



Monarch Butterfly (*Danaus Plexippus Plexippus*)

Field Guide

The monarch butterfly (*Danaus plexippus plexippus*) is a brushfooted butterfly with large, orange and black wings that uses open prairie, meadow, open woodland, gardens, and roadside habitat with suitable milkweed species for larvae and nectar plants for adults. This monarch butterfly subspecies is unique, however, in that its multi-generational migration life strategy necessitates widespread breeding and food resources at the right places at the right times (MAFWA 2018). Destruction and alteration in breeding, migrating, and wintering habitats, including loss of adult and larval food and places to live during critical stages of its life cycle over the past 30 years have reduced its range and abundance. At one time, the monarch was common in most states east of the Rocky Mountains during the breeding season and they gathered in large numbers on the wintering grounds in Mexico. Based on 20 years of wintering grounds surveys, the eastern population has fallen from approximately one billion to fewer than 35 million monarchs, representing a decline of 97% from the 1997 high and a 90% decline from the 20-year average (Rendon-Salinas and Tavera-Alonso 2014). It is considered vulnerable in Pennsylvania (NatureServe 2019), which serves as its summertime breeding habitat.



Photo courtesy of Jim Hudgins (USFWS)

The U.S. Fish and Wildlife Service (USFWS) was petitioned in 2014 to list this species. The USFWS announced in 2015 that listing may be warranted.

The agency is currently preparing the Species Status Assessment with the listing decision expected in December of 2020. In the interim, significant and expansive conservation measures are being undertaken throughout the species' range to boost populations in hopes of avoiding the need to list. The proactive conservation measures underway prior to the 2020 listing decision may preclude the need for listing; however, such measures will need to be maintained in order to prevent further population declines.

LIFE HISTORY

The eastern monarch butterfly population has a unique migratory behavior, traveling from their breeding range in the central to northeastern United States down to a single overwintering area in the mountains of central Mexico (Brower 1995). Those that survive the winter in Mexico mate, lay eggs, and fly north. These adults make it to the southern states before they lay eggs and die. The next generation begins reaching the northern core breeding range in April and May when milkweed foliage becomes available (NatureServe 2019). Based on 2019 records, migrating adults begin to arrive in Pennsylvania in mid-April (Journey North 2019). During an average summer in North America, several generations of breeding butterflies will be produced. The final generation or "super generation" of eastern monarch adults, that emerge in late summer and early fall, migrate to the overwintering grounds in central Mexico.

Within their breeding habitats, mated females lay hundreds of eggs on the underside of milkweed leaves during their 2- to 5-week lifespan. Monarch females lay a single egg at a time but will move from leaf to leaf on a suitable milkweed plant. Although the reason(s) has not been identified, monarchs lay more eggs per milkweed stem bordering agricultural fields than in non-agricultural areas (Pleasants and Oberhauser 2013). Eggs hatch in 3 to 8 days. Larvae take 10 to 14 days to go through five instar stages before pupating (Pelton et al. 2018). Monarch metamorphosis from egg to adult occurs in 25 days at warm temperatures to 49 days in cool conditions (MCSP 2018). Monarch eggs and larvae have mortality rates of over 90% during the egg and larva stages (Nail et al. 2015), while adult mortality rates are undocumented.

HABITAT

Monarchs use numerous habitat types, providing milkweed and nectar are readily available. They have been documented in emergent and scrub-shrub wetlands, croplands, hedgerows, grasslands and old fields, dunes, savannas, suburban yards, orchards, roadsides, and open woodlands (NatureServe 2019).

LARVAL HOSTPLANTS

Milkweeds (*Asclepias* spp.) are the sole larval hostplant for the monarch, though the species of milkweeds used varies by region (Xerces 2018). The butterfly might possibly use any species of milkweed in its habitat, but in northern states like Pennsylvania eggs or larvae are most often observed on common milkweed (*Asclepias syriaca*), followed by swamp milkweed (*A. incarnata*) and butterflyweed (*A. tuberosa*) (MCSP 2018). The milkweed leaves from young or intermediately aged plants are preferred (Fisher et al. 2015). This preference may be due to levels of cardiac glycoside toxins which depend on species, sun exposure, and previous herbivory (Agrawal et al. 2012, Oyeyele and Zalucki 1990).

The level of monarch activity is directly related to the density of milkweeds (Pleasants et al. 2017). The increases in acreage of glyphosate-tolerant crops are negatively correlated to monarch numbers, with the area of milkweed in U.S. farm fields declining from an estimated 213,000 to 40,300 ha (>80%) since the 1990s (Pleasants & Oberhauser 2012). Furthermore, the declining availability of milkweed resources has been shown to be the driver of the decline in the size of the overwintering monarch population (Pleasants et al. 2017; Flockhart et al. 2015).

ADULT NECTAR PLANTS

Adult monarchs are opportunistic nectarivores. They feed on seasonally blooming flowers throughout their northward migration, breeding period, and southward migration. As observations indicate that monarchs arrive in Pennsylvania as early as late April (Journey North 2019), a limited floral resource is likely to be early blooming trees and shrubs. While these target species should be included in restoration plantings, it is also equally effective to target nectar and milkweed plantings near areas that already include spring-blooming plants (i.e., hedgerows, old farmsteads with fruit trees, scrub-shrub wetlands with willows, and American plum). During the summer, breeding adults nectar on many native perennial flowers such as milkweeds, native thistles, blazing stars, joe-pye weeds, bee balms, and ironweeds (Xerces 2018). With monarchs requiring substantial nectar resources for migration, fall nectar supply is also critical. Plantings that include a high diversity of goldenrods and asters provide this late season nectar for the migrating adults.

HABITAT RESTORATION RECOMMENDATIONS

Priority areas in Pennsylvania

- Primary: North Core (West of Appalachian Mountains)
- Secondary: North Exterior (East of Appalachian Mountains)
- Areas surrounding agricultural lands are essential to reaching restoration targets because they occupy a large percentage of all potential monarch habitat (Thogmartin et al. 2017).

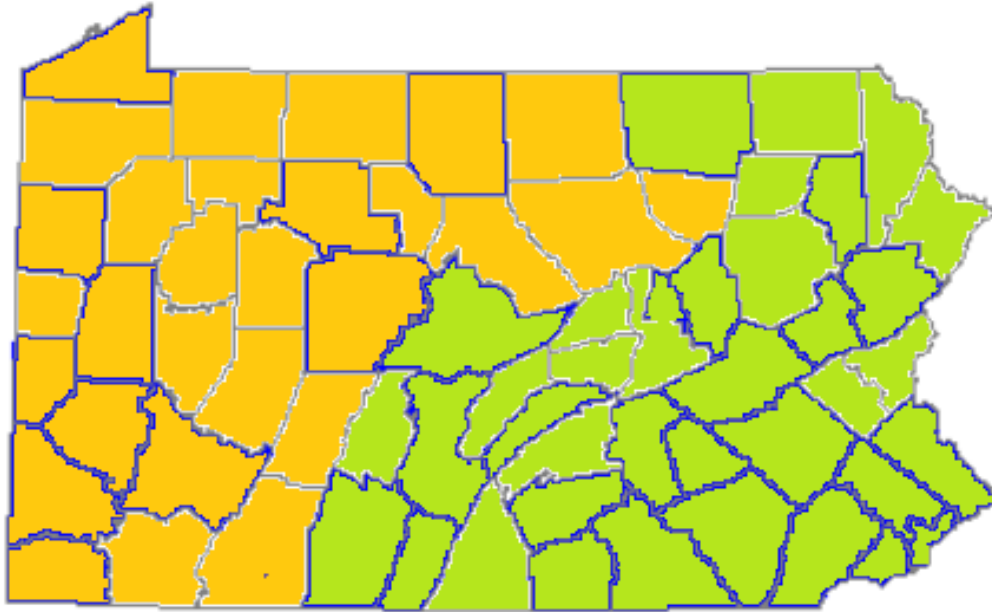


Figure 1. Priority areas of North Core (primary; orange) and North Exterior (secondary; green) zones of the eastern population of Monarch Butterfly (*Danaus plexippus*) in Pennsylvania.

Habitat Sub-Types and Target Species

Meadows with spring to fall nectar supply and high milkweed stem density in patches or borders

- Larval host plants
 - o limiting factor for populations (Flockhart et al. 2015; Pleasants et al. 2017)
 - o southern exposure will provide for early milkweed emergence (Journey North 2019), although planting within a variety of microhabitats will ensure milkweed will be available throughout the spring, summer and fall
 - o target 500 stems/acre (Kaul and Wilsey 2019)
 - *Common milkweed (*Asclepias syriaca*) – throughout; moist soil
 - Swamp milkweed (*Asclepias incarnata*) – throughout; moist to wet soil
 - Butterfly weed (*Asclepias tuberosa*) – all but northern excluding Erie Co; dry to moist soil

*most important northern host plant (MCSP 2018)

- Adult nectar sources - critical to span period from mid-April to mid-October
 - o Spring nectar – select sites with existing sources or supplement
 - Abandoned orchards or hedgerows with early blooming fruit trees
 - Wetlands or streambanks with American plum, chokecherry, and willows
 - Forest edges with mountain laurels or native azaleas
 - o Summer and fall nectar – preserve or restore high diversity native meadows

Common Name	Species	Period	Range in PA
Spreading Dogbane	<i>Apocynum androsaemifolium</i>	Su	Throughout
Indian Hemp	<i>Apocynum cannabinum</i>	Su	Throughout
Swamp Milkweed	<i>Asclepias incarnata</i>	Su	Throughout
Common Milkweed	<i>Asclepias syriaca</i>	Su	Throughout
Butterfly Weed	<i>Asclepias tuberosa</i>	Su	All but Northern, excluding Erie County
Buttonbush	<i>Cephalanthus occidentalis</i>	Su	Throughout
Redbud	<i>Cercis Canadensis</i>	Sp	Southern counties
Field Thistle	<i>Cirsium discolor</i>	SuAu	All but Erie Basin and West Central
Pasture Thistle	<i>Cirsium pumilum</i>	SuAu	Throughout
Blue Mistflower	<i>Conoclinium coelestinum</i>	SuAu	Southern and Erie County
Boneset	<i>Eupatorium perfoliatum</i>	SuAu	Throughout
Grass-Leaved Goldenrod	<i>Euthamia graminifolia</i>	SuAu	Throughout
Joe Pye Weed	<i>Eutrochium fistulosum</i>	SuAu	Throughout
Spotted Joe Pye Weed	<i>Eutrochium maculatum</i>	SuAu	Northern Tier, Southeast, Southwest
Sweet Joe Pye Weed	<i>Eutrochium purpureum</i>	SuAu	Throughout
Wild Geranium	<i>Geranium maculatum</i>	Sp	Throughout
Spotted Geranium	<i>Geranium maculatum</i>	Sp	Throughout
Thin-Leaved Sunflower	<i>Helianthus decapetalus</i>	SuAu	Throughout
Woodland Sunflower	<i>Helianthus divaricatus</i>	SuAu	Throughout
Smooth Oxeye	<i>Heliopsis helianthoides</i>	SuAu	Throughout
Blue Flag Iris	<i>Iris versicolor</i>	SpSu	All but Susquehanna Basin
Shaggy Blazing Star	<i>Liatris pilosa</i>	Su	Southern
Tall Grayfeather	<i>Liatris scariosa</i>	Su	Appalachian Range
Dense Blazing Star	<i>Liatris spicata</i>	Su	Southeast, Allegheny Watershed
Blue Lupine	<i>Lupinus perennis</i>	Sp	All but Northern Tier and Southwest
Scarlett Beebalm	<i>Monarda didyma</i>	Su	All but Appalachian Ridge Top
Wild Bergamot	<i>Monarda fistulosa</i>	Su	Throughout
Purple Bergamot	<i>Monarda media</i>	Su	Southwest, Eastern Border
Foxglove Beardtongue	<i>Penstemon digitalis</i>	Sp	Throughout
Eastern Smooth Beardtongue	<i>Penstemon laevigatus</i>	Sp	Western
Wild Blue Phlox	<i>Phlox divaricata</i>	Sp	All but Northeast Counties
Creeping Phlox	<i>Phlox stolonifera</i>	Sp	Appalchian Ridge Counties
Wild Plum	<i>Prunus Americana</i>	Sp	All but Northeast
Choke Cherry	<i>Prunus virginiana</i>	Sp	Throughout
Hoary Mountainmint	<i>Pycnanthemum incanum</i>	Su	All but Allegheny Watershed
Bigleaf Mountainmint	<i>Pycnanthemum muticum</i>	Su	Southeast
Narrowleaf Mountainmint	<i>Pycnanthemum tenuifolium</i>	Su	Throughout
Virginia Mountainmint	<i>Pycnanthemum virginianum</i>	Su	All but Northern Tier

Black-eyed Susan	<i>Rudbeckia hirta</i>	Au	Throughout
Black Willow	<i>Salix nigra</i>	Sp	Throughout
Silky Willow	<i>Salix sericea</i>	Sp	Throughout
White Goldenrod	<i>Solidago bicolor</i>	Au	Throughout
Canada Goldenrod	<i>Solidago canadensis</i>	Au	Throughout
Wreath Goldenrod	<i>Solidago caesia</i>	Au	Throughout
Early Goldenrod	<i>Solidago juncea</i>	SuAu	Throughout
Gray Goldenrod	<i>Solidago nemoralis</i>	Au	Throughout
Sweet Goldenrod	<i>Solidago odora</i>	Au	Eastern
Roundleaf Goldenrod	<i>Solidago patula</i>	Au	West and Southeast
Downy Goldenrod	<i>Solidago puberula</i>	Au	Eastern
Wrinkleleaf Goldenrod	<i>Solidago rugose</i>	Au	Throughout
Showy Goldenrod	<i>Solidago speciose</i>	Au	West and Southeast
Bog Goldenrod	<i>Solidago uliginosa</i>	Au	Northeast and Northwest
Smooth Blue Aster	<i>Symphyotrichum laeve</i>	Au	All but Upper Allegheny Basin and Southwest
Calico Aster	<i>Symphyotrichum lateriflorum</i>	Au	Throughout
New England Aster	<i>Symphyotrichum novae-angliae</i>	Au	Throughout
Late Purple Aster	<i>Symphyotrichum patens</i>	Au	All but Erie Basin and Allegheny Watershed
Heath Aster	<i>Symphyotrichum pilosum</i>	Au	Throughout
Crookedstem Aster	<i>Symphyotrichum prenanthoides</i>	Au	Throughout
Purplestem Aster	<i>Symphyotrichum puniceum</i>	Au	Throughout
Ohio Spiderwort	<i>Tradescantia ohioensis</i>	SpSu	Western
Virginia Spiderwort	<i>Tradescantia virginiana</i>	Sp	All but Northern Tier and Southwest
Wingstem	<i>Verbesina alternifolia</i>	SuAu	All but North Central and Northeast
Giant Ironweed	<i>Vernonia gigantea</i>	SuAu	Western
New York Ironweed	<i>Vernonia noveboracensis</i>	SuAu	All but North Central and Northeast
Culver's Root	<i>Veronicastrum virginicum</i>	Su	All but North Central, Erie, Susquehanna and Wayne Counties

Restoration Approaches

Objective – In areas with spring blooming trees and shrubs, create dry or wet meadow habitat using suitable target nectar species with a milkweed-dense border or patches

- 1) Crop Field Conversion adjacent to spring blooming trees and shrubs
 - Herbicide – One application to control annuals
 - Native meadow seed mixes with spring forbs– selected for soil type
 - Milkweed seeds or plugs to achieve 500 stems/ac of two species in border
- 2) Hayfield/Pasture Conversion adjacent to spring blooming trees and shrubs
 - Herbicide – Two applications to control perennials and annuals
 - Native meadow seed mixes with spring forbs– selected for soil type
 - Milkweed seeds or plugs to achieve 500 stems/ac of two species in border
- 3) Warm season grass areas lacking forbs
 - Mow in Spring to 4 inches
 - Plant nectar plants between grass clumps
 - Plant milkweed plugs in border surrounding nectar planting
- 4) Suitable nectar and larval habitat lacking spring blooming trees and shrubs
 - Clear adjacent area to create hedgerows or swales
 - Plant area with bareroot trees and shrubs from target list
 - Plant shade-tolerant, spring-blooming forbs from target list under trees

LONG TERM MAINTENANCE

- 1) Existing Habitat
 - The species presence in the vicinity should be documented. Databases such as Journey North (<https://journeynorth.org/sightings/>), Monarch Watch (<https://monarchwatch.org>), and Butterflies and Moths of North America (<https://www.butterfliesandmoths.org/species/Danaus-plexippus>) should be queried. Local naturalists should be surveyed. As misidentification is unlikely, vouchers are not necessary for this species. Photo documentation is warranted.
 - If present, evaluate the existing disturbance regime (e.g., burning, mowing, cattle grazing). Where an existing population has been maintained without fire, do not introduce fire as fire is much harder to manage on small portions of the habitat. If fire has been used, burn one-third of habitat areas after monarchs have migrated on a 3- to 10-year cycle (Pelton 2018).
 - Due to presence of cardiac glycoside toxins in milkweed, grazing may pose a risk to livestock if not carefully controlled (Pelton et al. 2018, Borders and Lee-Mäder 2014). Management to increase milkweed for monarchs would not be advisable if unmonitored grazing occurs in the area.
 - Late winter mowing on a 3- to 5-year rotation is recommended for nectar areas as is practiced for other pollinator habitats. In addition, mowing one-third of milkweed borders or patches surrounding the nectar areas should occur each year before egg laying peaks (July 15 in PA) to maximize monarch butterfly reproduction (Knight et al. 2019). If milkweeds are dispersed within nectar habitat, mow one-quarter of the entire habitat during the middle of the day when adults are most active. The mower blade should be set at 10-12" to ensure rapid regrowth (Pelton et al. 2018).
 - Buffers of at least 150 feet should be in place between pesticide-treated crop fields. Milkweeds are sensitive to herbicides including glyphosate (Hartzler 2010; Pleasants and Oberhauser 2013). Neonicotinoids can impair growth of butterfly larvae at environmental concentrations (Whitehorn

et al. 2018). Best Management Practices must be implemented to ensure that pesticide drift does not cross buffers into monarch habitat.

2) Restored Habitat

- Conduct surveys and/or use citizen scientists to monitor butterfly occupancy
- Use late winter mowing to maintain nectar areas on 3- to 5-year cycle
- Use early July mowing of one-third of milkweed each year to maximize monarch butterfly reproduction (Knight et al. 2019)
- Maintain an adequate buffer to prevent effects from pesticide drift, particularly glyphosate and neonicotinoids

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