respond to monarch declines. Several multi-state efforts have been initiated, including a memorandum of understanding (MOU) between the transportation departments of the six states along Interstate Highway 35, which is roughly aligned with the heart of the monarch migratory pathway. In this MOU, the six states agreed to improve management practices for monarchs and other pollinators along the I-35 corridor. Recently the Midwest Association of Fish & Wildlife Agencies initiated an effort to develop a Mid-Continent Monarch Conservation Strategy that will cover the Midwest, along with Oklahoma, Arkansas and Texas.

Monitoring

A variety of citizen science programs have arisen to collect information about various aspects of monarch life history. For example, the Monarch Larva Monitoring Project monitors monarch egg and larval densities and survivorship at sites with milkweed; Journey North monitors adult migration, egg laying activity and milkweed plant phenology; and Project Monarch Health monitors OE disease. These and many other programs have made significant contributions to peer-reviewed literature, and have provided the data for much of the research into the causes of monarch decline (Ries and Oberhauser 2015).

A few national forests in the Eastern Region have participated in these citizen science monitoring programs in a limited manner. The exception is the Hiawatha National Forest, which has a well-established monitoring program associated with the Peninsula Point stopover site. Several forests have conducted some small scale butterfly or pollinator monitoring unrelated to these programs. A few of the partners forests have worked with to conduct these surveys include state and local butterfly groups (e.g. Illinois Butterfly Monitoring Network; The Northern Crescents (MN)), citizen science programs, e-Butterfly, state heritage programs, and local volunteers. Four forests take part in monarch tagging programs that track monarch migration (Chequamegon-Nicolet, Ottawa, Hoosier, Wayne).

There are limitations to collecting data through current citizen science programs. Sampling is not random; citizens monitor where they are likely to encounter monarchs making extrapolating some information across the U.S. difficult. Second, these programs to do not monitor all aspects of monarch habitat including relative abundance of blooming nectar plants or additional threats to monarch populations like fire ants. Third and finally, depending on data collection methods, it may be statistically tricky to combine data across programs, limiting analyses and interpretation of results. Indeed, utilization of citizen science data has led researchers to reach different conclusions regarding what factor are most important contributors to the observed monarch population decline. Because of these limitations, the Monarch Conservation Science Partnership is in the process of developing an Integrated Monitoring Framework, which will set up a spatially balanced sampling scheme and standardized monitoring protocols to track monarchs and their habitat. Protocols under development include how to: 1) ground-truth sites; 2) monitor adult monarchs through modified Pollard Walks and identify preferred adult nectar plants; 3) estimate milkweed species diversity and density as well as per plant density of monarch eggs and caterpillars; 3) estimate relative abundance of blooming nectar plants; 4) estimate monarch survival to adulthood; 5) estimate abundance of fire ants where geographically appropriate; and 6) data management.

Strategies for Addressing Threats to Monarchs in the Eastern Region

The following section identifies strategies that can be implemented by the Eastern Region of the Forest Service to address the decline of eastern monarchs. The strategies are organized under three goals:

1. Conserve, Maintain, and Enhance Monarch Habitat and Populations
2. Build Awareness of Monarch Conservation Issues and Opportunities Within and Beyond the Forest Service
3. Contribute to Research and Monitoring that Informs Monarch Conservation

Under each goal are strategies to move toward that goal, and specific actions to implement the strategy. The actions are ranked as high, medium, and low priority. Those identified with an “F” are actions best addressed at the forest/prairie level. Actions with an “R” may best be addressed at the regional level. The highest priority should be given to implementing Goals and Objectives for monarchs in the core and secondary breeding range (see figure 7). On national forests located in the peripheral monarch range (green on map), other pollinator species may drive which Goals and Objectives are implemented, resulting in a secondary benefit for monarchs. The framework of this section is adopted from the annual Monarch Conservation Implementation Plan developed by Monarch Joint Venture. The goals, strategies and actions in this plan complement those found the 2017 Monarch Conservation Implementation Plan, which can be found here.

GOAL 1: Conserve, Maintain, and Enhance Monarch Habitat & Populations (H)			
Strategy 1: Review and adapt national forest management activities to improve monarch habitat and minimize adverse impacts to monarchs.			
Objectives	*Actions (F=Forest, R=Region)*	*Regional Priority*	*Resources*
H-1: Consider monarchs in project planning.	F1) Consider including monarch and other pollinator habitat in the Purpose and Need statement for projects that include work in openings. Where appropriate, evaluate, disclose, and avoid or mitigate the adverse effects of projects to monarchs and other pollinators during project development. Consider including monarch habitat improvement activities in KV plans and stewardship projects.	High	• Example of a KV plan that includes monarch habitat improvement from the Chequamegon-Nicolet NF.
	R1) Consider designating monarchs as an RFSS, Species of Conservation Concern, MIS, focal species, or other designation that would trigger consideration in project planning.	Medium	• Forest Service Manual, Eastern Region Supplement regarding Regional Forester Sensitive Species
H-2: Implement monarch and pollinator-related Best Management Practices.	F1) Incorporate monarch- and other pollinator-friendly best management practices into forest/prairie activities, including those accomplished through contracts and agreements. Best management practices may apply to many Forest/ Prairie activities, including but not limited to roadside and right-of-way management, facilities maintenance, herbicide use, open lands management, and reforestation efforts. Appendix 1 includes BMP's that are most applicable to management in the Eastern Region.	High	• Appendix 1: Selected BMP's for Eastern Region National Forests • Links to additional BMP documents can be found in Appendix 1.

	F2) Collaborate with partners, permittees, and other entities that conduct management within or near the forest/prairie to integrate monarch and pollinator-friendly BMPs into their management. For example, develop relationships with county, state, tribal, and federal land managers, utility managers, and surrounding private landowners to encourage adoption of monarch and pollinator-friendly practices. Utilize available tools, such as agreements, permits and contracts to encourage implementation of measures to improve monarch and pollinator habitat in ROW areas within forest.	High	• Appendix 1: Selected BMP's for Eastern Region National Forests • Tallgrass Prairie Center: Integrated Roadside Vegetation Management • Xerces Society: Pollinators and Roadsides Web Page • Baum and Sharber (2012): Fire Creates Host Plant Patches for Monarch Butterflies • Fischer et al. (2015): Enhancing Monarch Butterfly Reproduction by Mowing Fields of Common Milkweed • IVM Partners: Integrated Vegetation Management Partners • Monarchs in a Changing World: Biology and Conservation of an Iconic Butterfly Ch. 17 (2015). Grassland and Roadside Management Practices Affect Milkweed Abundance and Opportunities for Monarch Recruitment • Pollinator Partnership: Monarch Habitat Development Manuals • Tallgrass Prairie Center: Integrated Roadside Vegetation Management • Tallgrass Prairie Center: Hydroseeding Survey of IRVM Counties in Iowa • Xerces Society: Pollinators and Roadsides web page
	R1) Pursue landscape-scale agreements with companies that manage rights-of-way on multiple ownerships. Agreements should focus on BMP's and habitat improvement activities companies can incorporate into their ROW management to improve habitat for monarchs and other pollinators. Consider utilizing a program such as Energy for Wildlife as a tool for building partnerships to	Medium	• Energy for Wildlife is a program of the National Wild Turkey Federation focused on improving habitat in energy rights of way.

	benefit monarchs and other pollinators. Individual forests (e.g. Wayne, Hoosier) have successfully used this program to improve early successional habitat.		
Strategy 2: Enhance existing monarch habitat: Manage for diverse native plant communities that include milkweeds and native nectar plants that bloom throughout the growing season.			
H-3: Identify and evaluate existing and potential monarch habitat on each unit.	F1) Conduct GIS or other analyses to identify existing and potential monarch habitat and evaluate need to supplement. Consider areas not traditionally managed for habitat values, including roadsides, transmission corridors, utility rights-of-way, campgrounds and trailheads. Identify priority areas for further evaluation.	Medium	• Appendix 1: Site Selection section provides sources of data, sample GIS queries that can be used to identify existing and potential habitat, and criteria to consider in prioritization
	F2) Conduct field evaluations of existing and potential habitat to assess quality of habitat and identify management needs. Where possible, coordinate evaluations with surveys or evaluations for other pollinators.	Medium	• Monarch Joint Venture: Breeding Habitat Assessment Tool • Pollinator Partnership's Monarch Habitat Site Evaluation Rubric (Appendix 2) • Xerces Society: Pollinator Habitat Assessment Form and Guide • Coming soon: Monarch Habitat Quantification Tool, currently under development by the Monarch Butterfly Habitat Exchange. Currently available for some areas of the country, this tool provides a way to quantify functional monarch habitat, and improvements to habitat.
H-4: Implement monarch habitat enhancement on USFS and,	F1) Manage for the continued suitability of long-term congregation sites, roosting trees, or migratory pathways, such as Peninsula Point (Hiawatha), Nordhouse Dunes (HMNF), north shore of Lake Superior, Shawnee grasslands (Wayne) forested sites on Midewin, and any other identified sites. This may include establishment of	High	• MJV Handout: Invasive Species Alert • Example plan: Huron-Manistee Nordhouse Dunes NNIS Management Plan (available in reference documents folder)

where feasible, adjacent lands, in a prioritized manner.	young trees to eventually replace existing congregation trees, augmentation with nectar plants, treatment of non-native invasive species, signage, management of public visitation, or administrative designation.		
	F2) Maintain existing high quality habitat through active management, such as mowing at appropriate times and intervals to rejuvenate aging milkweed patches, prescribed burning, removal of encroaching trees and shrubs, and non-native invasive species treatment.	High	• Appendix 1: Selected BMP's for Eastern Region National Forests • Pollinator Partnership: Monarch Habitat Development Manuals • Prairie Restorations: Guidelines for Establishing a Prairie • Tallgrass Prairie Center: Prairie Reconstruction Technical Guides Series #6-10 • Xerces Society: Pollinators in Natural Areas • Xerces Society: Pollinator Habitat Installation Guides Xerces Society: Pollinator Resource Center • Baum and Sharber (2012): Fire creates host plant patches for monarch butterflies • Fischer et al. (2015): Enhancing Monarch Butterfly Reproduction by Mowing Fields of Common Milkweed
	F3) Enhance existing medium or low-quality monarch habitat, particularly on those Forests in the heart of the monarch breeding range (Mark Twain, Hoosier, Shawnee, Wayne, Monongahela and Allegheny). For example: i. Modify existing mowing regimes (e.g. timing, extent, and mowing height) in openings, roadside, or ROWs to favor milkweed and nectar plants.	Medium	• Pollinator Partnership: Monarch Habitat Development Manuals • Prairie Restorations: Guidelines for Establishing a Prairie • Tallgrass Prairie Center: Prairie Reconstruction Technical Guides Series #6-10 • Xerces Society: Pollinators in Natural Areas

	ii. Remove priority non-native invasive species. Priority should be given to treatment of swallow-worts, which attract monarchs to lay eggs but do not provide nutrition for monarch caterpillars. iii. Accelerate restoration of prairies, savannahs and other open native plant communities that support monarchs. iv. Where necessary, augment the existing native plant community with seeds or plugs of native milkweeds and a diversity of native plants that provide nectar throughout the spring, summer and fall. See Appendix 1 for information on selecting and sourcing appropriate native plant materials. Consider requesting seed and plants through J.W. Toumey Nursery. v. Create/restore habitat where current vegetation is of low habitat value and requires heavy augmentation or complete removal and replanting. (Note that grasslands may not include milkweed or many nectar plants, but conducting heavy-handed plant community alterations in high quality grass-dominated habitats is not recommended.)		• Xerces Society: Pollinator Habitat Installation Guides • Xerces Society: Pollinator Resource Center • Baum and Sharber (2012): Fire Creates Host Plant Patches for Monarch Butterflies • Fischer et al. (2015): Enhancing Monarch Butterfly Reproduction by Mowing Fields of Common Milkweed • IVM Partners: Integrated Vegetation Management Partners • Monarchs in a Changing World: Biology and Conservation of an Iconic Butterfly Ch. 17 (2015). Grassland and Roadside Management Practices Affect Milkweed Abundance and Opportunities for Monarch Recruitment • Tallgrass Prairie Center: Integrated Roadside Vegetation Management • Xerces Society: Pollinators and Roadsides Web Page • Monarch Watch: Native Plant Vendors by State • Monarch Watch: Free Milkweed Plugs for Restoration
	F4) Pursue opportunities to utilize partnerships to improve monarch habitat across boundaries. Tools for this may include use of the Wyden Amendment, Joint Chiefs projects, Good Neighbor Authority and various agreement types. This may also include participation in state-level monarch or pollinator conservation initiatives.	Medium	
	F5) Develop a brochure (or adapt an existing flyer from partners) listing local species of milkweed and easy-to-	Medium	• Pollinator Partnership Ecoregional Planting Guides have species lists would be a helpful starting point.

	grow native nectar plants, along with suggested sources for obtaining seeds and plants. Share with employees, permittees, partners, gardening groups and the public.		• This table of monarch nectar plants from NRCS would also be a good starting point.
	F6) Develop and stock local monarch-friendly seed mixes for restoration efforts, soil stabilization, wildlife openings and seeding needs in potential monarch habitat. Encourage use of these seed mixes wherever seeding is needed in open habitat. Temporary openings such as log landings can also be seeded with monarch-friendly seed mixes.	Medium	• See Appendix 1 for information on selecting and sourcing appropriate native plant materials • PlantNative: This website includes directories of native plant nurseries and regional lists of species that are commercially available. • Native Plant Materials Policy (USDA 2012) • Native Plant Framework for the FS Eastern Region 2004: seed zones in this framework are based on ecological sections (ECOMAP) • Roadside Use of Native Plants: Includes lists of native trees, shrubs, vines, grasses, and forbs for each state. • FSM 2070: Discusses use of native plant materials • Xerces Society Regional Pollinator Plant Lists • Generalized Provisional Seed Zones for Native Plants (Bower et al. 2014): this mapping refines the seed zones used in the Eastern Region framework by adding climate factors.
	F7) Develop partnerships, contracts, or in-house capacity (such as seed-production plots at Toumey Nursery and Oconto Seed Orchard) to establish reliable sources for regionally appropriate native plant materials, including seeds and plugs for milkweed and nectar plants. (See also Action **R4**).	Medium	• J.W. Toumey Nursery: USFS nursery with capability to produce native plant plugs and seed. • Oconto River Seed Orchard: USFS seed production facility • National Seed Strategy for Rehabilitation and Restoration • USDA Plant materials program • Generalized provisional seed zones for native plants (Bower et al. 2014)

			• Milkweeds: A conservation practitioners guide (Xerces Society)
	F8) Monitor effectiveness of habitat management efforts. Monitoring may include both habitat quality, and monarch use. Adapt future management based on monitoring. Share lessons learned (success and failures) with other national forests.	High	• Sample Pollination Monitoring Datasheet (CNNF) • Sample Wildflower Inventory Datasheet (CNNF) • Coming soon: Monarch Habitat Quantification Tool, currently under development by the Monarch Butterfly Habitat Exchange. Currently available for some areas of the country, this tool provides a way to quantify functional monarch habitat, and improvements to habitat.
	F9) Report monarch conservation activities per regional guidance.	Medium	
	R1) Provide clear guidance to forests regarding how monarch conservation activities should be tracked and reported.	Medium	
	R2) Facilitate exchange of information between forests regarding availability of native plant materials, effective tools & techniques, and funding sources.	Medium	
	R3) Improve access to funding for monarch habitat evaluation, improvement and outreach (including pollinator gardens). This may include • Setting aside regional funds specifically for monarch and pollinator habitat improvement • Identifying monarch and pollinator habitat improvement in budget guidance. • Identifying and sharing grant/funding sources and coordination to help forests identify and develop multi-forest proposals for grants and	Medium	• USDA NRCS: Using Farm Bill Programs for Pollinator Conservation • Appendix 2: Some funding sources that support monarch conservation work.

	partnerships. For example, consider development of multi-forest Joint Chiefs initiative project to provide funding support for monarch habitat enhancement on national forests and adjacent private lands. (See Appendix 2 for additional funding sources) • Develop partnership and funding opportunities through the Forest Service's International Programs. • Develop or modify partnerships or agreements with regional and national conservation organizations that work in early successional habitat. Some national examples include the National Wild Turkey Federation and Ruffed Grouse Society. • Provide guidance on use of KV funding and retained receipts from stewardship contracting for monarch projects.		
	R4) Work within the National Seed Strategy to improve access to native and regionally appropriate seeds and plugs for use in restoration and habitat improvement projects. This could include working with USFS, Tribal or state nurseries, NRCS Plant Materials Centers, or commercial nurseries to grow out locally collected seeds from forests. Monarch Watch has a contract with commercial nurseries to grow plugs of regionally-appropriate milkweeds, which could be a model.	Medium	• National Seed Strategy for Rehabilitation and Restoration • FSM 2070: Discusses use of native plant materials • Native Plant Materials Policy (USDA 2012) • Native Plant Framework for the FS Eastern Region 2004: seed zones in this framework are based on ecological sections (ECOMAP)
	R5) Identify a regional liaison to participate in Monarch Joint Venture and regional monarch conservation initiatives in order to build regional partnerships, and	Medium	• Monarch Joint Venture • Midwest Association of Fish & Wildlife Agencies

	disseminate new science and monarch conservation tools to forests. Liaison would also engage with development of the Mid-Continent Monarch Conservation Strategy currently under development by the Midwest Association of Fish & Wildlife Agencies. Support participation in state-level monarch or pollinator conservation initiatives by individual national forests.		

GOAL 2: Build Awareness of Monarch Conservation Issues & Opportunities within and beyond the Forest Service (A)			
Strategy 1: Raise awareness of monarch conservation issues and opportunities within Forest Service			
Objectives	*Actions (F=Forest, R=Region)*	*Regional Priority*	*Resources (lists are a work in progress, not complete)*
A-1: Identify monarch conservation as a regional priority.	R1) Provide a briefing to the Regional Forester and Regional Leadership Team of the completed Eastern Region Monarch Strategy.	High	
	R2) Distribute regional monarch conservation strategy and BMP's to R9 Forests through formal communication from the Regional Forester. Communication should identify pollinator conservation and specifically monarchs as an emphasis area for the Region. Ensure that consistent communication is channeled to units across Botany, Wildlife, Ecology, and Range programs for monarch work.	High	
A-2: Increase within-agency awareness of monarch	F1) Raise awareness of monarchs and other pollinators among forest staff. This may include presenting monarch and other pollinator information at meetings, meeting individually with resource groups to share BMP's and	Medium	• Monarch Joint Venture website

threats and conservation opportunities.	discuss ways they can reduce adverse impacts of management, and sharing news items, websites or printed resources.		
	R2) Communicate recent and relevant research, monitoring, collaboration opportunities, and outreach materials to R9 forests.	High	
	R3) Work with Regional staff from resource areas including Engineering and Lands to build awareness of opportunities to protect and enhance monarch and pollinator habitat in roadsides, ROWs, special use areas, and other areas not traditionally managed for habitat values.	Medium	
Strategy 2: Engage the Public with Monarch Conservation Issues and Opportunities			
A-3: Provide outreach to enhance public understanding of monarch threats and opportunities.	F1) Make educating about the threats to, and needs of, monarchs a priority within each unit's conservation education program. Integrate monarch citizen science opportunities into education efforts where appropriate.	Medium	• USFS Celebrating Wildflowers Monarch Page • MonarchLIVE – A Distance Learning Adventure • Celebrating Wildflowers: Monarch Teacher & Student Resources • Bas Relief, LLC • Journey North: Symbolic Migration, informational lessons • MJV: Monarch Conservation Webinar Series • MJV: Free resources including presentations • Monarch Lab Curricula: Monarchs and More Curriculum, Schoolyard Ecology Explorations Curriculum, Driven to Discover Monarch Curriculum
	F2) Engage unit public affairs staff to share information about monarchs and forest management for pollinators through social media, websites, and press releases.	Medium	
	R1) Partner with Urban Connections and other suitable regional, state and national entities to engage the public in monarch conservation.	Low	

	R2) Develop educational toolkits, similar to the existing Project EduBat trunks, for distribution or sharing across the region. These toolkits could focus broadly on pollinators with some units specific to monarchs. Consider emphasizing Pollinator week, supporting field units in hosting events related to monarchs during that week.	Medium	• Monarch Larva Monitoring Project: Online Training Series • Monarch Live! A Distance Learning Adventure • Texas Wildlife Association Youth On-Demand Webinar *The Magic of Monarchs* • Monarch Lab: North American Monarch Institute • Monarch Teacher Network: Teacher workshops • Examples of Forest Service native plant garden interpretive panels
	R3) Provide a platform for forests to share outreach resources.	Medium	
A-4: Demonstrate utilization of native nectar plants and milkweed as landscaping materials.	**F1)** Develop new and maintain existing pollinator gardens at Forest Service offices and recreation facilities. Ensure that interpretive signs are provided at these pollinator gardens to increase public understanding of monarch threats and opportunities to support monarch conservation.	High	• Examples of USFS Interpretive Panels at the Celebrating Wildflowers site. • Monarch Lab: Schoolyard Garden Grants • MJV Handout: Gardening for Monarchs • MJV Handout: Schoolyard Butterfly Gardens • Monarch Watch: Waystation Brochure • North American Butterfly Association: Butterfly Garden and Habitat Program • National Pollinator Garden Network: Million Pollinator Garden Challenge • National Wildlife Federation: Garden for Wildlife • National Wildlife Federation: Monarch Conservation in America's Cities Guide • Wild Ones: Wild for Monarchs Brochure • Xerces Society: Bring Back the Pollinators
	F2) Partner with local horticulture groups, such as master gardeners, native plant societies, extension agents, city or county parks, and garden centers to provide public information about the use of native milkweeds and nectar plants for pollinator-friendly landscaping.	Low	
	F3) Partner with local schools to establish pollinator gardens that can be used for educational programs.	Low	

GOAL 3: Contribute to Research and Monitoring that Informs Monarch Conservation (R)			
Strategy 1: Contribute to existing monarch habitat and population monitoring efforts			
Objectives	*Actions (F=Forest, R=Region)*	*Regional Priority*	*Resources*
R-1: Consider participation in the international monitoring program currently under development.	**R1)** Evaluate need, value, and resources available for participation in the Monarch Integrated Monitoring Strategy currently under development by the Monarch Conservation Science Partnership. Provide guidance, financial support, and budget guidance to forests/prairie if involvement is recommended or required.	Medium	• Monarch Integrated Monitoring Strategy • Monarch Conservation Science Partnership
	F1) Participate in the Integrated Monitoring Framework in accordance with direction provided by the regional office.	Medium	
R-2: Encourage forest or citizen participation in citizen science monitoring programs.	**F1)** Partner with interested citizens/groups to recruit and train citizen scientists to contribute to existing monarch and butterfly monitoring programs. Citizen science programs include migration tracking, larval monitoring, and breeding population monitoring.	Medium	• MJV web page: Citizen Science Opportunities • MJV Handout: Monarch Citizen Science • NatureDigger: Monarch SOS app is available for iOS devices as an educational app. Reporting functions under development. • MJV has provided citizen science training workshops and can provide sample agenda and evaluation materials for workshops (monarchs@monarchjointventure.org)
	F2) Forests should participate in citizen science or other monitoring programs to the degree deemed achievable and desirable at the local level, taking into account location of the forest/prairie in the migratory or breeding range of the monarch, and availability of resources.	Medium	

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Appendix 1: Best Management Practices for Monarch Butterflies on Eastern Region National Forests/Prairie

These Best Management Practices (BMPs) were developed to provide guidance to national forest units regarding how to minimize adverse effects to monarchs and to improve monarch habitat while conducting activities that are common to national forest management. The BMPs were developed from the best available science, and are adapted from documents developed by Xerces Society, Monarch Watch, Natural Resources Conservation Service (NRCS), Monarch Joint Venture, US Department of Transportation, Pollinator Partnership, North American Pollinator Protection Campaign and others. The BMPs should be considered dynamic, with potential to be updated as new information becomes available. They are organized under the type of activity to which they apply; there is both overlap and cross-referencing. Links for more information are provided. Note that local circumstances may preclude following all BMPS in all instances, such as a prescribed fire that is best implemented in mid-summer for maximum ecological benefit, despite being outside recommended management windows.

USDA Forest Service photos

Contents

Habitat Management

Openings and Native or Restored Prairie/Grassland Enhancement

(Forest glades are placed under a separate heading due to their unique composition).

Openings can provide areas where milkweed and nectar plants can flourish. Prairies and native grasslands can be priorities for enhancement due to usually containing a high diversity of plant species.

- Manage openings to include a mix of native annual and perennial forbs, including legumes, grasses (to 25-40%), shrub thickets and sparse patches.
- Highly diverse stands of tall grass prairie habitat or native grassland may already contain sufficient diversity of forbs to sustain monarch. If milkweeds are added, limit their use to appropriate species and carefully plant the milkweed to avoid disturbing intact high quality plant community.
- Remove undesirable woody species to create sunny, meadow-like openings, replacing nonnative trees, shrubs, grasses, or herbaceous plants with native species.
- Prescribed fire (when possible), mowing and other mechanical treatments may be needed to maintain openings. Timing (winter, spring, or fall) and frequency (annual, biennial, periodic) should be varied to determine the optimum method to benefit pollinators, wildlife, and desired plant community condition (see Management of Milkweed, Prescribed Burning, and Mowing sections).
- Consider using grazing to manage vegetation (see Grazing section).
- Seed, as needed, to establish native plant communities. Seed in strips or patches if seeding whole openings is not feasible. Native wildflower mixes that include species that bloom during different times of the growing season and in different flower colors should be given the highest preference. Select plants, when possible, that serve as butterfly larval host plants. (See Plant Selection section.)
- Plant local milkweed species seed or seedlings where milkweed is absent or sparse; add milkweed seed to seed mixes. Rejuvenate established milkweed patches if needed (see Management of Milkweed section).
- Where bracken fern (*Pteridium aquilinum*) is dominant in a monarch enhancement project area, consider control treatments to allow for increased plant diversity and reduced competition for desired nectar forbs. Possible methods to reduce bracken density include bruising strips or patches of fronds when they are fully open, such as using a roller with bruising bar that damages but does not sever the stems, or whipping stems with sticks or rods. Avoid managing bracken early or late in the day when reptiles may be using it for cover.
- Consider habitat connectivity and create pollinator enhancements near plant communities with differing bloom periods, to create a diversity of nectar plants and bloom times, such as upland openings near wetlands or oak-pine savannas and roadways.

References

Pollinator Friendly Best Management Practices for Federal Lands Draft May 2015

Habitat Enhancement for Rare Butterflies on Fort Lewis Prairies

Managing Woodlands for Butterflies and Moths

Glade Management/Restoration

Forest glades are present in the Central Hardwood Region, Interior Highlands (Missouri) and Interior Low Plateau Highlands (Tennessee, Kentucky, southern Indiana and Illinois) (Nelson and Fitzgerald 2013). Comprised of shallow fragile soils and rock outcroppings, glades contain unique communities of drought-resistant plants. These communities are classified by the type of bedrock present (limestone, sandstone, shale, etc.). Calcareous soils produce glades with red cedar thickets while siltstone, sandstone or shale-derived soils are more acidic with pine and oak as the dominant tree species (NRCS Missouri 2008).

Soils in glades typically have a higher pH than the surrounding forest. Soil properties of the glade itself (such as water-holding capacity, nitrogen and potassium content) may determine the outcome of management activities (Rhoades, Miller and Skinner 2005). In general, management on these sites may need to occur on longer rotation than in openings on richer, less xeric sites. Due to their shallow rocky soils, mechanical treatments are more likely to damage the soil and vegetation. Threats to glades are similar to those for permanent openings (including non-native invasive species and woody species encroachment), but glades are more susceptible to over-grazing and off-road vehicle traffic.

- Plant drought-tolerant native grasses, sedges and wildflowers. Whorled milkweed (*Asclepias verticillata*) tolerates dry alkaline soils; butterfly weed (*Asclepias tuberosa)* thrives in well-drained soils and tolerates drought.
- Prune limbs or remove encroaching trees surrounding the glade to allow sunlight to reach the ground vegetation.
- Complete restoration activities by hand to protect the thin soils and underlying rock formations from damage.
- Prescribed fire is recommended to restore and rejuvenate flora associated with glades. The rotation for prescribed fire is dependent on the community type associated with the glade, since burn prescriptions will depend on fuels present.
- Control non-native invasive plants.

References

Central Hardwoods Joint Venture Glade Conservation Assessment for the Interior Highlands and Interior Low Plateaus of the Central Hardwood Region

Glade Information Sheet Conservation Practice Information Sheet Restoring and Managing a Glade

Forest Vegetation and Soil Patterns across Glade-Forest Ecotones in Knobs Region of Northeastern Kentucky

Open Woodlands and Oak Savannas

(Pine barrens are not included since they usually do not represent quality monarch habitat due to dry soils.)

Deciduous tree woodlands allow light to reach the ground for early spring plant and larval insect development, while supplying shade in the summer which increases the longevity of host plants. Oak savannas with lupine provide habitat for monarchs as well as Karner blue butterfly.

- Control non-native invasive plants.
- Remove encroaching woody vegetation to maintain partially open grassy/forb habitats.
- Plant milkweed along with nectar plants.
- Consider rejuvenating stands of milkweed that are declining.
- Include prescribed fire as a tool to maintain desired vegetation on the site.
- Retain some trees, depending on the site, preferably in different heights and life stages to provide shade for thermoregulation, roosting sites, and habitat for other pollinators.
- Consider connectivity to other pollinator habitat.
- Consider using grazing to maintain an open understory.

References

Managing Woodlands for Butterflies and Moths

Streambank, Shoreline and Wetlands Habitats

Wetland habitats can provide important feeding and breeding habitat for monarch butterflies. Wetlands provide a transition between upland and aquatic systems, with moist soil conditions where flowering plants are able to persist later in the summer and in early fall. Shoreline areas along large bodies of water such as the Great Lakes are used by monarchs as flyways during fall migration.

- Maximize plant diversity along riparian corridors, aiming for distributed blooming times.
- Choose local native trees, shrubs, and forbs that provide pollen and nectar for pollinators for enhancement projects.
- Include swamp and aquatic milkweeds (*Asclepias incarnata, A. perennis)* where possible and appropriate.
- For streambank protection, choose local species of willow (*Salix*), dogwood (*Cornus*) and goldenrod (*Solidago*) to provide pollen and nectar for pollinators.
- Control the introduction and spread of nonnative invasive species, especially those with little value to pollinators.
- In wetlands construction or enhancement, include plants that provide pollen and nectar. Select local native species that tolerate wetland conditions; consult with your local plant specialist for options.

References

Natural Resources Conservation Service Pollinator Biology and Habitat, Michigan Biology Technical Note, No. 20, April 2013 (revised 3/2014)

Mowing

Mowing can be a useful tool for the enhancement and maintenance of monarch and other pollinator habitat if timing and extent are given consideration. Mowing can also be used to rejuvenate milkweed patches if timed appropriately, to encourage new, leafy stems vs. old senescing leaves and stems which are less useful for monarch reproduction (see Management of Milkweed section). Repeated and frequent mowing promotes grasses over forbs and is not recommended for monarch habitat enhancement.

- Ideally, mowing or haying should be done in the early spring, fall or early winter, especially in areas with breeding monarchs. However, milkweed plants may be rejuvenated through mowing during the early part of the growing season (before egg-laying). See Management of Milkweed section.
- Monarch Joint Venture has developed recommended spring/summer/fall management windows by latitude (Figure A1-1). Projects should be planned to occur before the spring date shown or after the fall date. If this is not feasible, the time frame shown in brackets for a given geographic area is a better choice than time frames excluded (such as between May 1 and June 30 for the Midewin).
- Only a portion of pollinator habitat should be burned, mowed, grazed, or hayed at any one time to protect foraging larvae and adults and to allow for recolonization of the disturbed area from nearby undisturbed refugia. If possible, limit treatment to ¼ to ⅓ of the site annually.
- Maximize foraging and egg-laying opportunities by avoiding treatment while milkweed and other plants are in flower.
- Use higher mowing heights to favor native forbs: 8-12 inches is recommended.
- Mow only once per year, or once every 2-3 years, where possible (more frequent mowing may be needed when establishing new plantings).
- When developing contracts for mowing, incorporate appropriate BMPs as contract stipulations.

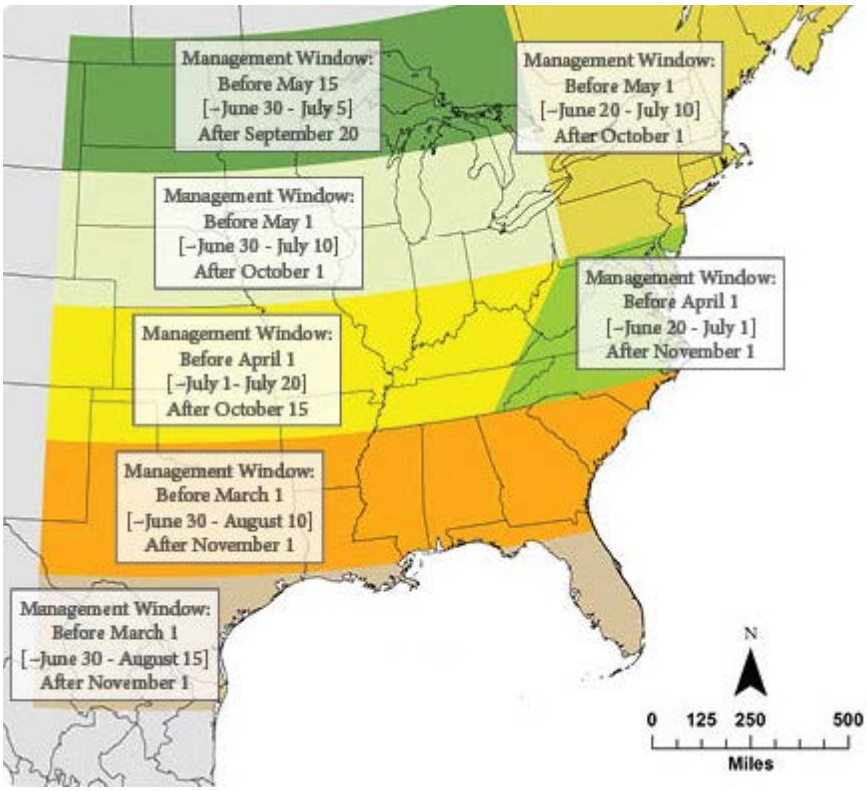

Figure A1-1. Management windows to minimize effects on monarchs. Source: Monarch Joint Venture (http://monarchjointventure.org/images/uploads/documents/MowingForMonarchs.pdf) Where feasible, conduct management before the spring date shown (which is based on monarch breeding activity) or after the fall date (to avoid breeding and migration periods). The dates in brackets are not recommended as monarch mortality is likely, but mortality is expected

to be less in that time frame than other dates so they are a second choice time frame for mowing and other management.

References

Natural Resources Conservation Service Pollinator Biology and Habitat, Michigan Biology Technical Note No. 20 April 2013 (revised 3/2014)

Monarch Joint Venture, Mowing: Best Management Practices for Monarchs, Management Windows

Prescribed Burning in Non-forested Habitats

Prescribed fire can be an excellent tool to manage open lands and pollinator plants if timing and extent are given consideration.

- Determine the types of pollinators using the project area. Consider the needs of pollinators in project design and burn plans. Consider any listed insect species that have been documented in project areas.
- Match the frequency of fire to the local site condition (vegetation, soil moisture and management objective for the site). Stands of warm season grass develop a large amount of thatch in a shorter timeframe and are burned at an interval of 3-5 years, whereas cool season grasses and forbs have less accumulation of plant material and are typically burned on a longer rotation.
- Alternate burning timeframes and frequency of burns to increase vegetative diversity. Allow adequate recovery of pollinator populations between controlled burns in one area (dependent on the ecosystem and specific management goals).
- Encourage mosaic burns, where a variety of fire intensities are utilized and unburned patches remain within the burn area. Retention of unburned refugia is particularly important in large burn units.
- If burning during time periods when monarchs may be present, burn no more than 30% of a site during one prescribed burn to protect foraging larvae and adults and to allow for recolonization by pollinators from adjacent habitat.
- In foraging habitat, burn when pollinators are least active, that is, burn in late fall to early spring (see Fig. A1-1) and during active season, schedule burns early or late in the day.
- Avoid burning while nectar plants are in flower.
- Where milkweed plants are beginning to senesce, burning a portion of a stand during the growing season may assist in rejuvenation of milkweed plants. See Management of Milkweed section.
- Post fire monitoring of pollinators is encouraged in addition to monitoring to assure plant succession is not taken back too far for the site.
- See management windows by latitude, Figure A1-1; also consider fuels and site conditions.

References

Natural Resources Conservation Service Pollinator Biology and Habitat, Michigan Biology Technical Note No. 20, April 2013 (revised 3/2014)

Monarch Joint Venture Mowing: Best Practices for Monarchs, Management Windows

Pollinator Friendly Best Management Practices for Federal Lands Draft May 2015

Grazing

Grazing can be compatible with quality pollinator habitat and may assist in controlling invasive species and woody encroaching species in openings. Areas maintained as pasture, dominated by grasses, generally have little if any milkweed and attempts to establish milkweed are not recommended due to livestock toxicity and grass competition.

- When practical, incorporate management guidelines that promote diverse plant communities, with an emphasis on forbs.
- When practical, encourage even livestock distribution to reduce impacts of congregating animals. For example, design grazing systems that rotate grazing timing, frequency and intensity to help maintain open, herbaceous plant communities that are capable of supporting a wide diversity of butterflies and other pollinators.
- Adjust livestock utilization levels to provide forbs the opportunity to complete their life cycles.
- Include management guidelines that minimize the use of insecticides to control livestock pests.
- When practical, avoid or limit grazing intensity during periods when flowers are already scarce (e.g., midsummer) to maintain forage for pollinators.
- In important butterfly areas, and when practical, avoid or reduce grazing when butterfly eggs, larvae, and pupae are on host plants.
- Include reasonable protection measures for pollinator species in grazing management plans (Pollinator Friendly BMPs Federal Lands Draft May 2015).

References

Natural Resources Conservation Service Pollinator Biology and Habitat Michigan Biology Technical Note No. 20 April 2013 (revised 3/2014)

Pollinator Friendly Best Management Practices Federal Lands

Some hay fields can provide low quality pollinator habitat, such as if alfalfa is allowed to bloom before cutting or if parts of the field can be managed for nectar forbs and not for grasses.

- Manage haying areas to promote a diverse mix of forbs that bloom throughout the growing season, along with native grasses.
- If the hay field includes large numbers of flowering plants beneficial to pollinators, consider delaying hay harvest until after peak bloom.
- Recommend that permittees consider incorporating pollinator-beneficial forage plants into hay fields, when appropriate.
- If the entire hay field must be harvested within a short time period, harvest from one end of the field to the other, rather than harvesting the perimeter and inward, to allow insects and wildlife an escape route.
- Require that all pesticide use be coordinated with NFS personnel to ensure pollinator health is considered.
- When practical, avoid haying during periods when flowers are scarce (e.g., midsummer) to maintain forage for pollinators.

References

Natural Resources Conservation Service Pollinator Biology and Habitat Michigan Biology Technical Note No. 20 April 2013 (revised 3/2014)

Pollinator Friendly Best Management Practices Federal Lands Draft May 2015

Roadside Management

Roadsides represent extensive acreage that may be managed for monarchs and other pollinators in the Eastern Region. Research has shown the value of roadsides as insect habitat, despite the mortality risk from vehicle collisions (Kasten et al. 2016).

- Inventory roadsides to identify existing vegetation. Consider pollinators and native plants in roadside management plans.
- Mark areas with milkweed along roadways to protect from unsuitable mowing. Mow protected areas in the fall.
- Increase native nectar forb diversity along roadsides, including milkweed species. See Planting section. Avoid planting species likely to be attractive to deer and other large herbivores, and avoid planting species that will be green when few other forage species are available, so that herbivores are not attracted to roadsides (to reduce vehicle accident potential). Consider if road salt use is heavy enough that salt-tolerant native plants are needed (such as yarrow, some asters, and wild bergamot).
- Adjust mowing practices to benefit pollinators by a) reducing the frequency of mowing, b) considering the timing of mowing, and c) adopting mowing techniques to reduce impacts to pollinators (e.g. restrict mowing to clear zone and mow beyond the clear zone only to reduce brush growth). Tailor mowing patterns to the type of vegetation present at the site. Consider mowing only once per year, or once every 2-3 years. Mowing several times early in the growing season may assist in controlling non-native invasive species.
- See management windows map (Figure A1-1) and Mowing section.
- Incorporate techniques such as spot mowing or adjusting mowing height to 10 inches or higher.
- Avoid mowing in the afternoon period when pollinators are most active.
- Use a flushing bar when mowing.
- When developing contracts for mowing, incorporate appropriate BMPs as contract stipulations.
- Reduce the impacts of herbicides by using selective herbicides formulated to control specific weeds or groups of weeds, and timing application based on the herbicide's mode of action and when weeds are at vulnerable life stages. See Pesticide section and consult your unit pesticide coordinator for more information.
- Apply herbicide when insects are less active (before sunrise, after sunset, during cooler temperatures).
- If using prescribed fire to manage roadsides, leave some sections unburned. Vary timing of burns and conduct burns 3-5 years apart. Refer to management windows map (Figure A1-1 and Prescribed Burning Section. Consider timing of burns relative to objective: brush control may need a spring burn while fall burns may be used to stimulate cool season grass growth.
- Consider interpretive signage regarding pollinators in these highly visible areas.

References

Roadside Best Management Practices that Benefit Pollinators, Handbook for Supporting Pollinators through Roadside Maintenance and Landscape Design US Dept. of Transportation, Federal Highway Administration

Invertebrate Conservation Guidelines, Pollinators and Roadsides, Managing Roadsides for Bees and Butterflies, Xerces Society for Invertebrate Conservation

Monarch Joint Venture Mowing: Best Practices for Monarchs, Management Windows

Managers Guide to Roadside Revegetation Using Native Plants, U.S. Department of Transportation

Forest Service Interpretive Panel Examples at Celebrating Wildflowers site

Utility Corridor Management

Utility corridors represent extensive linear habitat that may be managed for monarchs and other pollinators.

- Work with partners and permittees to expand monarch habitat along rights-of-way. Utility corridors such as pipelines and powerlines that are planted with pollinator-friendly vegetation can provide substantial, continuous habitat for monarchs and other pollinators, while saving maintenance money.
- Work with utility special use permittees to develop operations and maintenance plans which provide for pollinators. For example, the O&M plan can specify brush removal is to occur in fall and winter, and use of native nectar forb seeds in revegetation after pipeline maintenance digs.
- Prioritize the use of local native plants in utility corridors management. Encourage a shift from low grass to a variety of herbs and shrubs.
- Manage non-native invasive species and encroaching brush using integrated pest management (see Pesticide section). Use of mechanical treatment methods, selective herbicides, and spot treatments are recommended over broadcast non-selective chemical applications.
- See Mowing section and management windows map (Figure A1-1).
- Consider managing only the center of the utility corridor intensively, such as with short grasses, and allow the edges to have a more diverse mix of forbs and shrubs.
- Seed mixes for erosion control should have at least 50% native wildflower component.
- Select flowering species that have sequential and overlapping bloom times.
- Include plant species known to provide quality forage to pollinators.
- Include milkweeds for monarch larvae.

References

Monarch Habitat Development on Utility Rights of Way, Northeast

Pollinators and Roadsides: BMPs for Managers and Decision Makers

Facilities Management

(administrative sites, campgrounds, recreation sites, day use sites)

- Plant native plant and pollinator gardens including milkweed species at administrative and recreation sites where appropriate. In one study (Cutting and Tallamy 2015), monarchs were found to oviposit more frequently on milkweed in garden settings than natural sites, suggesting garden milkweed may help mitigate loss of milkweed in croplands. See Planting section.
- Reduce the use of pesticides. See Pesticide section.
- Consider reducing the amount of area mowed and instead planting native forbs and milkweeds to provide pollinator habitat at administrative sites.
- Provide interpretive signage where appropriate.

Special Uses

- At ski areas within monarch range, where recreation use is limited during the summer, modify permit to stipulate permittees rotate mowed areas and/or mow late in the season. Share management windows chart (Figure A1-1) with permittees where appropriate. See Mowing section. Encourage planting of native plants including milkweed and nectar forbs in low traffic, f4f4suitable areas.
- Encourage special use permittees within national forests to reduce extent of mowed lawn and to add milkweed and nectar forbs to seed mixes used on their access routes and other open areas on their property. Include permit conditions that benefit pollinators where feasible.
- During permit inspections, monitor for invasive plants and work with permittees for treatment (in concurrence with permit clause D-10 in Forest Service Handbook 2709.11.)
- Consider preparing a unit-specific handout on local sources for milkweed and nectar forbs that can be provided to special use permittees for planting advice for their private land.

Native Plantings

(milkweed and nectar species)

Management of Milkweed

Species Information

The following information about milkweed is drawn from sources including Borders and Lee-Mäder (2014) Milkweeds: A Conservation Practitioner's Guide and USDA Plants Database, among others.

Milkweeds are in the genus *Asclepias*. In Region 9, there are several species:

A. amplexicaulus, clasping milkweed aka blunt-leaved milkweed (threatened in NH, VT)
A. exaltata, poke milkweed
A. hirtella, green milkweed aka tall green or prairie milkweed (threatened in MI, MN)
A. incarnata, swamp milkweed aka rose milkweed
A. lanuginosa, sidecluster milkweed (endangered in IL, threatened in WI)
A. meadii, Mead's milkweed (endangered in IL, MO, reintroduced in IN)
A. ovalifolia, oval-leaf milkweed aka dwarf milkweed (endangered in IL, MI, threatened in WI)
A. perennis, aquatic milkweed
A. purpurascens, purple milkweed (endangered in WI)
A. quadrifolia, fourleaf milkweed (threatened in NH)

A. speciosa, showy milkweed
A. stenophylla, slimleaf milkweed (endangered in IL, MN)
A. subverticillata, horsetail milkweed
A. sullivantii, prairie milkweed aka Sullivant's milkweed (threatened in MI, MN, WI)
A. syriaca, common milkweed
A. tuberosa, butterfly milkweed (endangered in NH, threatened in VT)
A. variegata, redring milkweed aka white milkweed (endangered in PA)
A. verticillata, whorled milkweed
A. viridiflora, green comet milkweed aka green milkweed
A. viridis, green antelopehorn aka green milkweed (endangered in IN).

Milkweeds are perennial forbs, dying back to underground parts each year after seed dispersal. Most have a milky latex sap (hence the name) with cardenolides, chemicals that make the plants unpalatable. All but butterfly weed ooze the milky sap if injured. Milkweeds produce complicated flowers with hoods, organized in umbels. Flowers vary in color by species, with blooms in green, white, yellow, pink, purple, orange, and red. Some are very fragrant. Most milkweeds cannot self-pollinate to produce viable seed although swamp milkweed is self-fertile. Pollen is produced in sacs called "pollinia". Milkweeds attract many floral visitors and are mainly pollinated by large bees, wasps and some butterflies, although monarchs are not usually effective pollinators for milkweed. Milkweed seeds are produced in pods and have fluffy "parachutes" to help in dispersal (except aquatic milkweed). Leaf shape, plant height, hairiness and other characters vary by species. Many milkweeds have deep roots.

Milkweeds can grow as scattered individuals, in clumps, and in large clonal patches (common milkweed is the most clonal of the Eastern Region species). They are often pioneer species that respond well to occasional disturbance. Indeed, a couple species are considered weeds, particularly those that form colonies and send shoots up from rhizomes to rapidly spread.

BMPs

Mowing, prescribed fire and pruning are management actions that can rejuvenate senescing milkweed plants. Mowing milkweed patches in fall or early in the growing season was found to benefit monarch reproduction by creating areas of young milkweed plants which were preferred for egg laying over senescing plants with yellowed and dropped leaves. However, optimal timing of mowing is not yet well defined; local experimentation may be needed to determine when to mow, burn or prune to promote milkweed growth without harming monarch larvae and without unduly extending the breeding season (which can have negative impacts). A milkweed area at Oconto River Seed Orchard has been mowed each autumn with positive results; one recent year when the mower was broken, they found greatly reduced milkweed density the following year.

- Include milkweed in field surveys, to determine where major habitat patches exist. Monitor patches for senescence and need to rejuvenate.
- If needed, utilize disturbance activities such as mowing, prescribed burning and pruning to rejuvenate older milkweed stands. Experiment with methods and timing to determine what is most effective in local conditions. If using one of these methods to rejuvenate milkweed, limit treatment to ¼ to ⅓ of the site annually.
- Add milkweed to suitable habitats with existing diverse nectar plant populations. Planting seedlings is generally more effective than seeding for milkweed. Remove existing competing ground flora in small patches by tilling, digging, sod removal, smothering, or chemically treating before planting

milkweed in these areas (see Site Preparation and Planting sections). Mulch milkweed seedlings with straw (wood-based mulch is not recommended for milkweed). Typically, milkweeds initially are focused on growth of below ground parts, with little above ground activity visible for one to two years.

- When selecting species for enhancement, consider site conditions and choose the best-suited species for the site. Note that swamp milkweed has been found to be preferred over common milkweed for monarch oviposition and larval growth is often higher on swamp milkweed compared to common milkweed (Lemoine 2015). Recommended design is planting milkweed in patches of 3-4 plants, with 10-13 patches per acre (MonarchWatch 2016).
- Enhance milkweed seed germination using cold moist stratification (40-41°F); this can be accomplished by seeding in the fall or artificially in a refrigerator.
- Follow guidance in Milkweeds, A Conservation Practitioner's Guide (Borders and Lee-Mäder 2014) for dealing with milkweed diseases and pests. Available: http://www.xerces.org/milkweeds-a-conservation-practitioners-guide/
- Follow guidance in Pollinator Plants of the Central United States, Native Milkweeds for propagating milkweed, collecting seed, minimizing transplant shock and other activities. Available: https://www.nrcs.usda.gov/Internet/FSE_PLANTMATERIALS/publications/mopmcpu11905.pdf
- Free or low cost milkweed for restoration projects greater than 2 acres may be available through MonarchWatch: http://monarchwatch.org/bring-back-the-monarchs/milkweed/free-milkweeds-for-restoration-projects/

References

For information on the various milkweed species, see Plant Milkweed for Monarchs by the Monarch Joint Venture, available:
http://monarchjointventure.org/images/uploads/documents/MilkweedFactSheetFINAL.pdf

Species profiles http://monarchwatch.org/bring-back-the-monarchs/milkweed/milkweed-profiles/

Lady Bird Johnson Wildflower Center Native Plants Database, information for milkweed

Fire Effects Information System Summary for *Asclepias incarnata*

Fire Effects Information System Summary for *Asclepias speciosa*

Monarch Butterflies Use Regenerating Milkweeds for Reproduction in Mowed Hayfields

Enhancing Monarch Butterfly Reproduction by Mowing Fields of Common Milkweed

Monarch Butterflies Use Regenerating Milkweeds for Reproduction in Mowed Hayfields in Northern Virginia

Site Selection

- Generally, select an open (zero to few trees) site that has abundant sunshine. Easy road access is a plus for implementation.
- Consider proximity to other openings for habitat connectivity and efficiency.
- Consider using the cover type and vegetation fields in the existing vegetation layer in your unit's geographic information system (GIS) to find potential open sites. One useful query is

"[EV_CODE] ='97' OR [EV_CODE] = '98' OR [EV_CODE] = '99') AND [VEGETATION_TYPE] >= 50 AND [VEGETATION_TYPE] <= 56", where 97 = lowland shrubs, 98 = upland shrubs, 99 = open; 50 = upland opening, undifferentiated, 51 = upland opening grass, 52 = upland opening forb, 53 = upland opening shrub, 54 = savannah, and 56 = orchard. Depending on the quality of the unit's mapping, this should show many upland and lowland openings to consider for planting (or other enhancements). Local knowledge, topographic maps and aerial photos can then be used to select the best sites for habitat work from the candidates. General aerial photograph review may also be used to locate sites. LIDAR (light detection and ranging) remote sensing can be used to find open canopy areas as well (see Lefsky et al. 2002). The unit archeologist may have maps showing open sites, such as old homesteads, which may be suitable for hand planting. Lands staff may have maps for rights-of-way and utility corridors with options for planting.

- The following site conditions will require extra planning and effort: sites dominated by non-native invasive species or aggressive native species such as bracken fern, goldenrod and dense grass colonies (or with these conditions immediately adjacent); sites with species at risk or sensitive habitats; areas with frequent road maintenance such as grading, plowing, salting, or snow storage; sites with heavy recreational use, livestock grazing or wildlife congregating; areas with frequent high winds; steep slopes; compacted soils; frost pockets.
- Sites with windbreaks for protection and rocks for adult butterfly basking are preferred.
- Test soil if needed: milkweeds grow well in acidic to slightly acidic soils. Avoid soils with pH below 4 or above 7.5.
- Larger sites generally provide greater benefit: aim for at least 2 acres.
- Provide for a buffer between Forest Service projects and agricultural land where pesticides may be used.
- For more help in site selection, see the site evaluation matrix in the Pollinator Partnership's Monarch Habitat Development on Utility Rights of Way, Northeast, Appendix 2 and Monarch Joint Venture's Monarch Breeding Habitat Assessment Tool (http://monarchjointventure.org/images/uploads/documents/Habitat_Assessment_Tool_Final_test.pdf)

Site Preparation

- Determine what planting method you will use—seeds or plants (irrigation is needed more for plants than seeds but establishment can be quicker).
- Remove existing and competing vegetation, particularly invasive species and dense grasses. (Follow non-native invasive plant standard prevention practices to avoid spread.) See Pollinator Meadow Upper Midwest Install Guide and Checklist (Xerces Society for Invertebrate Conservation 2015) and Establishing Pollinator Meadows from Seed (Lee-Mäder et al. 2013) for methods to prepare sites including use of non-selective, non-persistent herbicides, sod removal, and solarization.
  Note that the use of herbicide in site preparation, as recommended in some of these guides, may not be suitable for most national forest sites.
- Consider need for deer fence or repellents.
- Consider need for compost (use weed-seed free compost). Fertilizing is not usually recommended with native plantings.
- Use integrated pest management in treating invasive species at the site.
- Prepare the soil surface with raking, tilling, a turf roller, or similar methods to remove stubble, clumps and clods.

Plant Selection

- Select local native plants from your ecoregion which are genetically appropriate (see FSM 2070.3 .
- See Native Plant Framework for the FS Eastern Region and Generalized Provisional Seed Zones for Native Plants (Bower et al. 2014) for transfer zone guidance. The 2004 Framework recommends seed zones based on ecological sections while the Bower et al. map refines these units with climate factors. Species-specific research on suitable provenance is lacking for many native plants, and is costly and time-consuming to conduct. The provisional seed zones combined with ECOMAP sections can suffice in the interim. The provisional seed zones are shown in a map found on-line at http://www.esapubs.org/archive/appl/A024/053/. GIS data for these zones is found at Seed Zone Data (use CONUS data for Eastern Region). The climate-based zones, ECOMAP sections and Eastern Region units are shown on this seed zone map and in Figure A1-2.
- Aim for at least three species that bloom during each blooming period—early, mid-summer and late summer/fall. Increased diversity often results in increased pollinator diversity.
- Generally choose perennials, but consider a few annuals or biennials if there are no host and nectar plants on the site, since perennials may take three or more years before blooming.
- Generally plant few grasses since they do not provide nectar and they compete with forbs, but consider planting one or two species of short, clump forming grasses to be host plants for other pollinator larvae, provide nesting sites, and to help support forbs and in erosion control. If burning is planned for maintenance, grasses will help support prescribed fire.
- See planting guides from the Pollinator Partnership for species to consider by color and bloom time. Sub-regional planting guides are available at http://www.pollinator.org/guides.htm. (See the guides for Laurentian Mixed Forest; Adirondack New England Mixed Forest; Central Appalachian Broadleaf Forest; Eastern Broadleaf Forest; Lower Mississippi Riverine Forest Province; and Prairie Parkland.)
- Avoid hybrids and cultivars which often produce less nectar.
- Do not use plants treated with neonicotinoids or other systemic pesticides. Confirm with your provider that these chemicals have not been used on the seeds or plants.
- Red, orange, yellow, and purple are particularly attractive to butterflies as are species with ample nectar.
- Avoid species attractive to deer and other ungulates.
- Include larval host plants (milkweeds for monarchs).
- Do not plant introduced milkweed species. Varieties that do not die back in winter (southern tier) may concentrate monarch parasites due to longevity of the milkweed. *Asclepias curassavica* (bloodflower) also has been thought to cause diapause termination in monarchs.
- See Management of Milkweed for more information on the genus that hosts monarch larvae.

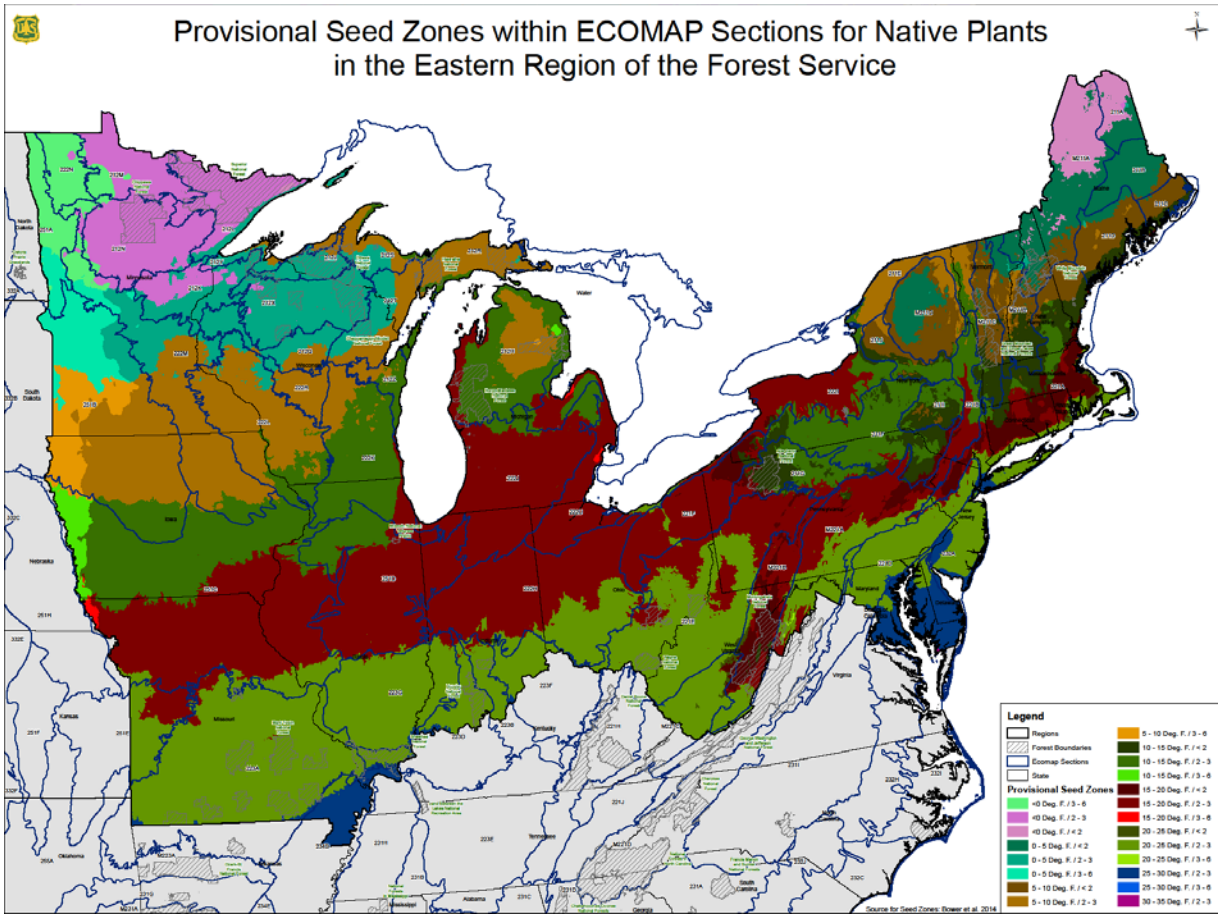

Figure A1-2. Provisional seed zones, ecological sections and Eastern Region units.

References

Pollinator Partnership Ecoregional Planting Guides

NRCS Pollinator Habitat, Iowa Job Sheet

Wildflower Plant Characteristics for Pollinator and Conservation Plantings in the Northeast

Pollinator Resource Values for Upland and Wetland Prairies, Minnesota

Plant Recommendations for Monarch Butterflies, Midwest Plant List

Monarch Nectar Plant List by Subregion

Catalog from Native Plant Vendor Carno Native Plant Nursery

Monarch Watch List of Native Plant Vendors by State

Lidar remote sensing

Planting Plugs or Container Stock

- Keep plants well-watered and out of full sun after acquisition and before planting. If planting bare-root shrubs, keep roots damp. Consider whether hardening off period is needed. Milkweed can be cut back to below the first true leaves to help reduce shock of transplanting for container stock.
- Plant 3-5 forbs per square yard (2-3 foot centers); grouping plants for insects as well as for re-locating them to weed and water. Generally plant in single species clumps at least 3 feet by 3 feet, or larger, to provide efficient foraging. Plant shrubs on 4-10 foot centers.
- Dig a hole just large enough for the plug's roots. Plant so that root collar is at ground surface. Use a shovel, trowel, or auger.
- Tamp soil down well.
- Water as needed after planting, for the first year if possible, depending on site.
- Fall planting favors forbs over grasses, and usually results in less need to water. Early fall planting often works well for perennials.
- Avoid planting during prolonged hot, dry, windy weather.
- Add deer/rodent repellents if needed (such as collars or "PlantSkydd" porcine blood repellent).
- Mulch is recommended, at about 1 inch depth. Use materials such as wood chips, straw, nut shells, or coconut fibers. Ensure mulch is free of seeds or other propagules of invasive species. If your state has a certified weed-free straw or mulch program, utilize it. Do not use hay. Do not use mulch that has a plastic webbing included unless you check with wildlife biologist that it is not a concern for trapping snakes, etc.

Seeding

- Seed should be genetically appropriate, local native species per FSM 2070.3 (2008, page 7). See Native Plant Framework for the FS Eastern Region and Generalized Provisional Seed Zones for Native Plants (Bower et al. 2014) for transfer zone guidance.
- Seed can be broadcast, drilled, or hydroseeded. See Tables 6.1 and 6.2 of Roadside BMPs that Benefit Pollinators for comparisons of the methods (page 61, https://www.environment.fhwa.dot.gov/ecosystems/Pollinators_Roadsides/BMPs_pollinators_landscapes.pdf). Plots less than five acres are usually planted by broadcast methods. Hydroseeding may work for difficult to access sites but often does not result in firm seed to soil contact which can mean lower germination.
- Seed mixes should include one or two species of short, clump forming native grasses (up to about 25%), to help support the forbs and provide erosion control.
- Seeding is most successful in areas with open soil created from a disturbance. Seed beds should be firm, and free of most weeds and residual cover. (Conduct weed control **prior** to planting, see Site Preparation.) Tilling before seeding may improve seed to soil contact.
- Use a moistened carrier to help distribute seed, such as sawdust, vermiculite, coarse sand, cornmeal, chick starter grit, clay-based kitty litter. Use about 2.5 cubic feet of carrier per 1000 square feet to be seeded. See NRCS's Seeding Pollinator Plots for details on seeding (https://www.nrcs.usda.gov/Internet/FSE_PLANTMATERIALS/publications/ndpmctn10293.pdf)
- Plant 40-60 seeds per square foot, depending on the species. Use pure live seed (PLS) figures and seeds/pound to calculate seed needs. See NRCS publication for more information on PLS as well as a seed mix calculator at: https://www.nrcs.usda.gov/Internet/FSE_PLANTMATERIALS/publications/lapmctn9045.pdf. Seed vendors can usually help to determine seeding rates and seed needs.

- Seed shallowly, no more than ¼ inch deep.
- Ensure seed to soil contact by packing or rolling site.
- If rapid green-up or erosion control is needed, consider using a nurse crop such as wild rye (*Elymus canadensis*), oats (*Avena sativa*), winter wheat (*Triticum aestivum* strains), slender wheatgrass (*Elymus trachycaulus*), or buckwheat (*Fagopyrum esculentum*).
- Typically seed in fall so that winter provides the necessary stratification to break dormancy. Spring seeding favors grasses and may require artificial stratification for some species.

Maintenance of Planting and Seeding Areas

- Mow early in growing season for weed control, at a height of 10-12 inches. For perennial wildflowers, mowing each time the plants are about a foot tall will help control weeds.
- Water as needed, if possible, for the first 2 growing seasons.
- Avoid use of herbicides and pesticides but spot treatments may be necessary. Use integrated pest management.
- If using mowing, burning, grazing, etc., limit treatment to ¼ to ⅓ of the site annually. Early spring burns are recommended, before most of the desired plants have come up.
- Additional mulch may be needed, as well as reseeding or replanting.

Seed Collection and Storage

Collecting seed from local native plants can be a cost effective way to add milkweed and nectar forbs to Forest landscapes. Note that Toumey Nursery on the Ottawa National Forest may be able to provide seed cleaning, storage and stratification services as well as native seed expertise. Toumey Nursery: http://fsweb.ottawa.r9.fs.fed.us/teams/toumey/new_index.htm.

- Monitor seed maturation to schedule collection when seed is mature but not released.
- Document seed collection locations.
- Collect no more than 20-40% of the viable seed from the patch, collecting less if the site is used for collection frequently
- Promptly remove seed from collection container into bag or container where it can dry without molding and not be overheated. Paper or cloth bags are better than plastic for collecting.
- Clean seed and store in suitable facility.
- Germination tests may be needed before use.
- Provide stratification if needed for that species.

References

Nursery Manual for Native Plants, a Guide for Tribal Nurseries (USDA)

Pesticide Use

Review FSM 2150 Pesticide-Use Management and Coordination and FSH 2109.14 Pesticide-Use Management and Coordination Handbook before using pesticides.

Human Health and Ecological Risk Assessments have been prepared for many of the pesticides commonly used by the Forest Service. These are an excellent source of technical information on

individual pesticides and provide project planners with a rigorous science-based assessment of the risks to non-target organisms.

The Forest Health Protection (FHP) staff within State and Private Forestry consists of forest entomologists, plant pathologists, foresters and forest health technicians who are available to consult with you on a wide range of forest health and forest health-related issues. FHP staff can be asked to conduct forest health assessments and provide expert recommendations on forest pests and their management. FHP also provides pesticide-use management and coordination support and assistance to the Eastern Region. FHP technical (and sometimes financial) assistance is available to forest personnel upon request. To access FHP assistance contact:

Mike Bohne	FH Group Leader	Durham, NH	603.868.7708	Green Mountain & Finger Lakes NF; White Mountain NF
Rick Turcotte	FH Group Leader	Morgantown, WV	304.285.1544	Allegheny, Monongahela and Wayne NFs
Sonny Lucas (acting)	FH Group Leader	St Paul, MN	651.649.5180	National Forests in the Midwest and Lake States

Pesticides (in general)

Pesticides are any substances, or mixture of substances, intended to prevent, destroy, repel, or mitigate any pest; or any substance, or mixture of substances, intended for use as a plant growth regulator, defoliant, or desiccant.

- Pesticides should be used as part of an "Integrated Pest Management" or IPM approach. In general, the elements of an IPM approach include the following:
    - Take steps to prevent the introduction of pests.
    - Monitor pest populations to know when it is necessary to implement control methods.
    - Determine a tolerance threshold, above which damage by pests is not acceptable, and consider using pesticides only when that damage threshold is exceeded.
    - Try multiple non-chemical (cultural) methods to control pests such as physical removal of pests, removal of susceptible or affected plants or plant parts, and encouraging or introducing biological control agents (natural enemies).
    - If non-chemical control methods are not effective use pesticides and application methods which are (a) approved for use in controlling the identified pest, and (b) have reduced effects on non-target species.
- Select the correct formulation and follow label directions regarding dosage, application rate, and timing of application for the target species.
- Select pesticides with reduced toxicity to pollinators.
- Adjust the timing of pesticide treatment to minimize exposure risk to pollinators. This may include using pesticides before plants bloom or spraying in the evening or at night, taking into consideration the half-life of pesticides.
- Always follow mixing, disposal and cleanup instructions on the label
- Implement mitigating measures as necessary to minimize pesticide drift or runoff into unintended areas. This includes, but is not limited to:

    - establishing untreated buffers between treated areas and monarch habitat and applying pesticides when weather conditions best minimize drift; and
    - paying attention to the proper droplet size for the target pest and ensuring that application equipment is properly calibrated.
- Ensure that applicators of pesticides (contractors and FS personnel) have completed the necessary training and hold the proper certification(s) to apply pesticides.
- For all pesticide applications on National Forest System lands, a pesticide use proposal (PUP) must be created, reviewed, and approved by appropriate staff prior to application.
- Follow Regional and Forest-level best management practices (BMPs) related to pesticide use.

Insecticides

Insecticides are substances used to control insects. The effects are variable in that insecticides may target all stages of an insect or just a single stage. Similarly, toxic effects may be solely limited to the target and/or related insects (e.g. caterpillars) or be broader to include other insects that are not targeted for control (i.e. non-target effects). Monarchs and other pollinators are susceptible to many insecticides.

- Diagnose the insect problem correctly which includes the proper identification of the pest. You may request technical assistance from the FHP staff to conduct an evaluation and recommend a course of action to help achieve your management objectives.
- Use an application method that best targets the insect pest.
- When possible, time insecticide use to the season or time of day when pollinators are least active in the target area.
- If possible, avoid using seeds or seedlings that have been treated with neonicotinoids for planting projects in areas of known monarch activity during the year.
- Avoid the use of broad-spectrum, long-lasting insecticides if possible. Some of these products can still be toxic days or weeks after application to many insects visiting treated plants, including monarchs and other pollinators.

References

North American Pollinator Protection Campaign (NAPPC) brochure Solving Your Pest Problems without Harming Pollinators

Herbicides

Herbicides are used to kill plants. Some herbicides kill all plants (nonselective), while others kill only certain kinds of plants (selective). Since herbicide use can strongly influence the local plant community their use can have a direct connection to monarchs, both adults and caterpillars. Milkweed plants can be killed by many herbicides, as can other plants that monarch adults use as nectar sources. Most units have established invasive plant control programs; consult specialists in these programs for more information on NNIP control beyond the general guidelines presented below.

- Identify invasive plants correctly to avoid harm to native plants.
- Use herbicides efficiently and effectively, considering selectivity of herbicide, mobility and volatility, formulation and concentration necessary, adjuvants, timing, drift, weather, and method of application. Follow all label directions.

- Avoid damage to non-target plants that may provide food and shelter for monarchs and other pollinators.
- If practical, consider hand-pulling weeds rather than using herbicides in areas commonly used by monarchs.
- Use herbicides before plants in the target area flower to minimize exposure to pollinators after flowering occurs.
- If pollinators are active in or near the treatment area try to select treatment methods that would minimize exposure. For example: choose treating buckthorn with a cut stump and brush-on method as opposed to using basal spray; and choose basal spray before foliar spray. Use the lowest effective dose that will achieve your management objectives. Avoid herbicides with long residual effects.
- Communicate with adjacent landowners regarding encroaching weeds and herbicide drift. Work with Forest Service partners such as cooperative invasive species management areas (CISMA) to ensure use of BMPs to protect pollinators when using herbicides.

References

Roadside Best Management Practices that Benefit Pollinators, Handbook for Supporting Pollinators through Roadside Maintenance and Landscape Design US Dept. of Transportation, Federal Highway Administration

BMPs for Wildland Stewardship, CA Invasive Plant Council and Pesticide Research Institute

Forest Pest Control

- Request technical assistance from the FHP staff to conduct a forest health evaluation of the problem and to recommend a course of action to help achieve your forest pest control objectives.
- Consider valuable monarch and pollinator habitat in the planning process to determine whether or not treatments are necessary in forested areas adjacent to these habitats.
- Consider the ecological cost associated with treating or not treating areas for non-native invasive species (NNIS) such as the emerald ash borer (EAB), gypsy moth and hemlock woolly adelgid (HWA). If the trees are critical habitat for pollinators or other species, examine what treatment options (if any) may be available. Within and surrounding monarch habitat, use the most targeted method available if the area must be treated.
- Select treatment products with reduced toxicity to pollinators. For defoliators like gypsy moth the nuclear polyhedrosis virus product Gypchek is a good option to use where and when other caterpillars are actively feeding. Gypchek does not adversely affect monarch larvae or any other life stage of the insect (egg, larva, pupa, adult). *Bacillus thuringiensis var. Kurstaki (Btk)* may adversely affect actively feeding monarch caterpillars, but has no effect on other life stages of monarchs (eggs, pupae, adults) or other pollinators (flies, bees, wasps).
- Examples of other control measures that are harmless to monarch and other pollinators include the use of insect pheromones to disrupt dispersal, aggregation or mating; mass trapping; and release of biological control agents (natural enemies). These may be effective in certain or unique situations, but not in all cases. The FHP staff serving your forest can provide the

appropriate and effective recommendations to address your forest pest problem and minimize adverse effects to monarch, other pollinators and other non-target organisms.

- Neonicotinoid insecticides such as imidacloprid and dinofefuron are critical tools (and in some cases the only effective tools) to control NNIS like HWA and EAB. Selection of trees to be treated and the proper application technique to use must be taken into account to ensure that nearby trees and plants that depend upon pollinators do not take up the insecticide. The FHP staff serving your forest can provide assistance and advice with these site and application assessments.

References

Natural Resources Conservation Service Pollinator Biology and Habitat, Michigan Biology Technical Note No. 20, April 2013 (revised 3/2014)

Emerald Ash Borer, Evaluation of Systemic Insecticides to Control Emerald Ash Borer
Biological Control of the Emerald Ash Borer

Insecticide Options for Protecting Ash Trees from Emerald Ash Borer

Impacts of Insecticides on Monarchs

Emerald Ash Borer Management Options

USFS Pest Alert, Hemlock Woolly Adelgid

Integrated Pest Management

Outreach & Education

- Utilize opportunities such as staff meetings to present monarch threats and opportunities.
- Post or share printed materials within FS offices.
- Consider developing an interpretive display for offices and visitor centers. Bringing a monarch larva inside to be watched as it feeds, pupates and hatches can spur interest.
- Consider developing a brochure (or adapting an existing flyer from partners) showing local species of milkweed and easy-to-grow native nectar plants. Showcase these species in native plant and pollinator gardens at administrative sites.
- Consider developing a unit-specific handout on sources to obtain local native seed and plants for milkweed and nectar forb species. Share with employees, partners, gardening groups and the public.
- Share opportunities to participate in monitoring and learning activities with all employees.
- Partner with local schools and conservation organizations to deliver monarch outreach.
- Provide interpretive signage where appropriate (see examples of USFS Interpretive Panels at the Celebrating Wildflowers site).
- Consider certifying new or enhanced habitat through the Monarch Waystation program, and installing a waystation sign.

- Utilize resources available from various organizations to develop outreach programs. Some examples include:
    - USFS Celebrating Wildflowers Monarch Page and Monarch Teacher & Student Resources
    - MonarchLIVE – A Distance Learning Adventure
    - Bas Relief, LLC
    - Journey North: Symbolic Migration, informational lessons
    - MJV: Monarch Conservation Webinar Series
    - MJV: Free resources including presentations
    - Monarch Lab Curricula: Monarchs and More Curriculum, Schoolyard Ecology Explorations Curriculum, Driven to Discover Monarch Curriculum
    - Monarch Live! A Distance Learning Adventure
    - Monarch Watch-In the Classroom
    - Texas Wildlife Association Youth on-demand Webinar The Magic of Monarchs.

Captive Raising Monarchs /Monarch Handling

Due to the potential for spread of disease and for disrupting genetic diversity, Monarch Joint Venture, Xerces Society, University of Minnesota Monarch Lab and others do not recommend using large-scale captive rearing of monarchs to supplement natural populations. Small numbers of wild-collected eggs or larvae may be raised for educational purposes.

- Not more than 10 wild caught eggs, larvae or pupae should be raised and released per educator per year.
- Be conscious of monarch diseases and appropriate prevention and treatment.
- When using captive reared monarchs in displays and programs, ensure fungi, bacteria, viruses and parasites are kept at a minimum by proper cleaning of nets, cages, tables and other equipment.
- Keep rearing containers clean. Sterilize initially with a 20% bleach solution in addition to placing cages in full sunlight for several days. These measures kill nuclear polyhedrosis virus (NPV/baculoviruses) as well as *Ophryocystis elektroscirrha* (OE) that may be present.
- Sterilize milkweed picked for forage with 10% bleach solution and triple rinse. Consider sterilizing eggs to remove OE.
- Keep milkweed in cage fresh; keeping the stem in a jar with water or wrapped in a damp paper towel covered with foil or plastic wrap will help prevent drying.
- Do not handle early instar larvae, wait until they are at least 3-4 days past hatching. Do not handle when they are molting or about to molt. Do not handle newly emerged adults; wait 3-4 hours.
- Keep larvae separate from adults.
- Do not release adults to the wild until several hours after emerging, or the next day. Release them in a warm, protected area near flowers.
- Avoid extreme temperature and moisture conditions; maintain airflow in containers.
- Regularly remove frass from containers.

Figure A1-3. Cages used for raising monarchs indoors. (Photo credit: Sue Trull, USDA Forest Service).

References

Monarch Joint Venture Rearing Monarchs Responsibly

Captive Breeding and Releasing Monarchs

International Butterfly Breeders Association, Monarch Disease Control

Monitoring and Tracking

- Monitor success of planting and habitat enhancement projects, mowing timing trials, and other activities, checking for establishment of milkweed, use by monarchs, establishment of nectar forbs that bloom in in early-, mid- and late-season, etc. Use results to inform future habitat projects and for adaptive management. Share your observations and lessons learned with other forests.
- Following implementation, enter habitat improvement, planting and related projects into FACTS and WIT as appropriate, using the 7000 and 7100 codes and marking the monarch initiative field, or enter data as otherwise directed by the Regional Office
- The Monarch Conservation Science Partnership is working on an integrated monitoring framework. This may be a tool for national forest units to use in the future.
- Citizen Science opportunities have developed monarch monitoring protocols that can be used on national forests. Priority for participation in these programs will vary between forests but is encouraged to provide a more balanced sampling effort (see Figure A1-4). For example, migration monitoring programs may be a higher priority on forests within monarch flyways. Data collected through these programs is used by scientists to understand monarch populations and habitat use, to model their ecological niche, and to predict how monarch populations may respond to changing conditions. The main monitoring programs are outlined below.

    - Journey North: tracks various species that migrate, including monarchs. Events to report include adult monarchs seen, peak migration events, night roosting. Data are used in real-time maps.
    - Monarch Watch: a program that places small tags on monarch wings for data gathering. Forests can order the tags and operate capture and tag events.
    - Peninsula Point is a place within the Hiawatha National Forest where monarchs gather to cross Lake Michigan. Migration censuses are conducted in early August through September. See also: http://www.fs.usda.gov/detail/hiawatha/news-events/?cid=STELPRDB5312060.
    - Monarch Larval Monitoring Project: Run by researchers at the University of Minnesota, larval populations and milkweed habitat are tracked.
    - Project Monarch Health: this data collection effort focuses on the protozoan parasite OE.

More information on these and other monitoring programs is available from the Monarch Joint Venture: http://monarchjointventure.org/get-involved/study-monarchs-citizen-science-opportunities

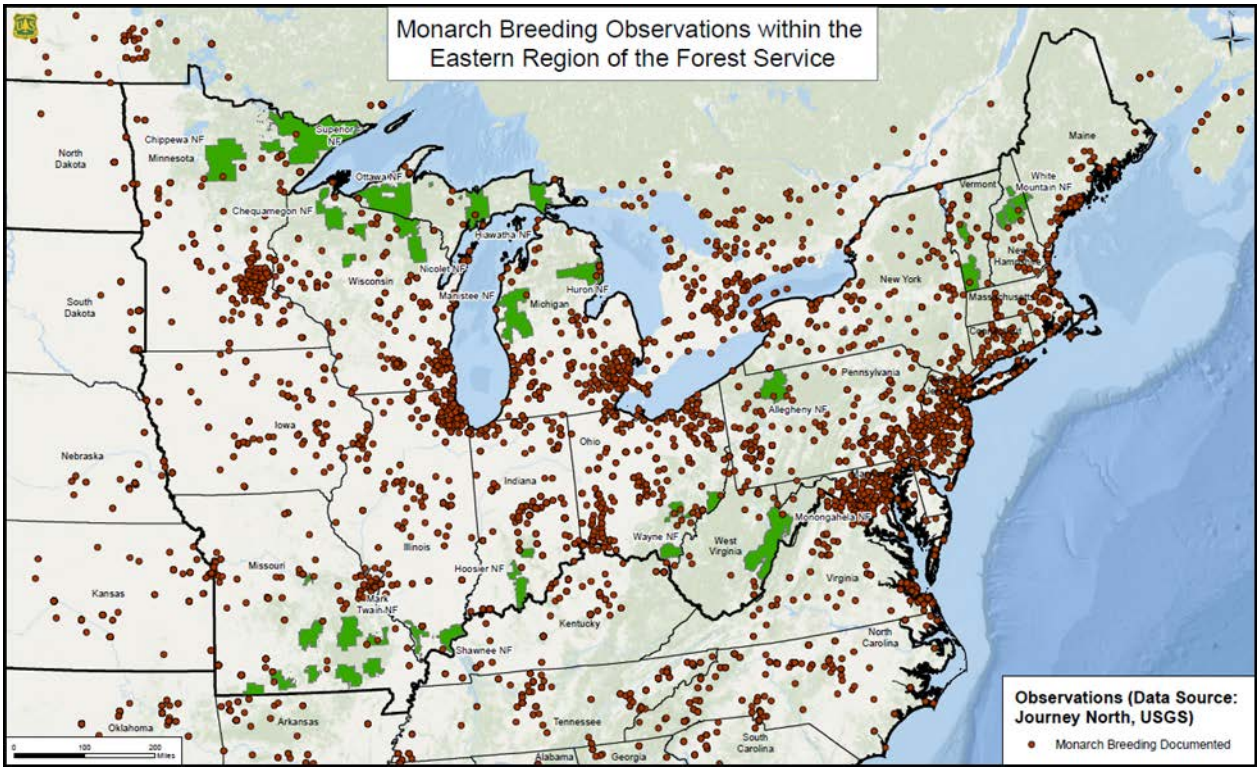

Figure A1-4. Journey North citizen science program observations of monarch breeding within the Eastern Region of the Forest Service. You can see observations clustered in metropolitan areas. The implied higher density of monarchs is mainly due to increased observer numbers and citizen input. National Forest units are under-represented. Submitting data to these citizen science programs will improve the knowledge base for monarchs.

Appendix 2: Some funding sources that support monarch conservation work

This appendix provides a list of some known sources of funding for monarch conservation work. These are primarily national programs that may be more difficult to access than local or regional programs. Some of these funds are not available directly to federal agencies, but may be applied for by or in conjunction with partners. Consider this list a starting point.

Monarch Butterfly Fund Small Grants Program: Provides limited support (<$2500) to projects that address conservation, scientific research and monitoring, outreach and education, or sustainable development. http://monarchconservation.org/grants/small-grants-program/

Monarch Joint Venture (MJV): MJV provides funding for habitat improvement projects. Check with MJV on deadlines and requirements. http://monarchjointventure.org/our-work/mjv-funded-projects

National Fish and Wildlife Foundation (NFWF): NFWF has more than 70 grant programs for protection and restoration of wildlife habitat. Grants are available to federal, state and local governments. Applications are completed through on-line application form.

In 2015, the National Fish and Wildlife Foundation (NFWF) established the Monarch Butterfly Conservation Fund to protect, conserve and increase habitat for monarchs and other pollinators. $3.7 million are available for funding projects in 2017. http://www.nfwf.org/monarch/Pages/home.aspx.

National Forest Foundation (NFF): NFF provides grants for on-the-ground conservation and restoration projects that improve Forest Health and the Outdoor Experiences. Grants can be applied for by non-profits, universities, tribes both through competitive and non-competitive processes. Although National Forests cannot apply directly for funds, their partners can apply for funds for work to be carried out by the partner on National Forest land. https://www.nationalforests.org/grant-programs.

NFF Matching Award Program https://www.nationalforests.org/grant-programs/map

U.S. Fish and Wildlife Service (USFWS): USFWS has a cooperative grant opportunities available to tribes, organizations, colleges and universities, non-profits and state and local government. Habitat improvement work can be completed through partners on National Forest lands. https://www.fws.gov/grants/programs.html.

In 2015 USFWS provided more than $2 Million dollars to help conserve pollinators, mussels and other at-risk-species in the Midwest States with a State Wildlife Grant Program https://www.fws.gov/midwest/news/784.html.

The USFWS and NRCS have also added the monarch to the Working Lands for Wildlife program, which aims to help species recover by working with agricultural producers to make wildlife-friendly improvements on their farms, ranches and forests. Assistance is available to producers in Illinois, Indiana, Iowa, Kansas, Minnesota, Missouri, Ohio, Oklahoma, Texas and Wisconsin. This program is focused on private land, but may be a useful tool in working with partners in an all-lands approach.

Additional Grant Opportunities: Additional opportunities for a wide variety of grants can be found at http://www.grants.gov/

Appendix 3: Existing Partnerships for Monarch Conservation within the Eastern Region

National & Regional Partnerships and Agreements

- Service-wide MOU with **Xerces Society** (signed 8/2014; 14-SU-11132421-200)
- Challenge Cost Share Agreement with **Xerces Society** to create BMPs for Western Rangelands (signed 2016)
- Service-wide MOU with **North American Butterfly Association** (signed 8/2014; 14-SU-11132421-187)
- Service-wide MOU with the **BLM and FS for the Conservation and Management of Pollinator Species** (signed 12/2015)
- Service-wide MOU stablishing the **Federal Native Plant Conservation Committee of the Plant Conservation Alliance** (signed 6/2014; 14-SU-11132421-352)
- Service-wide MOU with **Garden Club of America** (signed 2/2009; 09-SU-11132421-074)
- Service-wide MOU on **Vegetation Management for Powerline Rights-of-Way with Edison Electric Institute & Utility Arborist Association** (signed 9/2016)
- Service-wide MOU with **Pollinator Partnership** (signed 4/2015; 15-MU-11132421-168)
- US FS WO Master Challenge Cost Share Agreement with the **Pollinator Partnership** (signed 1/2012; 12-CS-11132421-086)
- Service-side MOU with **Botanic Gardens Conservation International** (signed 3/2013; 13-MU-11132422-030)
- Eastern Regional Challenge Cost Share Agreement with the **Pollinator Partnership** (signed 8/13; 13-CS-11090100-014)
- Monarch Joint Venture (http://monarchjointventure.org/)

Existing Local & Regional Partnerships

- U.S. Fish and Wildlife Service: Some forests have had success working with their local field office to fund monarch projects (Chequamegon-Nicolet, Midewin)
- Departments of Natural Resources (or equivalent in your state) offer a wide variety of collaboration opportunities. The Midewin has collaborated with the Illinois DNR to do work on both Forest Service and DNR lands using Wyden amendment authority. Many states are beginning to initiate pollinator and monarch programs, and some are convening partners to initiate state-level coordination regarding monarchs (e.g. state monarch summits).
- The Nature Conservancy
- Local or regional land conservation organizations. For example, the Midewin has partnered with The Wetlands Initiative and Openlands, regional not-for-profits in the Chicago area.
- Private charitable foundations. For example, the Midewin has partnered with the Grand Victoria Foundation and the Gaylord and Dorothy Donnelly Foundation, Chicago-area charitable foundations, to fund monarch conservation projects.
- Sportsmen's groups, such as National Wild Turkey Federation, Ruffed Grouse Society, Pheasants Forever, Wildlife Unlimited (local chapters and state-wide organizations)
- Garden Clubs

- Native Plant Societies (e.g. Wild Ones, State Native Plant Societies)
- Master Gardener or Master Naturalist organizations
- Butterfly organizations: The Superior partners with Northern Crescents, a local citizens butterfly group, to conduct butterfly surveys
- School districts
- Individual and group volunteers.

Local & Regional Partnership Ideas (Suggestions from Forests)

- State Pollinator Joint Ventures (e.g. Ohio Pollinator Habitat Initiative)
- State Natural Heritage programs (monitoring)
- State Conservation Corps (for example, Minnesota Conservation Corps, or YCC)
- Tribal governments
- Soil and Water Conservation districts, USDA Farm Bureau and Natural Resources Conservation Service (NRCS): NRCS and conservation districts work extensively with private landowners and Farm Bill programs that can be used for habitat conservation. Collaboration with NRCS may also lead to an opportunity to apply for funding through the Joint Chiefs initiative.
- Cooperative Weed/Invasive Species Management Areas (CWMA, CISMA)
- Northeastern Area State and Private Forestry (USFS)
- Northern Research Station (USFS)
- Universities and Technical Colleges
- Zoos and Botanical Gardens (often have expertise and resources for education and outreach)
- Special Use Permit holders (individual or commercial, such as utility companies)
- Audubon Society local chapters
- Youth groups, such as Boy Scouts and Girl Scouts.

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