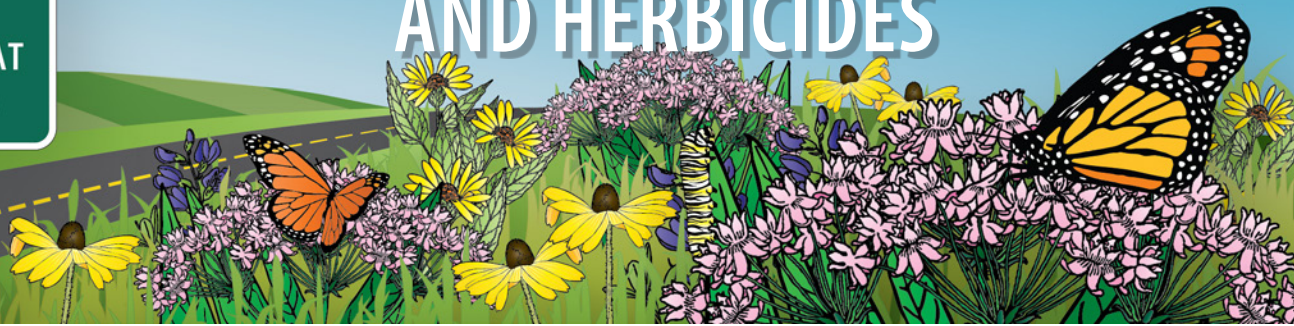


MONARCH BUTTERFLIES, WEEDS, AND HERBICIDES



Monarch butterflies are in decline in North America, and restoring monarch habitat, including roadsides, is important to the species' recovery¹. Monarch caterpillars require milkweed (primarily in the genus *Asclepias*) to complete their development. A diversity of milkweed species is found on roadsides^{2,3}, and monarchs lay their eggs readily on milkweed plants in roadsides⁴ and consume nectar from milkweed flowers.

Roadsides provide more than just milkweed; they can also provide diverse nectar sources to feed adult monarchs and other pollinators. Nectar fuels adult monarchs in their breeding, migration, and overwintering. Adult monarchs feed on nectar from a variety of blooming plants, including wildflowers and shrubs, throughout the growing season. Spring flowers support monarchs as they leave their overwintering grounds to breed, and summer flowers support several generations of breeding monarchs. Fall-blooming flowers are also important, as monarchs migrating to overwintering grounds require lots of nectar to build fat reserves to support their long-distance flights and sustain them through the winter.

Noxious and invasive weeds can degrade habitat for monarchs by displacing valuable nectar plants and milkweed. Herbicides are a tool employed by many transportation departments and other land managers to control noxious and invasive weeds or encroaching woody vegetation. However, some herbicide uses have nontarget effects that reduce the quality of roadside habitat for monarchs by removing flowering plants and milkweed plants or reducing plant diversity over time. This guide highlights best management practices to reduce the impacts of herbicides on monarchs.

Best Management Practices

Roadside managers and other vegetation managers can reduce the impacts of herbicide use on monarch butterflies by:

1. using herbicides within an integrated approach that incorporates a range of methods to prevent and manage weeds and non-compatible vegetation,
2. limiting nonselective broadcast applications, which can damage host or nectar plants,
3. using herbicides as efficiently as possible to reduce the amount applied,
4. reducing off-site movement of herbicides, and
5. limiting direct exposure of monarchs to herbicides when possible.

Specific management practices to reduce risk to monarchs from herbicide applications include:

Applicator Training

- ⇒ Train staff and contractors to distinguish noxious and invasive weeds and encroaching woody vegetation from similar species to reduce unintended damage to nontarget plants. For instance, training may help crews to distinguish the invasive Canada thistle (*Cirsium arvense*) from the native tall thistle (*Cirsium altissimum*), an important fall blooming native nectar plant for migrating monarchs in the central states.
- ⇒ Train applicators in herbicide application techniques that reduce damage to nontarget plants.
- ⇒ Create specifications that would hold contractors accountable to using proper techniques.

Assessment

- ⇒ Inventory roadside vegetation regularly to identify emerging noxious and invasive weed issues or encroaching woody

vegetation. Early detection of weeds can result in improved control and may reduce the amount of herbicide needed overall.

- ↪ Document desirable plants that may be present, such as native nectar plants and milkweeds.

Planning

- ↪ Use herbicides within an integrated vegetation management plan. Evaluate the range of management techniques (e.g., chemical, cultural, biological, physical, and mechanical) in order to select the most effective, feasible, and least harmful weed management method(s) that can increase or conserve the abundance and diversity of blooming plants.
- ↪ Prioritize selective herbicides—those formulated to control specific weeds or groups of weeds—whenever possible, to reduce damage to nontarget plants.
- ↪ If using nonselective herbicides—broad-spectrum products that kill or damage a wide range of plants—use direct or targeted application methods or apply when desirable plants are dormant. If possible, avoid applications during times when monarchs are present (Establish these times using on-site scouting as well as expected windows of monarch activity, found here: <https://monarchjointventure.org/images/uploads/documents/MowingForMonarchs.pdf>.)
- ↪ Coordinate spray operations with mowing crews to enhance weed control. For example, it may improve control to treat mature weeds when they are actively growing, shortly after mowing.
- ↪ Choose and calibrate equipment with drift management in mind. Use nozzles that produce larger droplets that are less likely to drift off target. Calibrate equipment regularly to avoid over-application.
- ↪ Select herbicides with low volatility, when feasible, to reduce the off-target movement of herbicide vapors. Do not apply herbicides when temperatures are high (see label for more information) or during temperature inversions, when herbicides are more likely to volatilize.
- ↪ Use appropriate drift control agents.
- ↪ Prioritize the use of formulations that are jointly terrestrial- and aquatic-approved, and that have lower residual activity and shorter half-life, when possible, in order to minimize potential impacts on the environment following application.
- ↪ Select adjuvants—products added to a spray solution to enhance performance of post-emergence herbicides—that are terrestrial- and aquatic-approved, and compatible with the selected herbicide formulation.



Swamp milkweed (*Asclepias incarnata*) growing along a roadside in Michigan. Identifying and recording the location of milkweed patches like this is a first step in ensuring that they are considered during subsequent maintenance operations. (Photo: Xerces Society / Jennifer Hopwood.)

Toxicity of herbicides to monarchs

Although herbicides are formulated to kill plants and do not target insects, recent research indicates that some herbicides may be toxic to butterflies, particularly when ingested by caterpillars eating treated plants. Often, the herbicides are not immediately lethal but still have negative effects such as reducing butterfly size, weight, development rates, and survival^{5, 6, 7, 8}. These sublethal effects may reduce butterfly populations over time⁶. These studies did not focus on monarchs and further research into the effects of commonly used herbicides, tank mixes, surfactants and other inert ingredients in formulated products on monarchs is needed.

Until more is known, we recommend a cautious approach when applying herbicides to milkweed where monarch caterpillars are present. Avoiding direct applications to milkweed plants when feasible, for example, can reduce direct herbicide exposure to monarchs.

Herbicide Applications

- ↪ Always apply herbicides according to label directions and use the minimum application rate that will effectively control the weed.
- ↪ Apply herbicides at the stage of growth when the weed is most vulnerable and the application likely to be most successful. This will be the seedling or rosette stage for some weeds. Consider the mode of action of the herbicide and the application technique when determining timing of application. For example, when using a systemic herbicide, treat perennial weeds in the late summer and fall, when perennials begin to move sugars down to their roots, so that the herbicide will be translocated to vegetative reproductive structures where it will be most effective at controlling the plant.
- ↪ When possible, treat plants before they convert from vegetative phase to floral phase and bloom; this will reduce the weed seed bank (reservoir of weed seeds in the soil). If weeds are treated just before bloom or after seed set, their populations may persist in future years. Treatment of weeds during their vegetative phase also reduce exposure of adult monarchs to herbicides and adjuvants.
- ↪ Apply herbicide sprays when weather conditions will minimize drift. Avoid applications when wind speeds are greater than 10 mph. Avoid applications during a temperature inversion (when warmer air above traps cooler air near the ground); these conditions cause herbicides and other pesticides to linger in the air, where they can move long distances off-site with any air movement. No wind or wind speed below 2 mph suggests a possible inversion.
- ↪ Make direct, selective applications to target plants to avoid weakening nontarget species. Target weeds or non-compatible species using spot treatment applications made with a backpack sprayer, weed wiper, or similar technology. Use highly targeted applications to cut stems, stumps, or underneath bark. Limit the use of broadcast treatments or pellet dispersal only for dense infestations of weeds or non-compatible vegetation, or for safety zone or guardrail treatments.
- ↪ Use an approved marker dye with spot treatments or cut stem/stump treatments to allow the applicator to know the target has already been treated and the extent of target coverage. Spray dyes reduce likelihood of an accidental retreatment or missing treatment of a target weed.

Post-Treatment

- ↪ Keep records of locations where herbicides are applied. Records on the plants treated, application method, type and amount of herbicides used, and dates of application can help to evaluate the effectiveness of treatments over time and can be useful when adjusting management decisions. Your state agency charged with education or regulation of pesticide use will have example application record keeping forms that can be used. Multiple seasons of herbicide applications or other weed control methods may be needed to fully control an invasive species.
- ↪ Follow label directions and standard practices when rinsing or cleaning spray equipment in between work

Use of noxious or invasive weeds by monarchs

Adult monarchs feed on nectar from a variety of blooming plants, including some noxious weeds or invasive nonnative plants (such as Canada thistle, *Cirsium arvense*). However, if invasive species become dominant, this can reduce the diversity of other plants available to provide nectar throughout the season. For example, if Canada thistle is the only flowering plant present in a stretch of roadside, monarchs will only have nectar available to them from that single species which blooms during a small portion of the growing season, rather than a diverse patch of vegetation that could provide nectar from spring through fall. Hence, managing invasive plants will generally increase the abundance and diversity of plants that support monarchs and pollinators throughout the growing season.

In highly degraded landscapes where native nectar sources are scarce, the large-scale removal of the noxious or invasive species may cause a short-term reduction in nectar for monarchs. In these circumstances, reseed with native blooming plants that are attractive to monarchs, known to compete well with weeds, and bloom within the first few years of planting in your seed mix. In time, these species and other native perennial plants should deter recolonization of invasive plants and provide a haven for monarchs and pollinators.

sessions; incomplete removal of a prior herbicide mix can have detrimental impacts to the next treatment area.

- ☞ Rinse off, or otherwise clean mower decks (upper and undersides), deflectors, gear box housing, and mower blades and shafts, between sites to avoid transferring weed seeds. This is especially important after mowing an area known to contain noxious or invasive weed species.
- ☞ After treating a dense infestation, consider seeding or replanting the area, if necessary (e.g., if the seed bank was depleted of desirable species). Plant with desirable, competitive native species to reduce the need to re-treat the area. Always make sure that seed and vegetative planting stock is free of weed species.
- ☞ After treatment, monitor resulting conditions and outcomes to evaluate the effectiveness of management practices on target plants and any effects on nontarget plants. If desired conditions were not produced or if site conditions change, adapt management practices accordingly.



Selective herbicide applications such as this treatment for Johnson grass (*Sorghum halepense*) can control the undesirable weeds while allowing milkweeds and other desirable plants to thrive. (Photograph courtesy Texas DOT.)

Resources

Monarch Joint Venture: Roadsides as Habitat for Monarchs

<https://monarchjointventure.org/roadsidehabitat>

Xerces Society: Regional guides to monarch nectar plants

<https://xerces.org/monarch-nectar-plants/>

Federal Highway Administration: Environmental Toolkit Review: Pollinators

https://www.environment.fhwa.dot.gov/env_topics/ecosystems/pollinators.aspx

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