Rangeland Management for Pollinators

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Pollinator conservation and rangelands don't seem like obvious bedfellows. In this era of sustainability, the connection between pollinator conservation and row crops or pollinator conservation and orchards is obvious. But pollinator conservation and rangelands?

The reality is that pollinators are a key component of a healthy rangeland ecosystem. As Kevan stated, pollination is "central to all human beings, livestock, and wildlife."[1] Pollinators are essential for rangeland food production, help with nutrient cycling, and are prey for many birds. In essence, they hold a central position in wildlife food webs. For example, many migratory songbirds require a diet of berries, fruits, and seeds from insect-pollinated plants and pollinator larvae are an important component of the diet of many young birds. Belfrage et al. demonstrated that butterfly diversity was a good predictor of bird abundance and diversity, apparently due to a shared requirement for a complex plant community.[2] Pollinators perform such a range of ecological services in natural ecosystems that they are clearly a keystone group in nearly all terrestrial ecosystems and are necessary for plant reproduction and in forming the basis of an energy-rich food web.[3]

The relationship between pollinators and rangeland goes both ways. Pollinators are important for rangelands but rangelands are important for pollinators because they can provide habitat. Pollinators in North America include hummingbirds and bats, but insects—mainly bees, butterflies, moths, wasps, flies, and beetles—make up the vast majority of pollinators. Of these, bees are considered the most important pollinators in temperate North America. There are approximately 4,000 species of native bees in North America, many of which will thrive in the varied conditions offered by rangelands. Shrubland and scrub habitat, in particular, can be very valuable habitat. Surveys of pollinators in different California plant communities show that the chaparral community has the largest diversity of bees per unit area of any ecosystem type.

Bee habitat requires two basic components: flowers on which to forage and nest sites. Many pollinators are adapted to forage on particular plants, so a diverse community of pollinators requires a diverse array of flowers. This can be easily provided by native grassland comprising a variety of grasses and forbs. Most native bees are solitary-nesting. Around 70% of bee species nest in the ground, excavating shallow tunnels in patches of bare soil, with most of the remaining 30% nesting in cavities in old trees or plant stems. Bumble bees require a small cavity such as an abandoned rodent hole. Ground-nesting bees (both solitary bees and bumble bees) are likely the most important pollinators in grasslands, but flies, beetles, and butterflies will also be prevalent.

Rangeland pollinators have benefits that go beyond the boundaries of the range. The role that adjacent natural habitat (including grassland, shrubland, and other rangeland types) plays in providing crop pollination services is increasingly well understood: The value of crop pollination by native, wild bees in the United States is estimated at $3 billion. Proximity to natural or seminatural nonagricultural land is often an important predictor of pollinator diversity in cropland.

There is evidence of declines in both managed and wild pollinators. Causes of declines are difficult to pinpoint, but loss of habitat due to increasing urbanization, expansion of intensive agriculture, invasive plant species, and the widespread use of pesticides all negatively impact pollinator populations, as do disease and parasites affecting the pollinators themselves. Protection of habitat is one way in which rangelands can be of great significance in protecting and conserving pollinators. Natural habitat is integral to maintaining a long-term population of native pollinators in agricultural landscapes. However, it is important that management of rangelands and other nonarable lands takes into account native pollinators.

Rangeland Management for Pollinators: General Considerations

Most of the habitat management techniques considered in this article—grazing, prescribed burns, mowing, and herbicide applications—can be used to benefit pollinators. Each can also have damaging, at times severe, impacts on pollinators if they are not used carefully. (The fifth technique discussed here is insecticide applications.) There's no single management plan that can provide ideal habitat for all pollinator taxa, but there are some general considerations that apply to all situations.

In using any of these techniques, it is important to leave some areas of the site untreated. Mowing or burning the entire habitat, for example, could severely impact pollinators and leave them with little chance to recolonize treated habitat. Historically, landscapes contained sufficient areas where vegetation was in various stages of succession to support populations of pollinators with differing habitat needs. However, now that habitat is typically reduced to fragments in agricultural or otherwise intensively managed landscapes, consideration of the heterogeneous vegetation mosaic required by pollinator communities is needed to ensure healthy populations. As such, it is generally better to treat separate parts of the site in a multiyear cycle, retaining refugia from which pollinators can spread.

Grazing

Grazing in natural areas and rangelands is a common practice throughout the United States. Livestock grazing alters the structure, diversity, and growth habits of the vegetation community, which in turn can affect the associated insect community. Grazing can harm pollinator habitat through destruction of potential nest sites, destruction of existing nests and contents, direct trampling of adult bees, and removal of food resources.[4] Studies of how livestock grazing affects bees also suggest that increased intensity of livestock grazing negatively affects their species richness.[4,5] Grazing during periods when floral resources are already scarce (e.g., midsummer) may result in insufficient forage available for pollinators such as bumble bees, which, in some areas, forage into late September.[5] For example, Hatfield and LeBuhn found that uncontrolled sheep grazing in mountain meadows in the Sierra Nevada removed enough flowering plants to eliminate bumble bees from some study sites.[6] Likewise, grazing during spring when butterfly larvae are active on host plants can result in larval mortality or remove important vegetation (host plants or shelter) and nectar resources.[7]

In Arizona, Debano conducted one of the few studies that focused explicitly on the impacts of domestic livestock grazing on invertebrate communities in a region that historically had not been grazed.[8] The results clearly show that invertebrate species richness, abundance, and diversity were all greater in ungrazed sites. Debano suggested that since insects in the Southwest had not evolved in the presence of buffalo or other large ungulates, adaptations to grazing pressure had not developed, making them more susceptible to the presence of cattle.[8]

Grazing is not necessarily harmful. Many parts of the world have experienced grazing pressure from both domesticated and wild animals for millennia and the indigenous flora and fauna are adapted to grazing. Even in areas where grazing is not historically found, light levels of rotational grazing can have positive effects on maintaining an open, herbaceous-dominated plant community that is capable of supporting a wide diversity of pollinators.[7]

Grazing does need to be carefully planned and implemented to be effective. A Swiss study found that although grazing was an effective management tool for limiting succession, (i.e., slowing the conversion of open grassland to shrubland or woodland) responses to grazing varied greatly among butterfly species.[9] The authors suggest that any management regime be attentive to historical and species-specific characteristics of the species at the site, and that a diversity of management techniques be used on a regional scale in order to preserve the greatest diversity of insect pollinator habitat.

Grazing can be a valuable tool for limiting shrub and tree succession, providing structural diversity, encouraging the growth of nectar-rich plants, and creating potential nesting habitat. However, grazing is usually only beneficial at low to moderate levels and when the site is grazed for a short period followed by ample recovery time—and when it has been planned to suit the local site conditions.

Grazing: Key Points

- Grazing can destroy nest sites and remove forage plants.
- Grazing can greatly alter the structure, diversity, and growth habits of the vegetation community.
- Grazing can be used to maintain open, forb-dominated plant communities that support a diversity of pollinator insects, but only if the correct combination of timing and intensity of stocking rate are found.
- At severely overgrazed sites, livestock should be excluded for long enough to allow the vegetation community to regain a diversity and abundance of forbs.
- Keep grazing periods short, with recovery periods for the habitat relatively long.
- Generally grazing that is of low intensity and short duration in the fall (when there is less competition for floral resources with pollinators) is best.

Mowing

Mowing is often used in place of grazing where site access and topography permit equipment access or where livestock would be inappropriate, such as urban sites and roadsides. Like grazing, mowing can alter grassland succession and species composition by suppressing growth of woody vegetation. Mowing can have a significant impact on insects through direct mortality, particularly for egg and larval stages that cannot avoid the mower. Mowing also creates a sward of uniform height and may destroy topographical features such as grass tussocks when care is not taken to avoid these features or the mower height is too low.[10] Such features provide structural diversity to the habitat and offer potential nesting sites for pollinator insects such as bumble bees. In addition to direct mortality and structural changes, mowing can result in a sudden removal of almost all floral resources for foraging pollinators; therefore it should not be conducted when flowers are in bloom.

Mowing: Key Points

- Mowing has significant impacts on the habitat quality.
- Mowing will create uniform vegetation height and remove flowering resources.
- Mowing can be used to control shrubs and trees to maintain open conditions.
- No more than a third of habitat should be mown in one year.
- Road edges may be an important resource for pollinators. Mowing management could be adapted to the maximum benefit of pollinators.

Prescribed Burns

Fire has played an important role in many native ecosystems, and controlled burns are an increasingly common management tool. Effects of fire management on arthropod communities are highly variable. If used appropriately, fire benefits many insect communities through the restoration and maintenance of suitable habitat. Other studies have found a negative or mixed response of invertebrates to fire.[11]

In Midwestern US prairie systems, fire as a management tool is based on the supposition that prairie species are adapted to wildfires, and thus can cope with regular burns.[11,12] This is dependent, however, on there being adequate unburned areas that can provide sources of colonizers into the burned habitat. In habitat fragments where populations are more isolated, prescribed burning can have much more deleterious effects on the population due to a lack of colonizing capacity. For example, Harper et al. found that overall arthropod species richness decreased in burned prairie sites, as did the abundance of all but one of the species measured.[11] Their results suggest that burning a small habitat fragment in its entirety could risk extirpating some species because of limited recolonization from adjacent habitat. Rare butterflies can also be negatively impacted by prescribed burning. Swengel found that fire had consistent negative effects on prairie-specialist butterfly species, and that these effects persisted for 3 to 5 years postburning.[12] In a recent study of the Mardon skipper, the butterfly was virtually eliminated from the burned portion of the habitat.[13] After 2 years the butterfly population in the burned portion of the site had still not recovered.

Fire can have serious impacts on population levels and unless there are adequate refuges from the fire or adjacent habitat, recolonization of a burned site may not be feasible. Timing of burns is also critical and should not be carried out when target pollinators are in a critical foraging stage. Habitat patches should not be burned completely, but rather a mosaic of burned and unburned areas is ideal.

Prescribed Burns: Key Points

- Fire has played an important role in maintaining many native ecosystems.
- Bee populations are significantly lower in years following a burn.
- It can take years for insect communities to recover from a burn.
- Impacts of burning can be reduced if areas of habitat are left unburned.
- Fires should not burn more than one-third of habitat in any given year.
- A program of rotational burning where small sections are burnt every few years will ensure adequate colonization potential for pollinators.
- As a fire moves through an area it may leave small patches unburned. These skips should be left intact as potential microrefuges.
- Care must be taken to avoid actions that could degrade habitat and kill individual pollinators as a result of heavy equipment use or people trampling meadows.

Herbicide Applications

Herbicides can kill plants that pollinators depend on, thus reducing the amount of foraging and egg-laying resources available.[7,14,15] Just as pollinators can influence the vegetation community, changes in vegetation can have an impact on pollinators. A pollinator community requires consistent sources of nectar, pollen, and nesting material during those times adults are active. The broadcast application of a nonselective herbicide can indiscriminately reduce floral resources, host plants, or nesting habitat.[7] Such a reduction in resources can cause a decline in pollinator reproductive success and/or survival rates.

Moreby and Southway found that invertebrate abundance (notably species of Diptera [flies] and Heteroptera [true bugs]) was consistently higher in unsprayed plots than in plots that received a single autumn application of herbicides.[16] Taylor et al. showed that herbicide applications in field margins reduced the number of arthropods (including Lepidoptera [moth and butterfly] larvae) that were food sources for pheasant and partridge chicks.[17]

Other studies have addressed herbicide use and its effects on pollinators in general. In a review suggesting that pollinators are useful bioindicators, Kevan reported that herbicides reduced the abundance of Asteraceae and Lamiaceae flowers in France, contributing to a decline in bumble bee populations.[1] Kevan also found that herbicide applications have reduced the reproductive success of blueberry pollinators by limiting alternative food sources that can sustain the insects when the blueberries are not in bloom.[1] Kearns et al. state “herbicide use affects pollinators by reducing the availability of nectar plants. In some circumstances, herbicides appear to have a greater effect than insecticides on wild bee populations … Some of these bee populations show massive declines due to the lack of suitable nesting sites and alternative food plants.”[3] In contrast, Russell et al. found that the use of selective herbicide when combined with mechanical removal of shrubs and small trees was an effective method of maintaining power line corridors as effective pollinator habitat.[18] In this study, however, nonselective broadcast herbicides were prohibited as they suppressed important nectar resources.

Herbicides: Key Points

- Herbicides kill plants on which pollinators depend for foraging or egg laying.
- Some herbicides can be lethal to bees by direct application or exposure during foraging.
- During vegetation management, treat only the minimum area necessary for the control of weeds. Take care to minimize overspray to habitat around the weeds.

Insecticide Applications

In rangelands and forested areas, insect pests are targeted with a variety of pesticides and can have a significant negative impact on pollinators.[1,19]

One of the most robust case studies of the effects of insecticides on pollinators details how the use of fenitrothion to control spruce budworm in Canadian forests devastated native bee populations. As summarized by Kevan, the reduction of native pollinators due to fenitrothion caused a series of effects to ripple through the ecosystem.[1] Similar effects were discussed by Alston and Tepedino for the application of broad-spectrum insecticides in rangelands to control grasshoppers.[19] The insecticides used, due to their high toxicity, are not permitted on blooming crops being visited by bees, yet they were allowed to be sprayed on rangelands while native pollinators were foraging on wildflowers. The grasshopper spraying campaigns (generally from mid-April to late May) coincide with the flowering period of several endemic rangeland plants that grow among the grasses, a number of which are listed as endangered or threatened. This time period also overlaps the period of emergence and active foraging of many native bee species.[3] The usage of broadband insecticides in wild areas may potentially result in a number of ecosystem shifts due to pollinator limitation. These include "changes in future vegetation patterns via plant competition, reduction in seed banks, and influences on the animals dependent upon plants for food."[19]

The reports of die-offs of native bees are few and far between. Although there are reports of native pollinator die-offs in nonlaboratory conditions, many such poisonings in the wild are assumed to go unreported because the bees are unmanaged and do not gather in large aggregations. Low fecundity rates mean it can take many years for a native pollinator population to recover from a large reduction. Lethal effects on honeybees are often the primary focus of regulatory procedures for assessing the safety of a new insecticide for pollinators despite the enormous diversity of bees, butterflies, and other pollinating insects that may have a wide variation in their response to the same insecticide. As a result, a pesticide that has been deemed safe for honeybees when used according to the bee label may not be safe for native bees or other pollinators.

Insecticides: Key Points

- Insecticides can be lethal to bees or have sublethal effects such as reducing foraging efficiency or reproductive success.
- A pesticide that has been deemed safe for honeybees may not be safe for native bees, even when applied according to label requirements.
- Insecticides not allowed on blooming crops due to high toxicity may be allowed on rangeland while pollinators forage.
- Insecticide impacts are most severe within the agricultural matrix although spraying for mosquitoes, grasshoppers, or other insects may impact pollinators in a wide range of landscapes.

Conclusion

Pollinators are vitally important for functioning ecosystems worldwide. Managers of rangeland systems can play an important part in pollinator conservation. Pollinator conservation will not require a wholesale shift in how managers work in these landscapes but may require changes to timing, intensity, and scale. If managers start to think about all of the components of these ecosystems—even the ones that are not always easy to see—pollinators and all of the flowering plants that depend on them will benefit.

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