Pollinators and Roadsides

Managing Roadsides for Bees and Butterflies

Roadsides in the U.S. cover more than 10 million acres of land.

Managing roadsides for bees and butterflies will create high quality habitat for wildlife of all types.

Pollinator habitat along roadsides supports the pollination needs of adjacent farms and natural areas.

Photograph by Maria Urice, Iowa Living Roadway Trust Fund

Supporting a diverse community of wildflowers, this roadside in Iowa is an Integrated Roadside Vegetation Management site.

Roadsides cover more than 10 million acres of land in the United States (Forman et al. 2003), and in some states, they are the largest holdings of public land. Roadsides offer valuable habitat because they are typically set aside from further development and because they stretch across the landscape, connecting remnant habitat patches and creating a linear refuge for wildlife. This is particularly true in agricultural regions, urban areas, and other highly modified landscapes, where roadsides may be the only semi-natural habitat remaining. With four acres of open space in the United States lost to development every minute (U.S. Forest Service 2006), roadsides are too important to be neglected in conservation planning.

The abundance and diversity of insects and other invertebrates are key building blocks of the wildlife value of a site. They are a food source for birds, mammals, and other vertebrates and the services they provide maintain habitats on which these other animals rely. One such "ecosystem service" is pollination, a service that is central to the health of our environment. It is primarily provided by insects. Beetles, flies, wasps, moths, and butterflies all contribute to pollination but bees are considered to be the most important group of pollinators.

Managing roadsides to support pollinators brings benefits for both local natural areas and adjacent farms. One of the key considerations is the presence of native plants. Roadsides with a rich diversity of native plants support more pollinators. Incorporating native plants into roadside management strategies will not only make these areas better for wildlife, but it can also promote motorist safety, reduce maintenance costs, and improve roadside aesthetics.

Importance of Pollinators

An estimated 60 to 80 percent of the world's quarter of a million species of flowering plants depend on animals—mostly insects—for pollination (Kremen et al. 2007). Focusing on agriculture, eighty-seven of the world's 124 most commonly cultivated crops are animal pollinated, and insect-pollinated forage plants such as alfalfa and clover provide feed for livestock. Roughly 35 percent of global crop production is dependent on pollination by animals (Klein et al. 2006). Pollinators also sustain the wildland plant communi-

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ties that provide food and shelter for myriad other wildlife. Plant pollination by insects is essential to human health, global food webs, and protection of biodiversity. Pollinating insects are at the heart of a healthy environment.

Studies in multiple parts of the world give cause for concern about declining pollinator populations. In the United States, the National Research Council (2007) reported noteworthy losses of both managed and wild pollinators. Habitat loss, pesticide use, diseases, parasites, and the spread of invasive species were all cited as major causes of these declines. In Europe, parallel declines of pollinator and flowering plant diversity have been documented in both Great Britain and the Netherlands (Biesmeijer et al. 2006). Threats to pollinator communities affect not only pollinators themselves but also natural ecosystems and agricultural productivity.

In landscapes substantially altered by urbanization or agriculture, roadsides, hedgerows, and field edges can be particularly important for wildlife. These areas provide pollinators with places to forage for food and to nest, while also helping to link fragmented habitats.

Roadsides as Habitat

Roadsides have value as habitat for birds (Adams 1984), small mammals (Camp and Best 1994), amphibians and reptiles (Way 1977), and ants and beetles (Keals and Majer 1991; Vermeulen 1993). They also provide refuge for pollinators by supporting a diversity of wildflowers that provides nectar or pollen for all pollinators, as well as grasses and forbs that serve as caterpillar hostplants for butterflies and moths. In some cases, roadsides support plant communities that can no longer be found elsewhere (Forman et al. 2003; Noordijk et al. 2009). Roadsides offer nesting sites for bees, particularly ground-nesting bees because the soil is undisturbed compared to agricultural fields (Delaplane and Mayer 2000). Additionally, roadsides are protected from further development and promote connectivity between habitat fragments (Forman et al. 2003).

Natural History of Pollinators

In North America, most pollinators are insects: bees, flies, beetles, wasps, moths, and butterflies. Hummingbirds also pollinate some flowers, as do a couple of species of bats and a dove in the desert southwest. Pollinating insects have two basic habitat requirements: a source of food and a place to lay their eggs. Understanding which features in the landscape provide these resources is essential to maintaining or enhancing habitat for pollinators.

Bees and other pollinators are an essential component of any terrestrial ecosystem. Their basic habitat needs—flowers for nectar and pollen and a place to nest—can be successfully provided for on roadsides. Photograph by Eric Mader.

Nectar and Pollen Sources

Most flowers offer sugary nectar or nutritious pollen to attract floral visitors. The majority of flower visitors feed while at the flower. Bees are unusual because they provision nests for their offspring, so they not only feed but also gather and transport pollen, the major reason why they are particularly efficient and important pollinators. Pollinator habitat should have a diversity of flowers that bloom at different times to sustain a diverse group of pollinators throughout the growing season.

Sites for Nesting or Egg-Laying

Pollinating insects require a place to nest or to lay their eggs. Butterflies and moths generally lay their eggs on or next to the hostplant upon which their caterpillars will feed. In contrast, bees create a nest in which they construct and supply a series of brood cells. Nearly 70 percent of bee species nest underground, digging slender tunnels off which they excavate brood cells for their eggs. Most other bees choose to nest in wood tunnels, occupying existing holes in snags or chewing into the pithy center of stems, in which they create a linear series of partitioned cells. Some bees use materials such as mud, resin, leaf pieces, or flower petals to form the partitions (Linsley 1958). Bumble bees are social bees, forming their annual colony in a small cavity such as an abandoned mouse nest. Pollinator habitat should include a range of nesting substrates and materials to provide for the differing nesting requirements of pollinators.

Native Plants and Roadside Management

While roadside management in the United States differs from state to state, the primary goals remain the same: motorist safety, noxious weed prevention, and soil stabilization. In recent years, many states have incorporated native grasses and wildflowers into rights-of-way to achieve these objectives. Often, techniques already in use can make a difference in the conservation of pollinators.

Integrated Roadside Vegetation Management (IRVM) combines the planting of native vegetation with site-appropriate strategies to achieve cost-effective and more environmentally sustainable management of roadsides. As an alternative to intensive mowing and blanket pesticide spraying of roadsides, IVRM offers several significant advantages.

- Native grasses and flowers are best adapted to local conditions, and are able to tolerate drought or heat.
- An established diverse plant community provides the most stable cover for reducing soil erosion and keeping out weeds. For example, tallgrass prairie restoration can limit the invasion of noxious weeds, due to strong root development (Blumenthal et al. 2005).
- Native plants offer improved weed and soil erosion control, reducing the need to mow or to spray herbicides, and consequently also the costs.
- Native plants are less likely to encroach on land bordering rights-of-way, a common complaint about nonnatives such as crownvetch (*Securigera varia*) and sericea lespedeza (*Lespedeza cuneata*).
- Native plant communities will reduce runoff in the spring and act as snow fences in the winter, trapping and preventing snow from blowing across roads.
- Native plantings are aesthetically pleasing. Native flowers and mowing regimes that limit mowing to a single swath along the road were found to be the most attractive to drivers in Minnesota (Dan Gullickson, Minnesota DOT, pers. comm.).
- Native plantings may offer educational opportunities, as they demonstrate how the wider landscape once looked.
- Native plant communities support more native wildlife than nonnative plant communities.

Native plants offer several advantages for roadside management, such as erosion control and reducing the need to use herbicides, as well as improved habitat. Photograph by Kirk Henderson.

Benefits of Roadside Plantings to Pollinators

Seeding roadsides with native vegetation often increases the diversity of plants in the local area (Muguira and Thomas 1992; Forman et al. 2003) and may provide more abundant pollen and nectar sources compared to adjacent areas. Combined with the reduced need for pesticide spraying to control weeds when using native plantings, native roadsides offer a haven to pollinators and other wildlife.

Flowers

Research demonstrates the benefits to pollinators of having native wildflowers on roadsides. Working in Kansas, Hopwood (2008) found bees to be twice as abundant on roadsides supporting native plants compared with those dominated by nonnative grass and flowers; native roadsides also supported about 35 percent more bee species. Ries et al. (2001) compared butterflies on native prairie roadsides in Iowa with those on grassy or weedy roadsides. This work showed that habitat-sensitive butterfly species such as the regal fritillary (*Speyeria idalia*) and Delaware skipper (*Anatrytone logan*) were significantly more common in prairie roadsides. In Minnesota, butterflies were most abundant in filter strips between cropland and streams that were planted with tall and dense vegetation (Reeder et al. 2005).

These findings are supported by European studies. In Finland, the number of butterflies on roadsides was most influenced by the abundance of nectar producing plants, while moths were most abundant in areas with tall vegetation (Saarinen et al. 2005). In Britain, work by Munguira

and Thomas (1992) suggests that planting roadsides with native plants would increase the already high diversity of butterflies on roadsides.

Nest Sites

Many bees prefer to nest in sunny, bare patches of soil (Linsley 1958), like those found around the base of native bunch grasses such as big bluestem (*Andropogon gerardii*) and Indiangrass (*Sorghastrum nutans*). The research by Hopwood (2008) in Kansas found that ground-nesting bees were more common in roadsides with native plantings. Roadsides with a tight sod of brome or other nonnative cool season grasses, in contrast, had fewer ground-nesting bees. Many bumble bees nest underneath grass clumps (Svennson et al. 2000). In Britain, roadsides have been identified as providing breeding habitat for 8 of the country's 17 species of bumble bees, as well as 25 of its 60 butterfly species (Way 1977).

Landscape Linkages

Given their linear structure, roadsides may serve as corridors for pollinators and other wildlife. In Iowa, Ries et al. (2001) found that habitat-sensitive butterflies were much less likely to leave a roadside planted with native vegetation, suggesting that for some butterflies, roadside restorations could serve as protective corridors through which pollinators could move in highly modified landscapes. For example, roadsides could become corridors for breeding monarch butterflies returning north from their overwintering grounds, because their caterpillars feed exclusively on milkweeds (*Asclepias*), which grow readily in roadsides and are sometimes included in reseeding mixes. These same roadsides can also be nectar corridors for monarchs making the long trip south in the fall.

Stretching across landscapes that are generally inhospitable to wildlife, roadsides link other habitats and provide food for pollinators, including migrating monarchs. Photograph by Kirk Henderson.

Roadside Habitat Creation and Maintenance

With so many acres of land in roadsides and the obvious value of these lands for wildlife, it is clear that roadsides can be of great benefit to pollinators. Plant communities can be enhanced with native species and maintenance methods and schedules can be altered to reduce negative impacts. The principal considerations are the diversity of native plants, the availability of bee nest sites, the impact of mowing, and pesticide use.

Increasing Flower Diversity

As noted above, a diverse plant community will support a wider range of pollinator insects. When planning a project, determine the grasses and wildflowers best suited to the climate, soil type, and location of the site. With native prairie plantings, it is often tempting to increase the proportion of grass in the seed mix to keep costs down. However, Dickson and Busby (2009) demonstrated that reducing the density of grass seeds increases forb establishment. Seed mixes for roadside restorations should include flowers with differing but overlapping bloom times, to provide pollinators with continuous floral resources. A rule of thumb is that a planting mix should contain at least three species that bloom in each season from spring to fall.

Planting a range of wildflowers of varying colors and shapes will benefit more pollinator species. Bees do not easily see red objects, so mainly visit blue, white, yellow, and purple flowers. Of the other flower-visiting insects, butterflies tend to visit orange, red, yellow and purple species, and hover flies go to flowers of white and yellow. Hummingbirds, the only non-insect pollinators in most of North America, are drawn to red flowers in particular. Floral shape also influences which pollinators visit which flow-

ers; the various body sizes and tongue lengths of pollinators are adapted to certain sizes and shapes of bloom.

Many perennial flower species take several years to establish and begin to bloom, so consider including annuals in seed mixes. Annuals rapidly establish and offer pollinators nectar and pollen right away, while helping to block weeds during establishment of longer-lived species.

Providing Nest Sites

Bees that nest in the ground often prefer to dig their nests in patches of exposed earth, and while some species prefer sunny exposed slopes, others prefer level ground (Linsley 1958). Roadsides with trenches or ditches may provide more diverse locations for ground nesters. Native bunch grasses will stabilize ground while offering nesting resources to native bees: patches of bare earth for ground-nesting bees, and clumps under which bumble bees may nest. To encourage wood tunnel nesting bees within roadsides, consider leaving patches of native shrubs in areas furthest from the road itself.

While butterflies do not build nests, they do require the correct plants for their caterpillars to eat. In addition, they often overwinter in leaf litter or under dead vegetation, which should be left where possible.

Reducing the Impact of Mowing

Mowing of roadside vegetation generally has three aims: to improve driver visibility, to provide room for a vehicle to pull off the road if needed, and to prevent encroachment of brush or trees. There is no need to mow the entire roadside to achieve these objectives, even if tall grasses are present; it is only necessary to mow the portion of the road next to the shoulder, and any other areas required for safety. Planting native grasses and forbs in rights-of-way should reduce but not eliminate the need to mow, and determining appropriate times to mow may be a balancing act. Both the time of year to mow and the frequency of mowing have ecological consequences.

Well-timed mowing may improve species diversity of prairie roadsides. While mowing several times during the first growing season of a planting project can control noxious weeds and help native plants establish, frequent mowing in subsequent years reduces native plant growth and the ability of forbs to compete with grasses. For example, excessive mowing may have led to a decrease in flowers and a subsequent decrease in bumble bees in Belgium (Rasmont et al. 2006). Research in the Netherlands found that mowing roadsides twice a year, early and late in the growing season, resulted in the highest plant diversity (Forman et al. 2003) and was most beneficial for flower visiting insects (Noordijk et al. 2009). Collins et al. (1998) showed that in the U.S. Midwest mowing once a year in July knocked back dominant grasses and promoted wildflower growth. However, mowing at such a time will limit the growth of any fall wildflowers, such as asters and sunflowers, which are not only important forage sources for generalist insects but are also flowers which some specialist bees preferentially visit and are dependent upon. Mowing once a year in late autumn, when pollinators are not flying, or mowing every few years, may have the least impact on pollinators.

Pollinators are not the only wildlife vulnerable to the effects of mowing. Some Departments of Transportation

Mowing only a narrow road-edge strip can meet safety requirements and leave plenty of habitat. Photograph by Carl Kurtz.

(DOTs) have found ways to adapt mowing to accommodate wildlife while managing roadsides effectively, including:

- Minnesota DOT permits the first eight feet from the shoulder or road be mown on a regular basis, but the entire right-of-way may only be mown after August 1, in order to protect nesting birds.
- The state of Wisconsin works with state and federal agencies to protect roadside habitat of the federally endangered Karner Blue butterfly (*Plebejus melissa samuelis*). Lupine (*Lupinus perennis*) is the hostplant for Karner blue caterpillars and is common along roadsides. To prevent mowing of populations of these plants, Wisconsin DOT marks populations, allowing both lupine and the butterflies to persist (Forman et al. 2003).

Highway safety and good habitat are not mutually exclusive. Ultimately, roadside managers should develop a mowing policy that addresses the safety concerns of their area and the practicality of maintenance, while also considering potential benefits to the plants and animals.

Avoid Using Pesticides

Pesticides can kill bees, butterflies, and other pollinating insects. The impact of pesticides on pollinators can be lethal or nonlethal, fast–acting or delayed, limited to insects in the area sprayed or—as with bees—transferred to offspring in the nest.

Foraging pollinators are poisoned by pesticides when they absorb the toxins through the outer "skin" that forms their exoskeleton, drink toxin–tainted nectar, or gather pesticide–covered pollen or micro–encapsulated pesticides. Lower doses of pesticides may not kill pollinators but can affect their behavior. Bees that are exposed while foraging may have trouble navigating their way back to the nest, or they may simply be unable to fly. Sublethal doses—such as those that result from toxins brought into a nest along with nectar and pollen—may reduce egg–laying or stall the larval growth.

Wherever possible, avoid using pesticides. Where their use is unavoidable:

- Use a formulation that will offer the least threat (liquids are better than dusts) and apply in the lowest concentration possible.
- Avoid micro–encapsulated products: bees mistake it for pollen and will collect it to take back to the nest.
- Spot treat invasive plants to avoid killing non-target species. Avoid broadcast applications, which may destroy large numbers of beneficial plants.
- Choose equipment such as hand sprayers, which will minimize drift onto adjacent plants that may be in bloom—and therefore attracting bees and butterflies—even when flowers in the treatment area are not.
- Apply pesticides only when pollinators are inactive, such as at night or during those seasons when there are no flowers.

Traffic and Wildlife

For many roadside managers, the biggest concern about the presence of taller vegetation along roads is that it will increase the number of accidents involving deer. Although there has not been a study that specifically examines the relationship between tall, roadside native grasses and deer collisions, evidence from other studies indicates that the presence of tall vegetation does not increase deer-related collisions. Indiana DOT planted shrubs along roadsides, monitored mammal and bird mortality over a year, and concluded that there was no significant difference in road kill between planted and non-planted roadsides (Roach and Kirkpatrick 1985). Also, because deer often preferentially eat tender new growth of vegetation over tough older growth, allowing native plants to grow without frequent mowing may encourage fewer deer to browse in roadsides (Bonnie Harper-Lore, FHA, pers. comm.). It has also been suggested that taller grasses can provide a more secure place for deer to hide, reducing their need to bolt, and thus the chances of deer accidents (Joy Williams, Iowa DOT, pers. comm.).

Movement is fundamental to an animal's life, and roads can be barriers to animals moving between habitats. The degree to which roads are restrictive to animals appears to vary greatly between species (Bennett 1991). Although literature describing possible barrier effects of roads focuses primarily on mammals, it is likely that responses of insects to roads are also highly variable. Strong fliers are less likely to be isolated, and some insects are more vulnerable to traffic mortality than others. That pollinating insects die as a result of collisions with passing vehicles is certain, but studies of the impacts of roads on flying insects are few.

An inventory of dead Lepidoptera along roads in Illinois found that observed mortality was highest on roads with an intermediate level of traffic, with lowest mortality at the highest and lowest traffic levels (McKenna et al. 2001). In Iowa, research found that more butterflies were killed on roads that had predominately grassy roadsides than on roads flanked by prairie vegetation (Ries et al. 2001). In studying butterfly diversity, mortality, and movement within roadsides, Munguira and Thomas (1992) concluded that roads could not be considered barriers to the movement of the butterflies they observed. Between 0.6 and

7% of butterfly species were killed by vehicles, figures that the authors considered to be small compared to mortality due to natural factors. There is no correlation between the amount of traffic on nearby roads and numbers of butterflies (Munguira and Thomas 1992) or with bee richness or abundance (Hopwood 2008) in roadside habitats. Such research suggests that the benefit from roadside native habitat outweighs the hazard from passing vehicles.

Balancing the Costs and Benefits

Native grass and wildflower seed does cost more per acre than typical turfgrass seed. Seeds of certain species with a limited distribution may be particularly expensive. One way to reduce costs is to harvest seeds from established stands of grasses or wildflowers. Limited amounts of seed can be harvested in the fall by hand, with the help of volunteers, or sometimes through the use of farming equipment. Another advantage of collecting seed locally is that local ecotypes may be well adapted to the area.

Even with the higher costs of seeds and planting, managing roadsides with native vegetation may ultimately be more cost effective. Management of powerline rights-of-way through native plantings along with selective use of herbicides and manual removal of woody plants, rather than repeated mowing and blanket herbicide use, reduces maintenance costs (Russell et al. 2005). Roadsides planted with native grasses and forbs should, after establishment, have less erosion as well as reduced need for mowing and spraying of herbicides, which may provide savings (Steven Holland, Iowa DOT, pers. comm.). In 1987, Massachusetts' Department of Public Works spent about $330 per acre to mow roadside turf six times; for every acre managed instead as wildflowers, nearly $280 could be saved by a reduction in mowing (Platt et al. 1994). Reduced storm water flow and reduced blowing snow due to native plantings are more difficult to calculate but may also produce savings (Steven Holland, Iowa DOT, pers. comm.).

Despite the proximity of apparent danger, roadsides rich in native plants provide valuable habitat to pollinators and other wildlife. Photograph by Maria Urice, Iowa Living Roadway Trust Fund.

For More Information

Websites

The Xerces Society: Regional information on plants, guidance on providing nest sites, and detailed guidelines for habitat creation and management in a variety of landscapes.
http://www.xerces.org/pollinator-conservation/

Federal Highway Administration: Roadside vegetation management program.
http://wwwfhwa.dot.gov/environment/vegmgt/

Iowa Department of Transportation: Information about the use of native plants in Iowa for the state's roadside management program.
http://www.iowadot.gov/plant_guide/plant_profiler.pdf

Minnesota Department of Natural Resources: Roadsides for Wildlife program with information about using native plants on roadsides.
http://www.dnr.state.mn.us/roadsidesforwildlife/index.html

Monarch Watch: Information about providing habitat for monarch butterflies and monitoring migrations.
http://www.monarchwatch.org/

National Roadside Vegetation Management Association: Integrated Roadside Vegetation Management guide.
http://www.dot.state.mn.us/environment/pdf_files/irvm_howto.pdf

Books

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