technical manual

POLLINATOR PARTNERSHIP

Technical Manual for

Maintaining Roadsides for Pollinators

Establishment, Restoration, Management and Maintenance

A Guide for State DOT Managers and Staff

Mary Galea, Vicki Wojcik, Ph.D., Laurie Davies Adams, and Evan Cole

POLLINATOR PARTNERSHIP

info@pollinator.org • www.pollinator.org •

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Photo: Leah Lewis

How to use this guide

Pollinators are essential to our ecosystems and to agriculture but they are in trouble. Habitat loss, pesticides, pests, invasive species, and climate change are threats to bees, butterflies, birds, moths, and other insects that pollinate. Supporting habitat for pollinators is key, and roadsides across the country add up to more than 17 million miles of potential habitat. The roadsides that you manage and maintain have can help support pollinators. Modifications to your existing maintenance practices can make the difference and they include four simple steps:

1. Reduce mowing.
2. Use an Integrated Vegetation Management approach to address weed and pest issues.
3. Plant or seed native plants to enhance habitat.
4. Record and monitor your efforts.

This guide provides you with information on roadside enhancements that allow you to maintain safe and accessible roadsides and support pollinators. The information that follows outlines the science and research that lets us develop technical guidelines, case studies of roadside management for pollinators, and background on pollinator biology as a resource. If you are interested in pollinator biology you can use the content on pages 26-32 as a reference.

Introduction

There are many reasons for the roadsides of America to be planted with pollinator-friendly plantings; economic, ecological, and aesthetic. Since most visitors arrive to your state via vehicle and many form their perception of a location based on its roadsides, we understand how important it is to maintain roadsides. However, achieving an esthetic standard that everyone can agree upon is difficult. This guide provides the tools needed to design and maintain roadsides in a way that promotes pollinators and to communicate your actions in a positive light to the public.

FAST Act Pollinator-Beneficial Provisions

For the first time ever in American history, encouraging pollinator habitat along our nation's roadsides is the law of the land! "Fixing America's Surface Transportation Act (FAST Act-Public Law 114-94)" became law on December 4, 2015, providing a timely exclamation point to the "Transportation Leaders Summit: Restoring the Nation's Pollinator Habitat," convened by the White House on December 3-4, 2015. The Pollinator Partnership was part of the blueprint presented at this summit for state departments of transportation to make the most of this opportunity on roadsides everywhere. Here are some of the details:

Section 1415 of the FAST Act directs the Secretary of Transportation to use existing authorities, programs and funding to encourage pollinator habitat efforts through reduced mowing and integrated vegetation management (IVM) practices by willing State DOT's.

In support of this objective, Section 1415 also amends Section 329(a)(1) of Title 23,U.S.C., to make it clear that States can utilize funds provided for Section 329 "Eligibility for control of noxious weeds and aquatic noxious weeds and establishment of native species" on activities related to "habitat, forage, and migratory way stations for Monarch butterflies, other native pollinators, and honey bees."

Section 1415 does NOT authorize or provide new funding. The new law makes it clear that each State has the authority to utilize funds from its existing formula allocation of surface transportation funds if the State so chooses on activities related to pollinator habitat.

State DOT's have opportunities to invest in pollinator habitat by modifying maintenance practices through integrated roadside vegetation management (IRVM), when managing for invasive species, and when landscaping roadsides during new construction and rehabilitation projects. State DOT's also have the opportunity to establish pollinator gardens and information signage at rest stops to help educate the motoring public about the many benefits of IRVM and pollinator habitat along roadsides.

An important supporting role of the Federal Highway Administration is to provide guidance and encourage States to use federal funds on pollinator habitat activities.

There is also a Transportation Alternatives Program (TAP) under existing law. The national total reserved for the TAP is equal to 2 percent of the total amount authorized from the Highway Account of the Highway Trust Fund for Federal-aid highways each fiscal year. Eligible activities include landscaping and other scenic beautification—and thanks to Section 1415, now activities related to pollinator habitat.

Go to http://www.fhwa.dot.gov/environment/transportation_alternatives for more information. On this site you can find guidance, funding and links to additional resources. Go to http://www.fhwa.dot.gov/environment/transportation_alternatives/funding for information about funding. Go to http://www.fhwa.dot.gov/environment/transportation_alternatives/state_contacts.cfm for the TAP coordinator in your State.

Interested stakeholders can advocate for the use of eligible funds for pollinator habitat and offer to partner with States, leveraging scarce State resources through in-kind assistance and funding.

States are clearly in the lead on behalf of their citizens in realizing the potential of this new provision. As State DOT representatives showcased during the White House "Transportation Leaders' Summit: Restoring the Nation's Pollinator Habitat," much exciting work is already underway in a number of States in advancing this objective. P2 collaborated with leaders of State Departments of Transportation (DoT's), Administration officials and other key stakeholders at the Summit with the shared objective of advancing efforts to expand and improve pollinator habitat on transportation assets across the Nation.

Section 1415 is based on H.R. 2738, the Highways BEE Act, which was introduced prior to 2015 National Pollinator Week by Reps. Jeff Denham (R-CA) and Alcee L. Hastings (D-FL), co-chairs of the Congressional Pollinator Protection Caucus (CP2C). Sen. Kirsten Gillibrand (D-NY) secured a pollinator roadsides provision based on the Highways Bee Act in the Senate-passed bill. Rep. Denham led the effort to add the same language in the House-passed bill.

Advocacy efforts in support of the Highways BEE Act endured over 5 years, with the legislation first introduced in the House in 2011. Over 250 national, regional, and local organizations and 3,000 American scientists and individuals from all walks of life across the nation signed a petition in support of such legislation. For more information, go to pollinator.org/BEEAct.htm.

The Pollinator Partnership (P2) believes this statutory enhancement constitutes a major win for both States and pollinators. Highway right-of-ways managed by State Departments of Transportation (DOT's) represent 17 million miles of opportunity for States to both save money and improve pollinator habitat through Integrated Roadside Vegetation Management (IRVM), including reduced mowing and strategic plantings of native forbs and grasses and non-invasive plantings. Such win-win opportunities are also available for roadsides managed by counties and municipalities in each State.

Roadside Ecology and Pollinators

Roadways come in many forms, ranging from dirt roads, paved city streets, to interstate highways. Each of these road types can have both negative and positive impact on landscapes, wildlife, and people. Roads, regardless of type or size, fragment natural, urban, and agricultural landscapes into ever-smaller areas, irregular polygons, often referred to as habitat islands (Forman 1995; Dramstad et al. 1996). Dividing landscapes into smaller parcels has consequences on the plants and animals of those regions and neighboring areas. Fewer species can live and reproduce on smaller habitat islands (MacArthur and Wilson, 1967). Increased distances between critical habitats can isolate populations, or prevent species from moving naturally through a landscape. For example, bees have limits to their daily foraging activities. Generally, small bees travel only 600 feet or less to find food; some larger bees (such as carpenter or bumble bees) can travel up to a couple of miles. If abundant, quality habitat is not located within this scale, the bees simply won't be able to provision for their nests and populations will decline.

Roadways have been shown to function as natural conduits in both facilitating and causing the long-distance dispersal and establishment of plants and animals (Von Der Lippe and Kowarik 2007), creating long, interconnected tracts of habitat that pollinators inhabit. In some cases this can mean the spread of weeds and invasive species. Weedy and invasive plants have unique interactions with pollinators as they can provide food and resources. Pollinators can favor weeds, and in some cases, they can assist in their proliferation, making weed management more challenging.

Vehicular traffic introduces and spreads gasoline, motor oil, ethylene glycol (anti-freeze), other chemicals and debris such as automobile tires. Roadways are managed with chemical and mechanical disturbances that can cause potential negative impacts on species. Roads in colder climates are salted or sometimes treated with sand; this will also impact the characteristics of that roadside habitat, especially after spring rains wash salt onto roadsides. The specifics of pollinator interactions with roadway pollution, salt, and run-off are not well known. While it can be assumed that these factors would negatively impact pollinators, there are some species, such alkali bees, which prefer

more salty soils. Observations of bee nesting in soils have also shown higher concentrations in areas where there is more run-off.

Plant growth is often exuberant, thick and tall along roadsides during the growing seasons due to the increased concentration of water that results from runoff. Roadside flowers are visited heavily by all pollinating insects, butterflies, moths, beetles, wasps, ants, and bees. Beekeepers have utilized flowering roadsides as transient bee pastures to capture honey flows in many areas. Roadways could also create new areas, strips or patches of open compacted ground and may enhance nesting of certain native ground-nesting bees. And while there is habitat fragmentation caused by roadways, the habitat created along roadways and their associated verges can play significant roles in habitat connectivity, perhaps compensating for the some of the negative impacts. Throughout this guides there are numerous recommendations for enhancing the vegetation along roadsides to benefit pollinators.

Managing to Promote Pollinators on Roadsides

Roads require continuous management for accessibility, visibility, and user safety. This results in the maintenance of an early successional stage of plants presumed to be a positive habitat for pollinators. The approaches and techniques used to create and maintain a safe roadway or to ensure that weeds and other invasive species do not persist include mowing, burning, grazing, herbicide and pesticide use. Roadside that are managed and restored to mimic natural grasslands are preferred and used by more pollinators.

Mowing

Mowing is the most common management technique used to eliminate taller growing species that could obstruct views for drivers along roads or become fuel for fire. Frequent mowing can result in a carpet of grass with little or no known ecological value, or it can increase weediness and negatively affect local pollinator diversity by reducing the diversity of food availability (Valtonon et al. 2006). Targeted and selectively reduced mowing has been shown to positively impact the occurrence of pollinators and other species as it generally results in landscapes with increased plant diversity.

Local ecological and phenological patterns need to be considered to ensure that mowing does not interfere with the peak bloom or growth periods of key plant species. For example, do not mow milkweed plants during monarch migration while monarchs are laying their eggs on the milkweed leaves. Doing so would

reduce the number of the imperiled butterfly. While not mowing at all can lead to a landscape that is dominated by a few plant species that do not provide resources to pollinators, mowing too often or at the wrong time can reduce or eliminate floral resources for pollinators (Rasmont et al. 2006). Targeted mowing is when a decision is made whether and how often to mow, study results show that single-season mowing is better than no mowing, but targeted mowing efforts produce the most pollinator richness (Ries et al. 2001; Wynhott et al. 2011).

A study of roadside management in the Netherlands showed that increasing mowing to twice a year and removing mowing residues had the greatest positive impact on moth and butterfly diversity (Noordijk et al. 2009). This same study found that bumble bees were particularity positively influenced by roadside mowing (Noordijk et al. 2009). Based on this research, aim to mow twice per year depending on the growth period of key plant species.

Herbicide Use and Weed Management along Roadsides

The direct impact of herbicides on local pollinator communities results from the reduction of their food supply, which has been seen in milkweed loss throughout the Midwest (Pleasants and Oberhauser 2012). Studies of utility landscapes managed using IVM showed increases in pollinator occurrence and nesting at sites treated with herbicides when compared to those that were not treated, and this was linked to increases in floral diversity (Wojcik et al. 2016). Guidelines that aim to protect pollinating species in managed landscapes suggest minimizing the use of herbicides, or suggest treating the landscape in thirds to avoid the creation of pollinator deserts. Removing flowering species, of course, will impact food supplies and subsequently pollinators are expected to be reduced. When using herbicides, do not treat the entire roadside during one single treatment period. Instead, treat the roadside vegetation in thirds so the pollinators have a constant food supply. When possible, reduce the use of herbicide to increase the number of pollinators the roadside is supporting.

Mortality along roadsides: a cause for concern?

Accounts of the potentially negative impacts of roadsides focus on pollinator mortality, however most studies show that while mortality is a factor it is often lower in restored roadside habitats and not a significant factor in overall pollinator mortality. Some pollinators do indeed get killed by traffic, but the positive benefits to pollinators outweigh the small losses.

Are roads barriers to pollinator movement?

No. Roads were not found to be barriers to the movement of butterflies, nor were populations of butterflies separated by even busy roadways genetically isolated from each other, again indicating fluid species movement (Munguira and Thomas 1992). There are con-

trasting findings regarding whether bees do or do not cross roads. Bhattacharya et al. (2003) suggest that bees do not cross roads in suburban landscapes. Hopwood et al. (2010) observed that bumble bees do in fact cross roads when foraging along roadsides, although they tend to preferentially forage along the linear transects created by wildflower seeding efforts. Pollinators have the ability to fly and therefore can overcome some obstacles that grounded species cannot. While they can cross roadways, questions exist as to whether they do so easily, often, and safely.

Beautification and Restoration

Roadsides are often actively seeded with wildflower seeds as part of highway or municipal beautification projects. In other cases, roadbuilding requires the stabilization and restoration of landscapes that are seeded with plant mixes. Both of these cases provide opportunities to enhance the diversity of local native flowering plants which has been shown to increase pollinator occurrence. The pollinator support capacity of roadsides can be enhanced significantly with native plant seeding.

Step by Step

Maintaining roadsides for pollinators is easier when you follow tried and tested BMPs. The following BMPs have been proven helpful to many, but like any land management project, use what is applicable to your site and disregard what is not helpful. Some of these steps are especially helpful if you are engaging community partners in your roadside management or if you are seeing resistance within an agency, department, or location. If you are all clear to begin the process of adding pollinator –friendly vegetation, skip to Pollinator Habitat Site Selection. (page 13)

Build a Team, Gain Support

To make pollinator habitat projects as smooth and successful as possible, it is important to gain internal support from within your agency and the community. Evaluate whether it is possible to establish an internal Pollinator Habitat Team, and then reach out to the community for additional members as needed.


Photo: Laurie Adams

- Hold a public meeting
- Look for areas that provide opportunities for connectivity to existing pollinator habitat.
- Use the rubric on pages 24-25 to communicate the standardized results to your team and partners to make a final site selection.
- If the site is known habitat for a sensitive species, review all laws, regulations, and guidelines. Consult with the U.S. Fish and Wildlife Service for additional guidance. Even the slightest change in sensitive habitat can have negative effects on the rare, threatened, and endangered species it supports.

Photo: Laurie Adams

Planning for Pollinators

Pollinator habitat does not happen overnight. Once partners have been established and an area identified, try creating a 5-year work plan for developing pollinator habitat along the selected section of roadside.

- Use the expertise your partners bring to the table; they could help with planning, planting, plant selection, education and outreach, and many other areas. Delegate tasks to bring diversity and increase wider commitment to the project.
- Like any project, your timeline and budget will drive the scale. Start small, gain support with your success, and scale up.
- When possible, incorporate a multi-year (3 years is the scientific standard) monitoring component to your pollinator habitat. Creating pollinator habitat along roadsides is a new concept for many, and others are eager to learn proven Best Management Practices.
- When and where possible, plan to have some bare

ground to support ground nesting native bees.

- Work with the maintenance department to draft a management plan.
- Although volunteer hours are not monetary, commitments from groups such as Master Gardeners or Master Naturalists in your community can be helpful. Weekly or even monthly commitments to perform specific site maintenance tasks will reduce overall maintenance costs, especially if Adopt a Highway or other supportive concepts can be implemented.

- Conduct a pre-pollinator habitat vegetation assessment and make a checklist of existing plants and pollinators or work with a partner that can perform this task. Use this information to evaluate the success of the project.
- Draft, fabricate and install signage alerting maintenance crews that an area is designated pollinator habitat to avoid unintended mowing or spraying.

Managing Expectations

This guide is intended to aid in the development of pollinator habitat in specific stretches of roadside. It is not intended to be used as a large-scale management plan, although large-scale pollinator habitat development is encouraged after success with initial projects.

- Think about possible limitations to the project; be transparent and realistic with your team and partners. Create a list of limitations, similar to the one below. The following are major anticipated constraints to successfully developing pollinator habitat (select all that apply):

  ❑ Invasive species

  ❑ Species at risk or sensitive habitat

  ❑ Winter road maintenance (i.e. salting, snow removal)

  ❑ Public perception

  ❑ Water access/drought

  ❑ Seasonal timing

  ❑ Existing mowing and maintenance schedules

  ❑ Adjacent lands

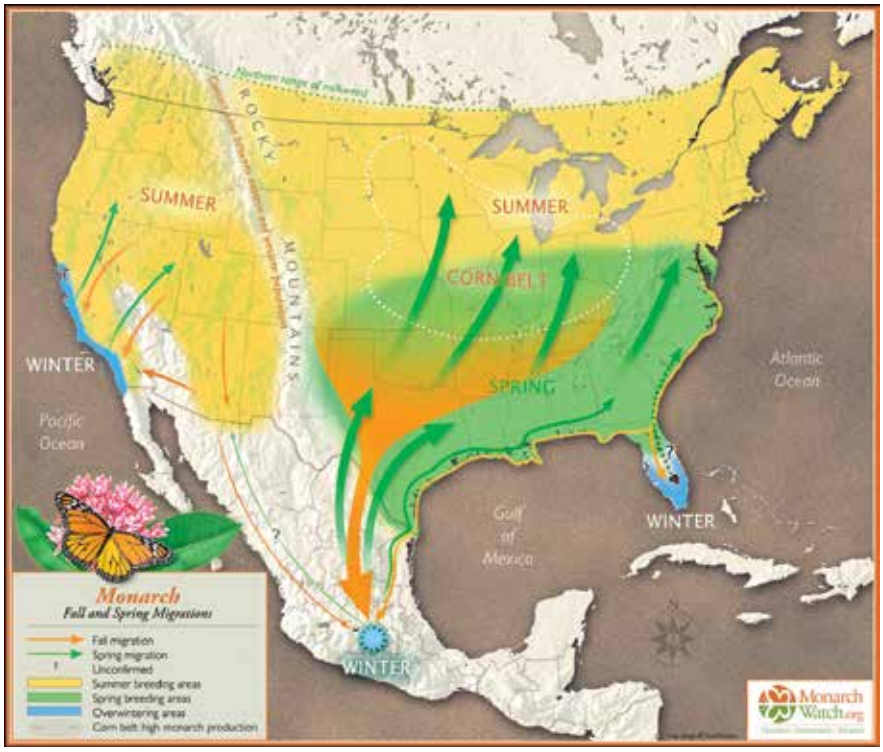
  ❑ Environmental deficits or challenges – lack of sun, high wind speed, intense traffic volume, etc.

- The above is not a comprehensive list; it can be used, along with the site evaluation rubric (pages 24-25), to begin identifying potential weak points in your project. Find ways to mitigate the issues before they turn into problems further down the road. For example, if the land adjacent to the project area is invaded with Japanese honeysuckle, you might try to contact the owner to see if he would be open to the plant material being removed by your crew free of charge. Then try to work with him to integrate their land into your Integrated Roadside Vegetation Management (IRVM) practices.

Pollinator Habitat Site Selection

Using the Site Evaluation Rubric on pages 24-25 begin evaluating potential project sites. The rubric is designed to help decision makers select a site for developing pollinator habitat along a roadway for the first time and intended to aid in objectively evaluating potential sites.

- Use the rubric to identify sites that pose the least amount of challenges for creating pollinator habitat.
- Look for areas that provide opportunities for connectivity to existing pollinator habitat.



but they are also adversely impacted when large swaths of habitat are removed.

• Manage mowing activities to reduce impacts on pollinators; consider a bi-annual mowing regime and leaving patches un-mowed so not all pollinator habitat is mowed down at once.

• Mow when the majority of plants are past bloom. Pollinators collect pollen and nectar from blooming flowers, after the flower is done blooming pollinator activity rapidly declines.

• Schedule mowing around pollinator activity. Certain times of the year are more active than others. See the monarch migration map at left for peak monarch activity in your region.

- Communicate the idea of a pollinator habitat project across your agency, inquire about proposed construction, and select a site that does not have any major construction planned.
- Use the rubric (pages 24-25) to communicate the standardized results to your team and partners to make a final site selection.
- Conduct a soil test to ensure that the sites will support pollinator-friendly plants. In general, some pollinator plants, like milkweeds for example, do well in acidic to slightly acidic soil, below a pH of 7 (neutral). If the pH is too high, the plants will not be able to absorb the available nutrients in the soil and will die.
- If the site is known habitat for a sensitive species, review all laws, regulations, and guidelines. Consult with the U.S. Fish and Wildlife Service, or in Canada with Environment Canada, for additional guidance. Even the slightest change in sensitive habitat can have negative effects on the rare, threatened, and endangered species it supports.

Mowing

There are several BMPs that can be applied to mowing regimes to reduce the amount of insect mortality. Not only are pollinators killed directly by the mower blade,

- Wherever possible mow only once a year in the late fall when the pollinator habitat has finished blooming.
- Mow at a slower speed and during the day when pollinators and other wildlife have a chance to escape.

Invasive Plant Removal

The removal of invasive plant material is more often than not one of the first actions needed in developing pollinator habitat. Pollinator-friendly plants have little opportunity to establish and thrive unless inva-

sive plants are removed. There are several BMPs for making this process as efficient as possible. Successful invasive plant removal takes time, commitment, and dedication to the process.

- Identify invasive plants during the planning stages of the removal.
- Set a manageable threshold of tolerance.
- Schedule and plan removal activities to reduce the spread of the invasive plants.
- Clean machinery, boots, and other tools used on-site to reduce the spread of invasive plant's seeds and other reproductive parts.
- Install desired plant material as quickly as possible after the invasive plant removal.
- Monitor the site frequently and have a plan in place for additional removal as needed.

Plant Selection

Pollinators depend on nectar and pollen for nutrient and energy. Flowering plants provide pollen and nectar resources; it is important that bloom periods coincide with pollinator emergence and activity to sustain both plant and pollinator populations.

- Provide continuous nectar and pollen sources from early spring through fall with native plants. Use a bloom chart to ensure continuous bloom. You can find one for your ecoregion at www.pollinator.org in the Eco-regional Planting Guide for your region - generally starting on page 16.
- In restoration planting projects, cluster plants of the same species together. This makes for more efficient foraging by pollinators.
- Maintain seed sources of locally adapted native plant species important to pollinators.
- Include larval host plants into seeding and planting mixes (i.e. milkweed).
- Remove non-native grasses from seeding mixes.
- Decide whether seeds, plugs or a combination of the two will be used.

Adopt-a-Highway program

Encourage active and interested community members and organizations to adopt a section of highway they have identified as pollinator habitat.

- Provide community groups with a list of pollinator-friendly plants they can plant along roadsides.
- Hold an Adopt-a-Highway information session to explain the program to the public.
- Provide community groups interested in a large-scale planting with a list of approved contractors.
- Work with the community to develop a multi-year work plan for the area(s) of roadside they are interested in managing for pollinators.

Spraying

When you use pesticides you could unintentionally harm pollinators and other beneficial insects. Your careful actions can prevent harming pollinators. When using pesticides, proper application and careful and coordinated timing can significantly reduce pollinator mortality.

- Use an Integrated Pest Management (IPM) approach which includes proper pest identification, monitoring, and evaluating all available factors in the environment potentially contributing to a pest problem IPM solutions can include mechanical removal of pests or setting a tolerance threshold. IPM does not mean land stewards automatically use pesticides to eliminate pests.
- Carefully diagnose your pest problem, and, before you apply a pesticide, make sure the pest population has reached a level where chemical control is necessary.
- Complete pesticide application before pollinator foraging plants bloom.
- Most pollinator poisoning occurs when bee-toxic pesticides are applied to crops during the bloom period. This is the time when pollinators are most likely to be attracted to the crop while actively searching for pollen and nectar. Coordinate spray timing with farms in your area to avoid spraying at peak crop bloom.
- Time applications to take place when foraging pollinators are least active both seasonally and daily (before 9am and after 3pm).
- Establish pesticide free buffer zones around important pollinator forge and nesting areas.
- Use all pesticides as directed.
- Treat less than 50% of any one pollinator's habitat in a single year.
- Minimize drift and broadcast spraying.
- Map each roadside, including areas to be protected.
- Consider climatic factors (wind direction and speed, temperature inversions, barometric pressure, fog, etc.) at the different times you spray.
- Plan buffer zones to intercept possible drift from sprayed sites.
- Check the weather forecast before pesticide application and be mindful of changing weather conditions during application. Optimal conditions are: mild breeze (>3 to <9mph) with considerable mixing of surface air, wind direction away from sensitive areas, cool and humid conditions.
- Follow the label directions regarding drift mitigation strategies.
- Do not spray when wind is blowing toward known pollinator habitats or areas where hives are placed.
- Always shut off the sprayer when making turns at field ends, near gardens, ponds, or other sources of water that may be used by pollinators.
- If available, use certified Drift Reduction Technolo-

gies (DRTs). In some cases the expense can be offset by incentives from USDA and other programs. Contact your local Extension Agent for information.


Photo: Caitlin Smith

- When doing hand removal of persistent multi-stemmed woody plants, consider carrying a spray bottle of herbicide on your belt and directly spray the cuts as you work through the site. This will avoid over spraying or killing desired plants, and spraying the cuts immediately will prevent the cut from healing over and allowing the undesired plant to persist and thrive.

Planting for Pollinators

Planting and seeding for pollinators will probably be one of the most engaging and rewarding activites your team and partners will undertake in creating pollinator habitat.

- Once your plant list is established, begin securing plants from commercial vendors. Be prepared to make minor adjustments due to availability.
- If plugs are being used, schedule the plant delivery as close to the planting date as possible. Designate a partially shared holding area with water to store


Photo: Caitlin Smith

Plugs are often more successful than seeds. A great resource for milkweed plugs is the Milkweed Market at http://monarchwatch.org/milkweed/market/.

the plugs until they are planted. Make sure someone is available to receive the plugs on delivery day. Never leave live plants in a car or truck.

- If planting using plugs or mature specimens, secure a water source that can be accessed the day of the planting and at a minimum of once per week for the 6 weeks following the planting. Increase watering in drought conditions.
- The planting windows in the Southern US are generally the early spring and late fall. Avoid planting young plug plants in the peak of summer as they may not receive enough water to establish roots and continue growing.
  In the Northwest there are several different planting windows depending on elevation and precipitation. The lower elevations west of the Cascades have a spring and fall planting window, while the east only has an early spring planting window.
  In the desert Southwest, plant in the winter (approximately November to March) so that the new plants can take advantage of the winter rains to help establish roots before the heat of summer.• Organize a planting day for community members to participate in the pollinator effort.
- Determine where plants will be planted before the planting day. Holes for plug plants can be dug with a basic trowel or small auger. To save time, have the holes dug in advanced.
- Generally, 3-5 plug plants are needed per square meter. Reduce this amount if using a combination of seeds and plugs.
- Deer graze along roadsides and if they prevalent in your area can eat your newly planted pollinator habitat. If your pollinator habitat is away from the roadway and operational zone, and the deer population is high, you might consider installing a temporary deer fence at least 7 feet high. There are many companies that provide deer fencing in various materials and price points.

Share the Success

Let the community know what your agency and partners are doing for pollinators!

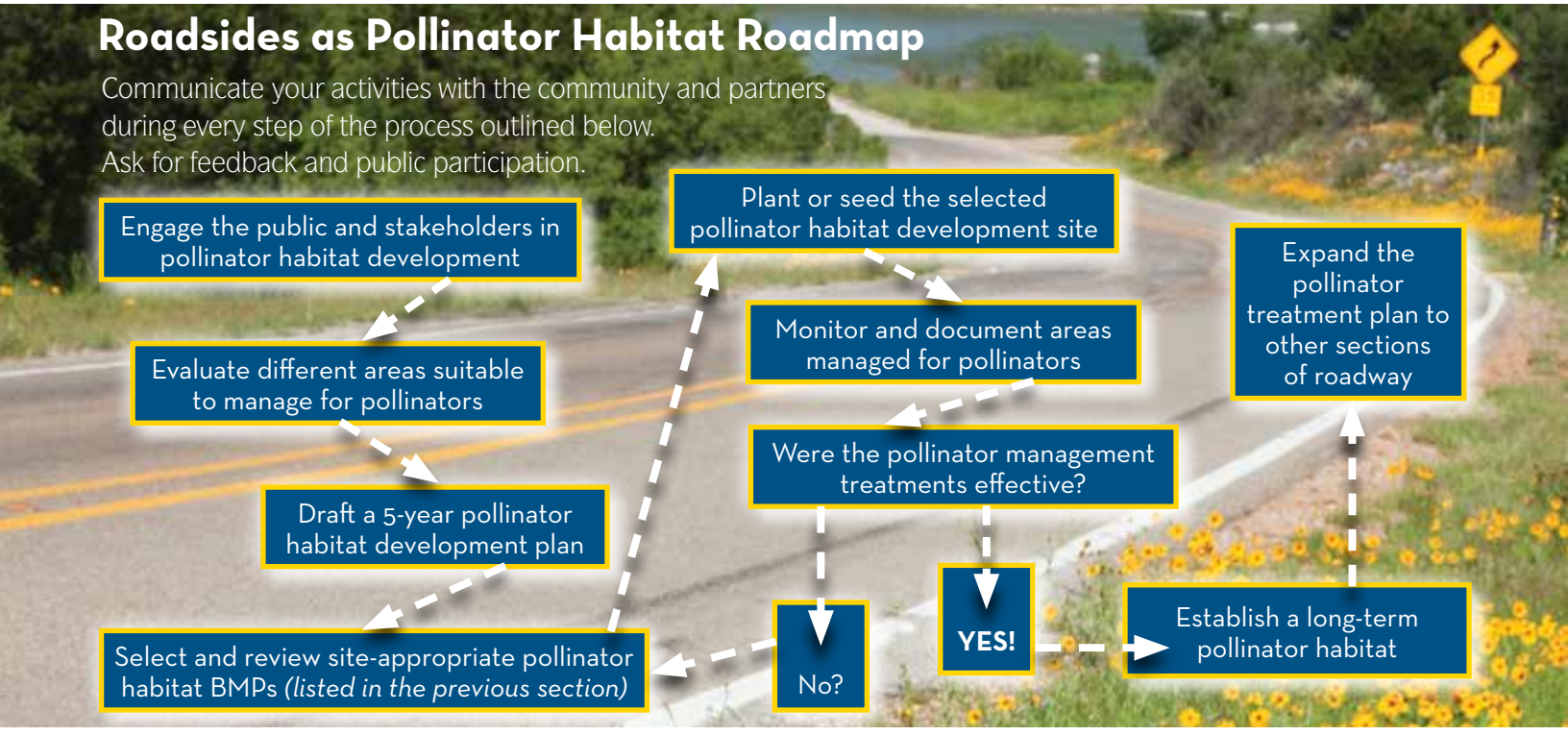
- Create a website, Facebook page, or a Twitter account to keep the public informed and engaged.
- Take before and after pictures.
- Post pictures of planting activities and the pollinators being attracted to the roadsides.
- Provide planting lists so members of the public can also plant for pollinators.
- Hold public meetings to communicate the status of the pollinator habitat throughout the course of the project. Make sure to invite varies partners and contributors to speak and be available for questions.
- Request outreach materials from the Pollinator Partnership.
- Register this site with the S.H.A.R.E. (Simply Have Areas Reserved for the Environment) program at: http://www.pollinator.org/SHARE.htm.
- Hold a Pollinator Week event and add it to the National Pollinator Week Event Calendar at www.pollintor.org.

Project Evaluation


Photo: Laurie Adams

Like any project, project evaluation is an important step in developing pollinator habitat. The entire team should participate in the evaluation process, and you should also seek additional comments from the broader community not represented on the pollinator project team. See Appendix X for a sample a blank form. Based on this initial project, use what you have learned to begin expanding pollinator habitat throughout other segments of your roadside landscape system.

- Before habitat construction, take an inventory of existing plants and pollinators. Identify plants and pollinators to their genus, if possible.
- Take 'before' pictures.
- After plants are established, conduct a pollinator survey or partner with an organization that can.
- After plant establishment (about 2 growing seasons) take the first of many 'after' pictures.
- Determine whether or not to install additional plant materials.



Roadsides Set the Table for Monarchs

At the University of Northern Iowa's Tallgrass Prairie Center the staff propagated milkweeds and collected seed for planting along Iowa's highway system. Through the Integrated Roadside Vegetation Management programs of the state of Iowa and with the guidance of Monarch Joint Venture biologists, the Tallgrass Prairie Center provides seed, technical assistance, training and education to county and state department of transportation staff. Since this effort began in 1998, 78 counties in Iowa and adjacent states have participated in the program and have helped restore 10,000 acres of roadside to natural vegetation, which includes milkweeds in many places. Under the direction of Dr. Laura Jackson, the Tallgrass Prairie Center is "setting the table" for the comeback of monarch butterflies, using native milkweeds [Wines 2013]. This model state program has fostered the kind of collaborations to implement tangible solutions on the ground, ones that are now being replicated in other states.

The Iowa-based initiative is not the only effort setting the table for monarchs. Over the years Monarch Watch has overseen the contract grow-out of hundreds of thousands of milkweeds for planting along roadsides and other public spaces. The annual production of milkweed grow-out capacity can increase if non-profit or corporate sponsors are able to make purchase commitments in advance of the planting season. Such roadside milkweed plantings have already occurred or are underway in Arizona, Iowa, Kansas, Minnesota, Texas and Virginia.

See more at: http://makewayformonarchs.org/i/archives/19#sthash.DsxDrxXz.dpuf

Plan, Don't React: Reducing Mowing and Spraying to Create Early Succession Habitat

The Washington Department of Transportation began a series of pilot land management tests along selected roadsides that aimed to reduce mowing and herbicide use involved in standard maintenance and weed control. A key shift was moving away from a reactive

Photo: Danelle Hevron Studio

model of weed management in favor of a planned, multi-year IVM cycle combined with the targeted removal of undesirable species. Goat grazing programs implemented over the past few years have eliminated mowing and resulted in a 70% reduction in the use of herbicides. Some trade-offs have been noted, including the persistence of some undesirable nuisance species, however, many of these species have pollinator value and the resulting ecosystem is more stable. Selective herbicide treatment is sufficient to maintain low levels of nuisance species, and the value of the landscape to pollinators is significantly increased. This program specifically targets roadside areas more than 30 feet wide which are managed to promote natural succession process at the site.

http://www.wsdot.wa.gov/Design/Roadside/Pollinators.htm

Special Actions Near Natural Pollinator Habitat

Many managed roadsides lie adjacent to remnant natural pollinator habitats. Nearness to managed roadways where non-native plants and weeds could colonize and degrade the native habitat could pose a threat to the habitat, however, this risk can be mitigated. The Washington DOT has developed a set of guidelines for managing roadsides near key native pollinator habitat. Guidelines for these sites include reducing and timing all mowing activities until after native wildflower blooms, leaving refugia areas undisturbed where possible and aggressively targeted the removal of invasive species that could threaten native prairie.

http://www.wsdot.wa.gov/Design/Roadside/Pollinators.htm

Adding Wildflowers Adds Value

Managing roadsides to promote pollinators and other ecosystem services has benefits that extend beyond maintenance cost savings. Healthy, functional ecosystems provide ecosystem service benefits, many of which can be valued in dollars. The Florida DOT recently compiled an assessment of the added environmental value of using IVM to enhance 1000 acres of roadsides with wildflowers. An increase of almost 15 million dollars worth of pollination and beneficial insect services was associated with this increase in wildflowers. Similarly, a cost savings of over half a million dollars was estimated for weed control from intact ecosystems. Florida has an estimated 93,000 acres of managed roadsides. Even a small increase in wildflowers made a huge difference in ecosystem services.

http://www.dot.state.fl.us/research-center/Completed_Proj/Summary_EMO/FDOT-BDK75-977-74-rpt.pdf

The Additive Approach: The 4B's of Pollinator Roadsides in Ohio

In many cases, adjustments to management plans that allow pollinator ecosystems to establish and rebound are used along roadsides because of the associated cost savings. Seeding wildflowers or creating habitat is more costly, and involves a higher degree of technical knowledge, but can have quicker impacts, as well as some that can't be realized with mowing and herbicide. In 2013 Ohio developed an integrated plan to support the 4 B's - birds, butterflies, bees and beauty – along roadsides. Selective actions such as intensive seeding of local wildflower mixes, milkweed planting, and providing set-asides for honey bee hives and coordination with local beekeepers aim to leverage the resources and capacity of the state road system. Working with local conservation organizations is a key element in the success of this program.

http://www.dot.state.oh.us/districts/D09/Pages/Bee-Pollinator-Program.aspx

Education, Outreach, and Certification

Your newly created roadside pollinator habitat will provide an excellent learning opportunity for everyone, from school children to college students and other land management professionals. It can also engage existing employees and attract new hires. Educational visits are also a great way to showcase your commitment to the community and connect with others. Registering your site as a S.H.A.R.E. site and holding an event during National Pollinator Week (both at www.pollinator.org) will ensure that others outside of your community will learn about the work your company is doing to promote pollinators.

Outreach

There are many ways to reach out to the community. Consider installing interpretive signage at rest stops so that any visitor to the site not only becomes more informed about pollinators but also learns about your state DOT and its commitment to the environment and community. Additionally, providing information on your website in the form of background, project summary, and future plans will reach beyond your local community to others that have interest in similar projects or learning more about your company. The Pollinator Partnership (P2) has completed a wide variety of projects utilizing outreach materials, and case studies are available at www.pollinator.org.

Certification and Recognition

Contact organizations such as the Wildlife Habitat Council (WHC) if you are interested in taking part in the Habitat Certification process. P2 can assist in connecting your state DOT to these types of organizations. Certification ensures that your habitat sustains pollinators and also puts your sustainability and habitat projects in the national spotlight. In addition, Pollinator Partnership's signature initiative, the North American Pollinator Protection Campaign (NAPPC) offers recognition to the best roadside pollinator habitat. Information can be found at www.pollinator.org/awards. Also, each site on your roadway should be registered as part of the Million Pollinator Garden Challenge, found at http://pollinator.org/million-pollinator-garden-challenge.htm. This will add to the connection (see below) that you roadside effort brings to a major continental movement for pollinator habitat.

Photo: JP Anderson

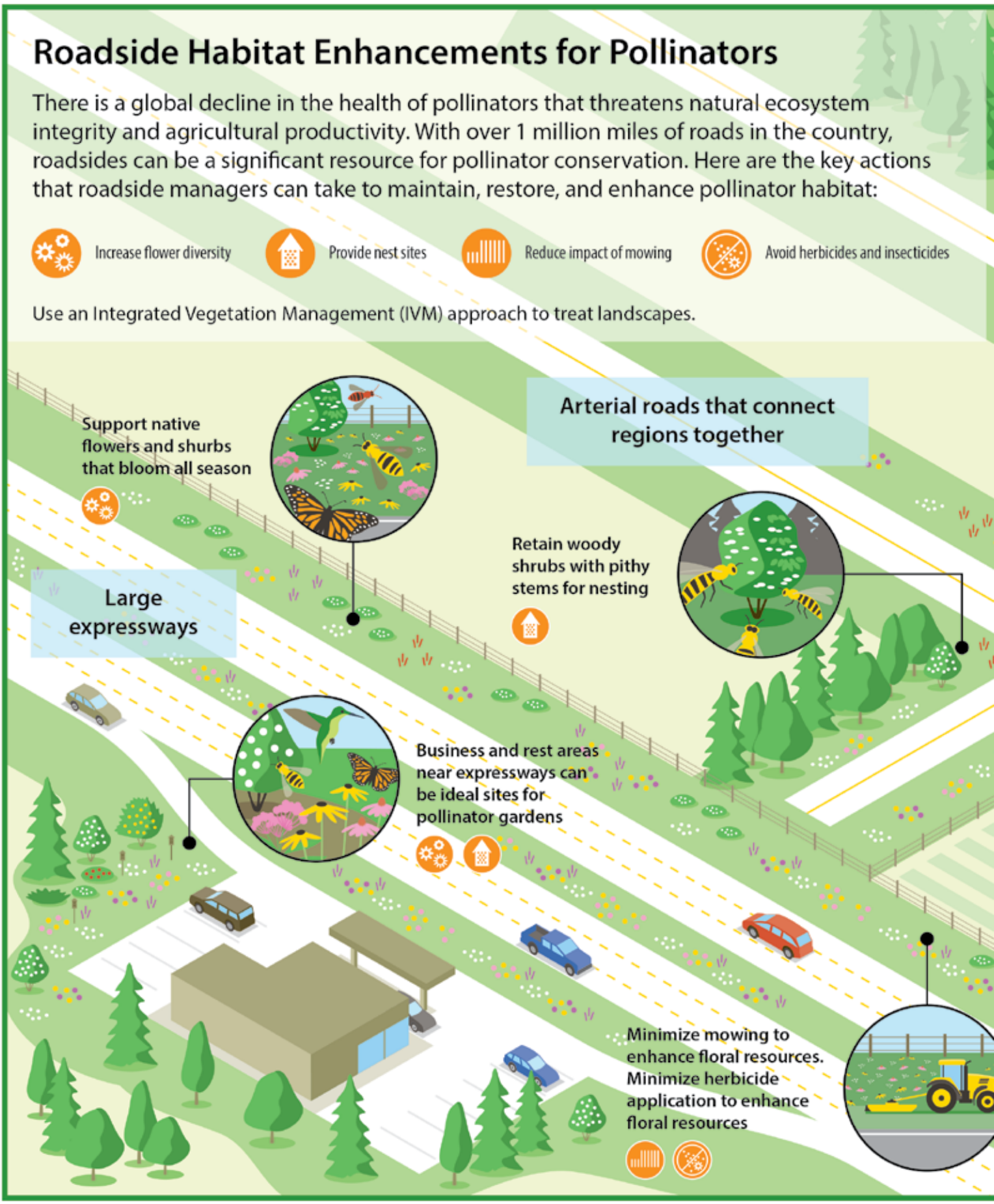
Connect

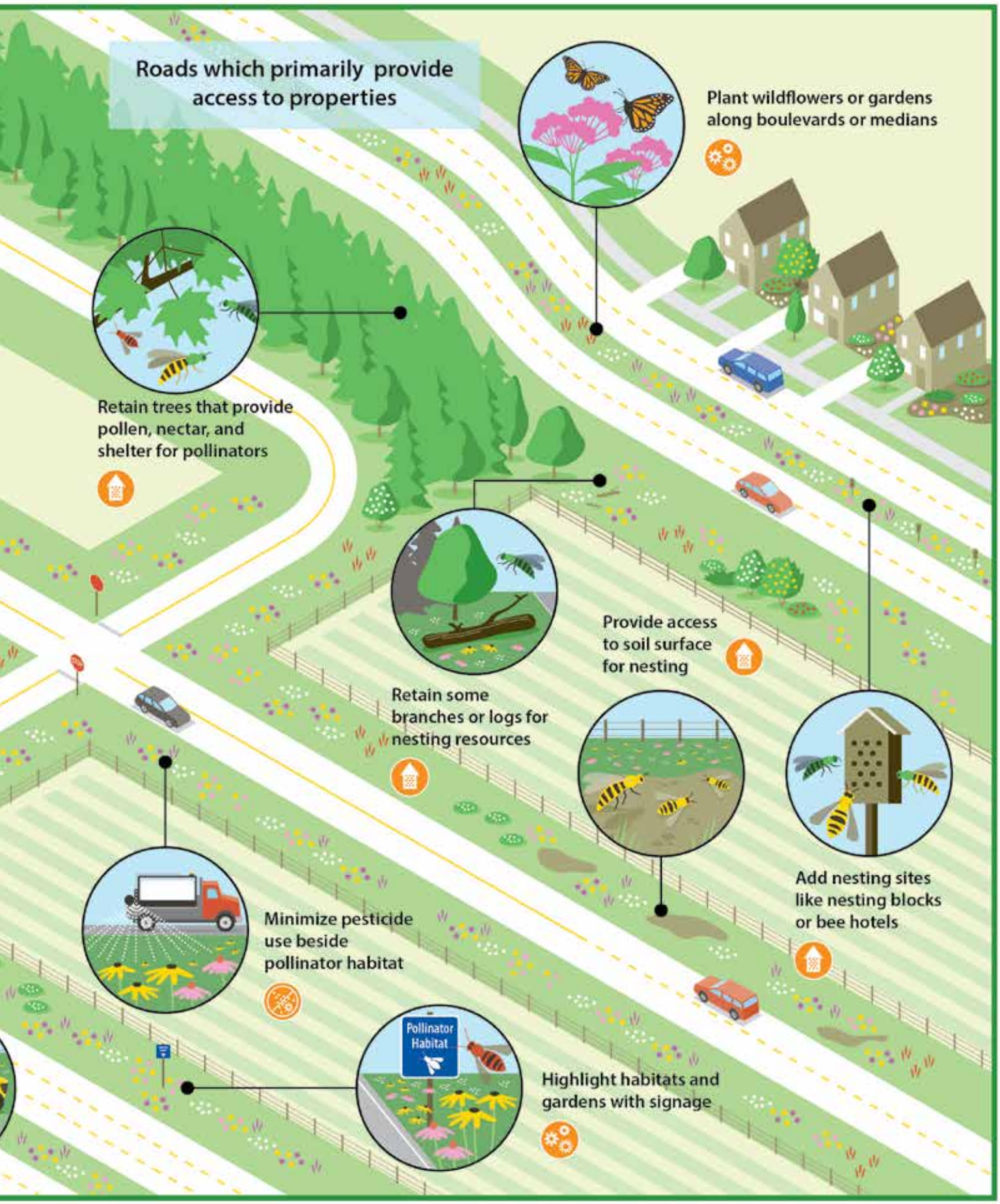
Stay connected with national and international conservation efforts! There are a lot of web-based networks that provide recognition and assistance and hold regional and national meetings to share your success. The Pollinator Partnership's www.pollinator.org will direct you to the S.H.A.R.E. map that registers all pollinator projects across the continent, and to the Million Pollinator Garden Challenge that allows you to upload photos and data about your sites.

Monitoring and Research

The Pollinator Partnership (P2) has partnered with many public and private pollinator landscapes to conducti monitoring and research. Contact P2 if you are interested in including your roadside pollinator habitat in a scientific study that can aid in pollinator conservation.

Consider a monitoring program such as Monarch Larva Monitoring Project: www.mlmp.org


Roadside Habitat Enhancements for Pollinators
There is a global decline in the health of pollinators that threatens natural ecosystem integrity and agricultural productivity. With over 1 million miles of roads in the country, roadsides can be a significant resource for pollinator conservation. Here are the key actions that roadside managers can take to maintain, restore, and enhance pollinator habitat:
Increase flower diversity
Provide nest sites
Reduce impact of mowing
Avoid herbicides and insecticides
Use an Integrated Vegetation Management (IVM) approach to treat landscapes.
Support native flowers and shrubs that bloom all season
Arterial roads that connect regions together
Retain woody shrubs with pithy stems for nesting
Large expressways
Business and rest areas near expressways can be ideal sites for pollinator gardens
Minimize mowing to enhance floral resources. Minimize herbicide application to enhance floral resources


Roads which primarily provide access to properties
Plant wildflowers or gardens along boulevards or medians
Retain trees that provide pollen, nectar, and shelter for pollinators
Retain some branches or logs for nesting resources
Provide access to soil surface for nesting
Add nesting sites like nesting blocks or bee hotels
Minimize pesticide use beside pollinator habitat
Pollinator Habitat
Highlight habitats and gardens with signage

Pollinator Habitat Site Evaluation Rubric

How to use this chart:

Use the chart below to evaluate each site being considered for pollinator habitat development. Circle the description that matches your site and note the score (found at the top of the column) in the last column on the right. Total the scores at the bottom and use the scores as guidance for selecting a site.

How to evaluate the scores:

- Sites with the lowest scores will be more challenging to develop into habitat. Sites with higher scores will generally pose the least challenges. Sites that score over 70 will have far fewer challenges. Sites with scores under 60 will be very challenging to develop into monarch habitat.
- Remember it is easier to start small and to scale up, than start big and scale down.

Site Name: Date: Evaluator:

Score	0 - do not proceed with site	1	2	3	
Existing Vegetation Management Regime	The vegetation is mowed weekly to about 3 inches and there is little flexibility for change.		There is not an existing vegetation management regime and the majority of plants are not desirable.		
Soil Texture			Compacted		
Soil pH	Alkaline soil, pH above 7.5 or Acidic soil, pH below 4			Acidic soil, pH between 4 and 5.5	
Site Size	10+ acres	3+ acres	1.5-3 acres		
Sunlight	Full Shade				
Visibility and Accessibility	Difficult to access for site managers/land owners.	Only visible and accessible to site managers/land owners.	Visible to the public and accessible to site managers/land owners.	Visible to the public and accessible to site managers/land owners and some of the public.	
Water Availability		No water available.			
Foreseeable Garden Duration	Unable to keep the pollinator habitat in place for more than a year.			Ability to keep the pollinator habitat in place for at least 3 years.	
Site Manager/Land Owner's Ability to Reduce Undesirable Plant Species	No ability to reduce undesirable plant species				
Signage		Interpretive signage cannot be installed			
Site Manager/Land Owner Ability to Maintain the Pollinator Habitat	Site manager/land owner is unable to maintain the pollinator habitat.			Site manager/land owner can help maintain the pollinator habitat, but unable to maintain the habitat to their standards.	
Volunteer Potential for Planting and Maintenance				Several groups have expressed interest in participating but have not made commitments.	

Pollinator Habitat Site Evaluation Rubric...*continued*

NOTE: Sites with a pH below 4 and above 7.5 should be eliminated and not considered for review; it will be extremely challenging to correct the pH to make the area hospitable to some pollinator-friendly plants.

Notes: Total Score:

	4	5	6	7
	The vegetation is mowed weekly but this practice can be changed.	The vegetation is mowed once or twice a year, invasives are not removed outside this period.		The vegetation is not mowed and invasive are removed regularly.
		Clay, gravel, or sand		Well drained loam
		Slightly acidic soil, pH between 6.5-5.5		Neutral pH between 6.5-7
	1.5-1 acre	1-0.5 acres	0.5-0.25	0.25-0.125
	Partial Shade	Partial Sun		Full Sun
			Visible to the public and accessible to site managers/land owners and some of the public. However, the site will be fully accessible with the installation of the pollinator habitat.	Visible to the public and easily accessible to the site managers/land owners and public (including children and persons with disabilities).
	No water on site, but ability to bring it in via truck or other means and available work hours.			Accessible water sources (spigots with hoses).
	Ability to keep the pollinator habitat in place for at least 5 years.			Ability to keep the pollinator habitat in place for more than 10 years.
	Initial removal of undesirable species will be incorporated into the project.			Aggressive and sustained removal of undesirable species will be incorporated into the maintenance of the site.
				Interpretive signage can be installed.
				Site manager/land owner can maintain the pollinator habitat.
		A core group of dedicated volunteers have committed to assist with planting.	A core group of dedicated volunteers have committed to assist with planting and some maintenance.	A core group of dedicated volunteers have committed to assist with planting and weekly maintenance.

Pollinator Primer

This section introduces the reader to the specific needs and life cycles f some of the world's 200,000 pollinating species. While this is helpful information, it does not usually impact the principles laid out in the guide to manage roadsides for pollinating species.

Photo: Derrick Ditchburn

Pollinators are a diverse group of organisms that visit flowers to feed on pollen and nectar or to collect oils and resins. Worldwide, 200,000 animal species perform this ecosystem service. In the process pollinators transfer pollen grains and assist plants in reproduction and support productivity in natural and agricultural landscapes.

Plant dependence on pollinators varies globally, with the most recent synthesis studies estimating a range from 65 to 96% (Ollerton et al. 2011). Pollinator dependence patterns generally map global biodiversity patterns, meaning that tropical ecosystems have the highest rates of pollinator dependence and this decline with increasing latitude and altitude. Across North America pollinator dependence is generally estimated at 80% for natural landscapes. The reliance that plants have on animal pollinators for reproduction also falls along a spectrum; some plants cannot reproduce without pollinators and others have reduced seed viability or smaller fruit without sufficient pollination (Klein et al. 2007; Gallai et al. 2009).

Producing less fruit or seeds is particularly worrisome in agricultural landscapes as it poses a threat to food security and can impact the economics of agricultural systems. The majority of cultivated crop varieties (1000 of the 1200 most commonly planted) require animal pollination (McGregor 1976). That means that 1 out of every three bites of food you eat is there because of pollinators (Buchman and Nabhan 1997; Klein et al. 2007). The most nutritious fruits and vegetables are pollinator dependent; without pollinators there would be food but it would not be nearly as nutritious. It is estimated that pollinators provide upwards of $217 billion to the global economy (Losey and Vaughan 2006; Gallai et al. 2009), and honey bees alone are responsible for between $1.2 and $5.4 billion in agricultural productivity in the United States (Southwick and Southwick 1999).

The beekeeping industry has evolved a sophisticated network to facilitate the pollination of key crops such as almonds, citrus, melons, and berries. Honey production also represents a significant portion of economic output, with nearly $400 million in production reported in 2014, and demand for honey as a sweetener growing (USDA 2015). For this reason supporting pollinators within agricultural landscapes has received a significant amount of attention.

In addition to the food that we eat, pollinators support healthy ecosystems that clean the air, stabilize soils, protect us from severe weather, and support other wildlife (Costanza et al. 1997). The critical roles that pollinators play in so many systems highlight how serious declines in pollinator numbers and health are.

For the past decade we have been more aware of the challenges faced by animal pollinators, especially bees.

Many pollinator populations and species have been noted to be in decline. Many wild bee species across North America have been noted to be diminishing in number; four species of bumble bees are of particular concern (NAS 2006). Similarly, wild native bees such as the yellow faced bees are showing signs of decline. Managed honey bees have displayed high winter mortality which cases logistic and economic challenges to beekeepers (USDA 2015).

Monarch butterflies have seen one of the most dramatic population declines with 90% losses and shrinking overwintering numbers (Monarch Joint Venture). A


Photo: Racquel Morris

complex set of factors often drives pollinator declines and losses, but habitat loss and degradation are key contributors. Without clean, safe, and connected habitats, pollinators cannot function to support terrestrial productivity. Establishing goals to secure habitat for pollinators is an essential strategy. These flower-visiting animals are a truly diverse group with each type of pollinator having unique habitat requirements. Understanding the unique biology and needs of each pollinator type allows us to more effectively protect, restore, and enhance habitat.

Bees

Bees are the best known and also the most important pollinators of wild and agricultural plants. While all pollinators visit flowers, bees are the only pollinators that actively collect pollen. For bees, pollen is an essential protein source that they collect and store to feed their developing young. The behavior of bees on flowers, along with the physical characteristics of their hairy bodies make them the uniquely suited to carrying and moving pollen from one plant to another.

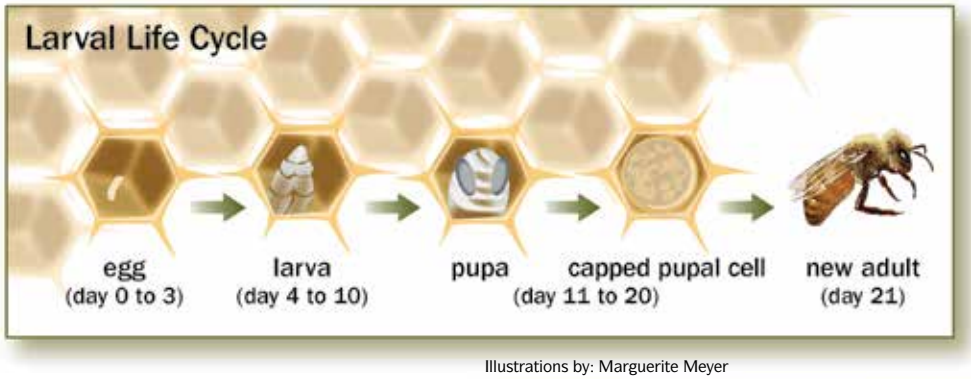
Wild bees are an incredibly diverse group of organisms with more than 4000 species in the United States and an estimated 20,000 species globally (Michener 2000). The diversity of lifestyles in the wild bee community is large and includes varied nesting habitats, as well as different levels of social interactions. Most bees live solitary lives and do not interact with one another, nor do they make honey. Some bees, like carpenter bees or sweat bees will live in aggregations, nesting side-by-side. Very few bees are truly social, living in colonies with multiple generations.

Bumble bees (Bombus spp.) are large social bees that live in colonies and produce honey. Bumble bees look for nests in abandoned mouse nests, other rodent burrows, upside down flower pots, under boards, and other human-made cavities. Colonies are founded by a queen in the spring. The number of workers in a colony can grow to 10,000 at the peak of summer bloom. Bumble bee colonies die out in the fall after producing new queens. New queens mate and then overwinter, hiding in cracks or small crevices until the next spring. Bumble bees are usually active during the morning hours and can forage at colder temperatures than honey bees, even flying in light rain. There are 47 species of bumble bees in North America, and they are some of the most easily identifiable and observable native bees.

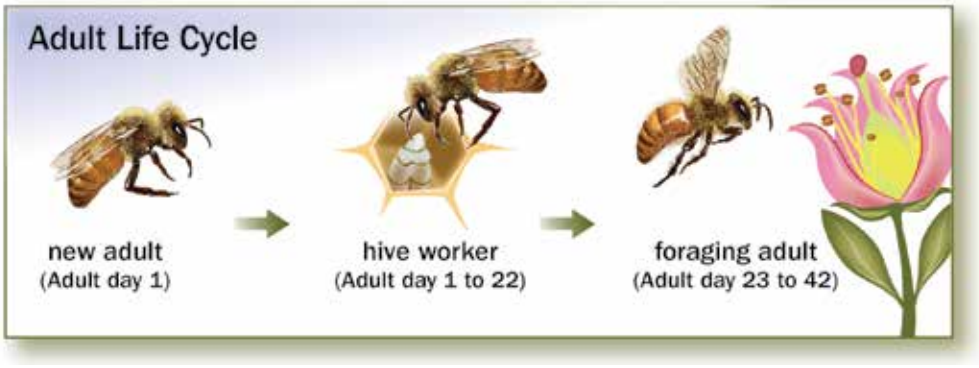
Most wild bees nest in the ground, including digger bees (Anthophora spp.), sweat bees (Halictus spp., Agapostemon spp. and others), squash and gourd bees (Peponapis spp.), plasterer or cellophane bees (Nomia spp. and Colletes spp.) and alkali bees (Andrea spp.), which prefer more salty soils. Ground nesting bees generally require sunny, bare ground, and less compacted soil. Large carpenter bees (Xylocopa spp.) nest in soft dead wood, poplar, cottonwood or willow trunks and limbs, structural timbers including redwood. Small carpenter bees (Ceratina spp.) chew out nests in pithy stems including the stems of roses and blackberry canes. Other wild bees make use of pre-existing holes and tunnels, often made by beetles. These bees include leaf-cutter bees (Megachile spp.), mason bees (Osmia spp.) and small yellow-faced bees (Hylaeus spp.).

Wild bee life cycle

Most solitary wild bees have short life cycles ranging from 2 to 4 weeks. Different species occur throughout the spring, summer, and early fall, and they all have unique preferences for floral resources. Bumble bee colonies have longer cycles, with queens living a year. Some other solitary bees, such as carpenter bees, can live for extended periods of time, over two months, in some cases, but they are seasonal and do not live from year-to-year. Because of this varied set of lifestyles and occurrence times (also known as phenology) floral habitats for pollinators must be diverse and must provide blooming flowers from early spring through to the fall. Estimates of the number of flower-visits required to support native bee populations range from 500 to 1100 a day – meaning that abundant floral landscapes are key to keeping bee populations healthy and stable. Floral resources also have to be highly localized, as wild bees generally limit their foraging to a maximum of 100 to 300 meters from their nests. Generally, bees spend a few days as an egg, a week or two as a larvae, and another week or two as a pupa, but they can overwinter or hibernate in any of these stages. For bees that nest in wood or dry plant stems, it is important to leave vegetative material undisturbed through the fall and winter seasons as they may contain bee nests.



Illustrations by: Marguerite Meyer



Wild bees are faced with significant challenges from habitat loss that is a result of land conversion for agricultural, urban, or industrial uses. As natural areas shrink so does their carry capacity, and populations of wild bees see reduced forage and nesting resources. In highly fragmented landscapes food resources may be beyond foraging ranges, which results in lower nest provisioning and smaller or fewer bees. Wild bees existing in or near agricultural areas also face challenges from pesticide use in the form of chronic exposure from non-target impacts, much in the same what that honey bees do. Current research indicates that impaired foraging and reduced reproduction correlate to chronic pesticide exposure, in particular from products that have extended residual toxicities and longer lifetimes in the environment (Godfray et al. 2015). Overall, wild bees that are impacted by pesticide misuse are not as healthy and productive.

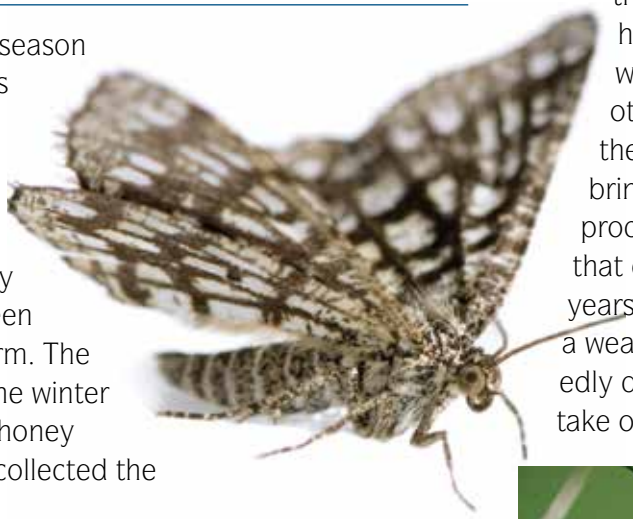
Honey bees are managed for pollination services and honey production throughout the world. Apis mellifera represents one species of the estimated 20,000 species of bees globally (Michener 2000). Honey bees are native to Europe and northern Africa and were imported into the United States in the late 1700's. The domestication and management of honey bees for honey production dates back thousands of years (vanEngelsdorp and Meixner 2009). Managing honey bees for agricultural pollination services is a newer phenomenon that has grown throughout the 20th century (vanEngelsdorp and Meixner 2009). Today managed honey bees are essential partners in the pollination of crops such as almonds, citrus, and row crops. Other common managed bees include bumble bees, leafcutter bees, mason bees, and alkali bees. The managed non-Apis bee industry is growing in size but is nowhere near that of the honey beekeeping industry.

A year in the life of a honey bee colony

Honey bees are unique in that they are truly social bees that live in a colony where they divide tasks and roles between workers, have a queen, and persist in the colony over multiple seasons and years. This lifestyle is very uncommon in the pollinator community, but it makes honey bees successful in many landscapes. Both wild and managed honey bees cycle through an annual schedule of growth and inactivity.

Winter

A bee hive has a season cycle that repeats from year to year. During the winter a hive is dormant. The bees in the colony surround the queen and keep her warm. The colony survives the winter by feeding off of honey stores that were collected the previous year.



Spring

When the weather gets warmer and spring flowers start to bloom the colony becomes more active. Overwintering foragers leave the hive to collect pollen and nectar; the queen has been laying eggs (between 1500 to 2000 each day) and the colony is ready for spring.

Summer

In early summer the colony is very active. Foragers leave daily to collect pollen and nectar and many new worker bees emerge. By late summer the colony has grown very large and strong. Workers start to produce new queen cells that will result in new queen bees (in warmer climates this can occur earlier in the spring, as well). After the new queens hatch, they leave the colony, each taking some worker bees with them. This is called swarming.

Fall

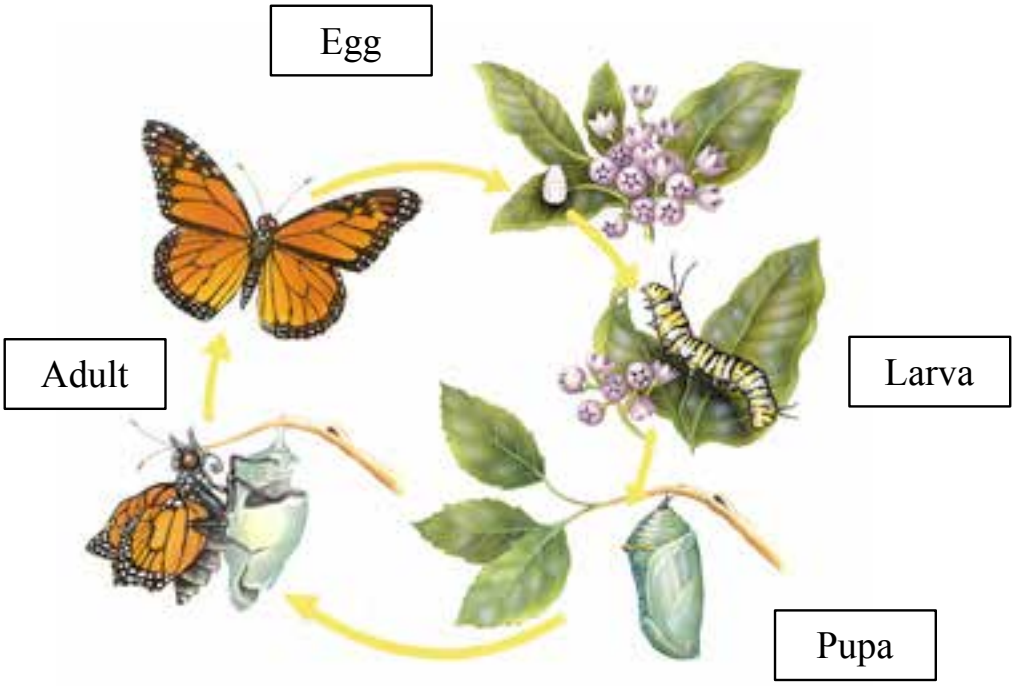
By the fall the flowers have stopped blooming and are producing fruit. The colony works on storing food and foraging for nectar slows. Foragers look for water and take cleansing flights throughout the winter. The worker bees and the queen will spend the winter feeding off of their stored honey, waiting for the spring bloom of flowers.

While a honey bee colony can live through multiple years, worker bees have limited lifespans of approximately 40 days. As a honey bee ages it cycles through various tasks inside and outside the hive. Right after emerging from their pupa, worker bees build combs and take care of other developing larvae. When they get older, they leave the hive and become foragers, bringing back pollen, nectar, and other plant products to the hive. Queens live longer lives that can range from two to ten years, but 5 years is a common average. When a colony has a weak, older queen, or loses a queen unexpectedly due to illness, new queens are produced to take on the role.

Butterflies and Moths

Butterflies and moths visit and pollinate wildflowers. Many moth species are particularly active in the evening and morning hours, visiting flowers that bloom at these times. Butterflies, on the other hand, are attracted to open sunny areas where they can bask and warm themselves. Meadows, grasslands, and other open spaces are ideal habitats for butterflies.

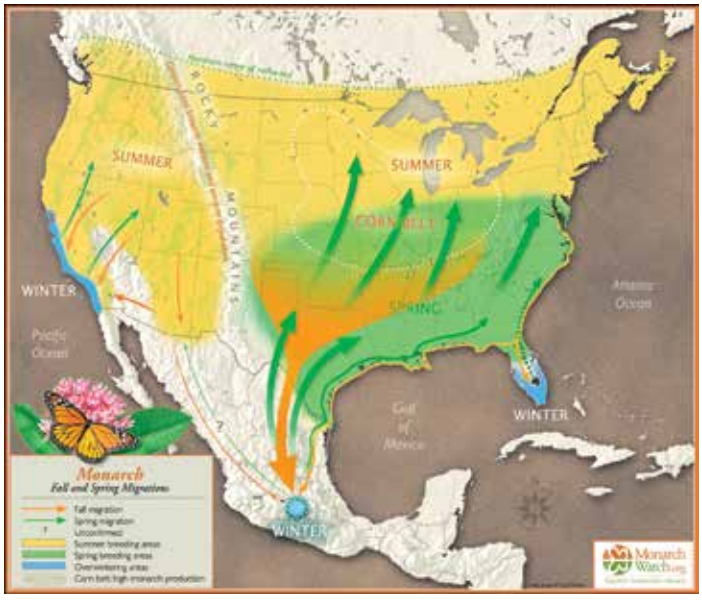
Butterfly and Moth Life Cycle



Butterflies and moths have very different habitat needs for their young (caterpillars) and for adults. Moth and butterfly eggs are laid on leaves of host plants. After a few days these eggs hatch into caterpillars that feed off of the host plant leaves, growing, molting (shedding their skin), and growing again. Caterpillars develop over a two week period during which they can molt up to five times. After their final molt caterpillars settle into a spot where they develop into a chrysalis and metamorphose into an adult. Metamorphosis usually takes between one to two weeks. When they mature into adults, butterflies and moths feed on nectar from flowers. In some cases, host plants and nectar plants are the same species, but not always. Butterfly and moth life-spans range from just a few days to over a year depending on the species and region.

Monarchs

Monarch butterflies (Dannus plexipus) are a unique migratory species that make a 3000 mile journey across North America. This journey can take four generations of butterflies to complete. The monarch migration takes these butterflies across three countries and all four seasons, along the way they encounter many different landscapes and challenges. The monarch butterfly life cycle is similar to that of other butterflies and moths, only monarchs have a unique host plant – milkweed. A monarch egg is laid on a milkweed leaf. This egg hatches into a caterpillar within 3 to 6 days. The caterpillar feeds and grows over a 2-week period. Once fully grown, it chooses a safe location to form its chrysalis, and after about 10 days an adult emerges.



What is the Monarch Migration?

There are two populations of monarchs in North America, one located east of the Rocky Mountains and the other to the west, although there is probably some interchange between these populations across the Rocky Mountains and in Mexico. Butterflies from the eastern population overwinter in Mexico, while those from the west overwinter at numerous sites along the California coast.

The Eastern Migration

The eastern migration starts in March as butterflies from Mexico travel north into Texas and other southern states, breeding as they move northward. The butterflies produced in these areas move northward in May and June to colonize the northern U.S. states and parts of southern Canada. Two or three additional

Photo: Leah Lewis

generations are produced before the southward migration begins two months later. Beginning in mid-August and continuing into fall, hundreds of millions of monarchs migrate south to spend the winter in high-elevation oyamel fir forests in central Mexico.

The Western Migration

In the spring, western monarchs move inland, breeding in scattered habitats containing milkweeds throughout much of the west but primarily in California. In November, western monarchs begin to return to forested overwintering sites along the California coast, from Baja to Mendocino County.

Milkweed is critical for monarchs as their caterpillars will not survive and thrive on any other plant. In particular, the Corn Belt and the I-35 corridor in the United States have been highlighted as area with growing deficits of milkweed within critical flyways. Land conversion throughout the migratory range (Wright and Wimberly 2013), and, in particular, the proliferation of herbicide-resistant crops and attitudes toward milkweed have created food deserts in which monarchs cannot survive as their caterpillars are entirely dependent on milkweed. The milkweed deficit that has been created in these agricultural lands will have to be substituted for in other landscapes that are a better fit for ongoing persistent milkweed populations.

Flies

Flies (including mosquitoes) pollinate a range of wild and cultivated plants. One of the most important of all fly pollinator groups are the flower flies in the family Syrphidae. Flower flies are dominant floral visitors and important pollinators wherever they occur. Midges (small flies) are pollinators of coffee, chocolate, and tea (McGregor 1976) and therefore linked to globally economically-important crops. Many flies mimic bees in pattern and coloration in an effort to gain protection from predators that avoid bees due to their ability to sting, but flies can't sting because they don't have a stinger. Unfortunately, less is known about landscape management for flies which have a complex life cycle where the maggot and the adult often require very different habitats.

Beetles

Beetles are the most ancient pollinators of plants and are considered to be associated with the widest range of species. Their role as functional and significant pollinators is debatable as many are pollen feeding and destroy pollen without significant transfer between plants. Generally, beetle pollinators (including scarabs, staphylinids and sap beetles) are somewhat indiscriminate in which flowers they visit, foraging for pollen and sometimes nectar on open bowl-shaped blossoms that offer easy access. Beetles are attracted to "primitive" blossoms including spicebush, magnolia and tulip tree. As with other wild pollinators, threats from habitat loss, climate change, invasive species, and non-target exposure to pesticides can reduce populations. Management and conservation strategies for beetles are not well-developed.


Photo: Ziegler

Bats

Pollinating bats have a limited range in North America, existing only in the far southern states and throughout Mexico. These pollinating bats, however, are keystone pollinators of desert plant species and some commercial crops like agave and mezcal. Bats feed on large, nectar-producing flowers in the evening. Many species of bats are also migratory, tracking patterns of food availability as they move throughout their range. Expanding rural and agricultural development in addition to cultural challenges to conservation, have impacted species throughout Mexico and the Southwest. The Lesser long-nose bat (Leptonycteris yerbabuenae) is a keystone pollinator for saguaro cactus (Carnegiea gigantean) in the desert Southwest. This species of bat is listed as a threatened species in the United States as much of its feeding and nesting habitat has been fragmented. White nose syndrome, a disease currently restricted to the eastern part of the United States, could threaten populations of pollinating bats if it continues to spread. Climate change and its impact on plant bloom and food availability is also among the key concerns for bat conservation. Bats generally do not interface with agricultural landscapes where pesticides are used, but there is the potential of harm to bats from the use of rodenticides.

Hummingbirds

Hummingbirds are resident and migratory throughout North America. In their adult form they are nectar feeders, visiting flowers and acting as pollinators of many wild species. Juvenile hummingbirds require insects as a protein-rich food source. Most often hummingbirds are associated with naturalized or urbanized landscapes where their preferred food plants grow or are cultivated. As with bats, they are seldom in areas where they experience a direct interaction with agricultural pesticide use, but can be impacted by chemical use in garden settings. Climate change and shifts in bloom period are expected to impact migratory species disproportionately, meaning that hummingbirds may face future challenges.

Basic Pollinator Resources

Many books, websites, and people were consulted to gather information for this guide. Use this list as a starting point to learn more about pollinators and plants in your area.

Bailey's Ecoregion Maps
USDA Forest Service
http://www.fs.fed.us/land/ecosysmgmt/ecoreg1_home.html

Pollination/Pollinators
Pollinator Partnership
www.pollinator.org

Natural Resources Conservation Service
www.nrcs.usda.gov

North American Pollinator Protection Campaign
www.nappc.org

USDA Forest Service
www.fs.fed.us/wildflowers/pollinators/

Wild Farm Alliance
www.wildfarmalliance.org

The Xerces Society
www.xerces.org

Illinois Natural History Survey
www.inhs.uiuc.edu

Buchmann, S.L. and G.P. Nabhan. 1997. The Forgotten Pollinators. Island Press: Washington, DC.

Committee on the Status of Pollinators in North America. 2007. Status of Pollinators in North America The National Academies. Press: Washington, DC.

Native Plants

Plant Conservation Alliance
www.nps.gov/plants

Seeds of Succes
www.nps.gov/plants/sos

Lady Bird Johnson Wildflower Center
www.wildflower.org/plants/

USDA Hardiness Zone Map
www.usna.usda/Hardzone/

U.S. National Arboretum
www.usna.usda.gov/Hardzone/ushzmap.html

Photo: Caitlin Smith

USDA, NRCS. 2007. The PLANTS Database
www.plants.usda.gov, 19 July, 2007

National Plant Data Center,
Baton Rouge, LA 70874-4490 USA

BONAP Biota of North America Program
www.bonap.org

Native Bees

National Sustainable Information Service
"Alternative Pollinators: Native Bees" by Lane Greer, NCAT Agriculture Specialist, Published 1999, ATTRA Publication #IP126
www.attra.ncat.org/attra-pub/nativebee.html

Agriculture Research Service
Plants Attractive to Native Bees table
www.ars.usda.gov/Research/docs.htm?docid=12052

Butterflies and Moths

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www.butterfl iesandmoths.org/ (Version07192007)

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North American Butterfly Association
www.naba.org

North American Monarch Conservation Plan
Monarch Joint Venture
www.monarchjointventure.org/

University of Minnesota Monarch Lab
www.monarchlab.org

Monarch Watch
www.monarchwatch.org/

Wildlife Habitat Council
www.wildlifehc.org/about-whc/

Thank you!

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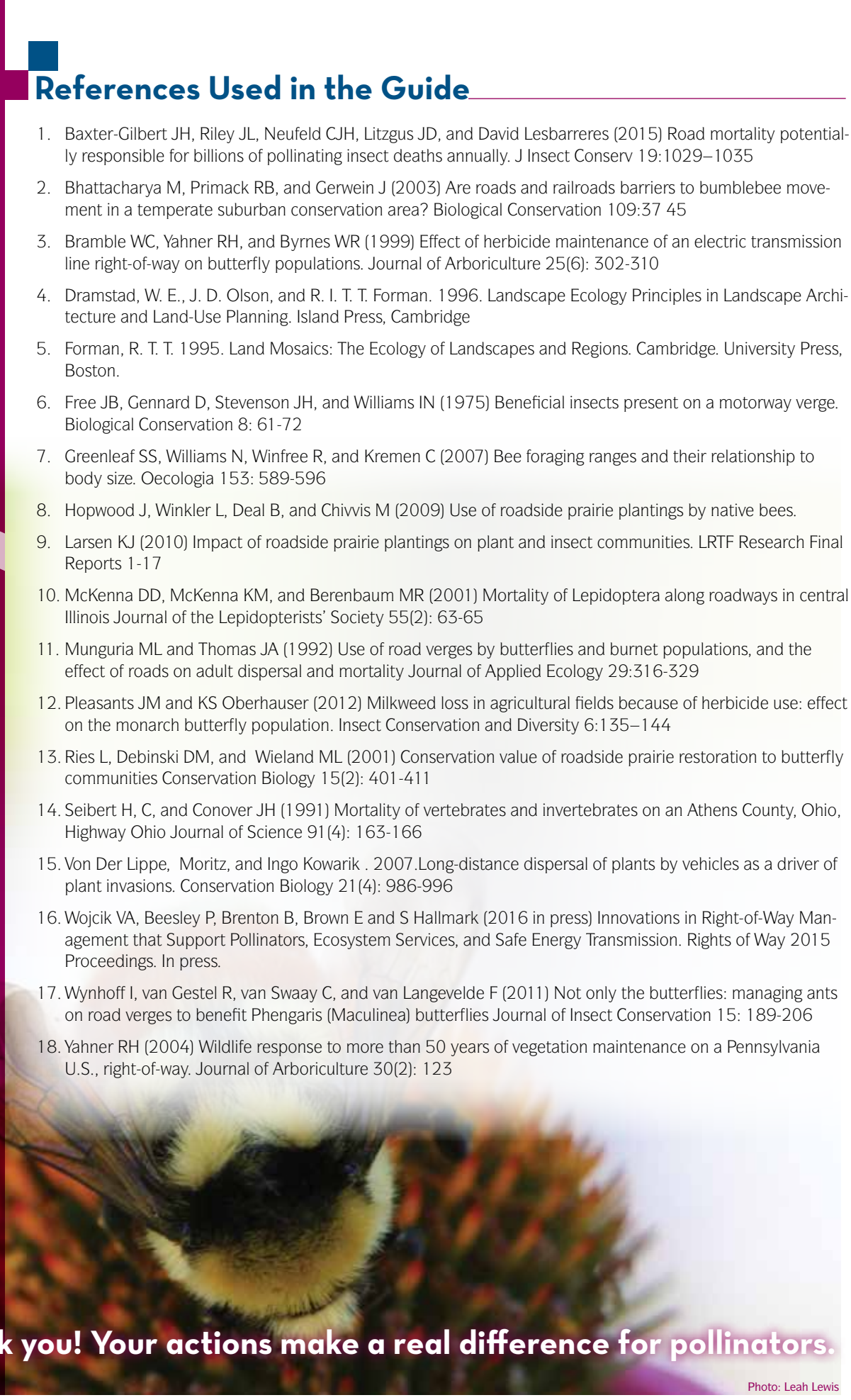

Thank you! Your actions make a real difference for pollinators.

Photo: Leah Lewis

Final Thoughts

A successful monarch habitat project on a roadside or transportation corridor holds the promise of supporting the buzz of bees, the hum of birds, and the wondrous migration of monarch butterflies while bringing your community great satisfaction. You will support nature in your own backyard while connecting to a migratory corridor across the continent. Regional lists are available if you need assistance in any location. These are available at www.pollinator.org.

Feedback

We need your help to create better guides for other parts of North America. Please e-mail your input to feedback@pollinator.org or fax to 415-362-3070 or call us at 415-362-1137.

- How will you use this guide?
- Do you find the directions clear? If not, please tell us what is unclear.
- Is there any information you feel is missing from the guide?
- Any other comments?

We welcome stories and pictures of your successes and are here to help you meet your challenges. E-mail your success stories to feedback@pollinator.org. Thank you for supporting ecosystems through habitat management and providing resources for the beautiful monarch butterfly.

POLLINATOR PARTNERSHIP

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Maintaining Roadsides for Pollinators: Establishment, Restoration, Management and Maintenance