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The Role of Native Bees in Prairie Restoration

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Introduction

North American prairies were thoroughly diminished as agriculture transformed the landscape. Prairies, unlike some ecosystems, have had no opportunity for post-disturbance regeneration (Jordan, 1997). This is one of the reasons why the science of restoration began with prairies. Successful recreation of a prairie depends on establishing pollinators, which are an essential part of a functioning ecosystem. Bees may be the most important of all pollinators (Neff et al., 1993). What part should bees play in prairie restoration? To maximize success of a prairie restoration, the role of native bees needs to be understood. Most prairie plants need pollination for seed production (Reed, 1993), which is necessary for the restoration to become self-sustaining beyond the initial planting. Currently, invertebrates like bees are not a focus in prairie restoration (Reed, 1995a) and are left to colonize restored sites on their own (Kline, 1997). To what extent does colonization occur? Are there consequences to a prairie restoration if this colonization does not occur? There may be steps that can be taken during and after a restoration to increase the rate of colonization on the habitat. Not only are native bees beneficial to prairie plants, they also aid in pollinating agricultural crops. There is some irony in this, as agriculture is the main reason that prairies were lost (Kline, 1997).

Prairies and restoration

Prairies are a species-rich grassland habitat that once comprised a large portion of the midsection of the United States (Kline, 1997). Along with the many species of monocots, other herbaceous species on the prairie include forbs and legumes (Kline, 1997). There are three main types of prairie: tallgrass, mixed-grass and shortgrass. Each type differs in the plant communities and rainfall amounts. Shortgrass prairies are characterized by lower amounts of precipitation and shorter grasses like Buffalo grass *(Buchloë dactyloides)* and blue grama *(Bouteloua gracilis)*. Shortgrass prairie occurs in the western Great Plains. Tallgrass prairie has greater rainfall with grasses like big bluestem (*Andropogon gerardii*) and Indian grass (*Sorghastrum nutans*). Tallgrass prairie is the type that occurs in Minnesota (Minnesota DNR, 1999). It is found from the eastern Great Plains into the Midwest. Mixed-grass prairie occurs between the other two categories and has a mixture of grass types including Western wheatgrass (*Agropyron smithii*) and green needlegrass (*Stipa viridula*).

Why do prairies need restoring? Less than 1% of prairies are left today. Europeans settled the area, which led to the loss of the habitat. The biggest loss was due to the conversion of the prairie to make farmland (Kline, 1997). Areas that were not suitable for farming were subject to grazing. The suppression of fire by the settlers helped to transform some of the rest into oak forests (Kline, 1997). Prairie plants, which have extensive root systems that allow them to survive burning, are adapted to fire. All these factors lead to the huge loss of the prairie ecosystem and to the need for prairie restoration. While there is now much known about prairie plant establishment, little is known about the establishment of insects including bees (Reed, 1993).

Importance of bees as pollinators

The diversity of plants on the prairie is related to its diversity of insect life. In Minnesota, Reed (1993) found almost 100 different bees species on prairie sites. Bumblebees, members of the genus *Bombus*, are an example of an important pollinator of prairie plants (Reed, personal communication). Other conspicuous and important bees on prairies are miner, carpenter, leaf-cutter, and mason bees. Are all these pollinators essential to a restoration? The plants within a prairie restoration could have had their original pollinators become locally extinct. However, very few plant species, especially in a prairie, have specialized pollinators (Reed, personal communication). Generalist bee species can colonize and fill the pollination niches if the specialists are lacking. The issue of missing one partner of a mutualistic relationship is probably more of an concern for the insects than for the plants (Reed, personal communication). Still, a diversity of pollinator species is a better guarantee of pollination, with the vagaries of population flux and variance in seasonal changes (Kearns et al., 1998; Wall et al., 2003). But some argue that for maintenance of many plant populations, loss of some pollinators is sustainable (Morris, 2003).

That is the relationship between bee and plant? The bee gains the food resource of pollen and/or nectar, while the plant optimizes its seed production and decreases inbreeding. Cross-pollination is especially important in plants that are incapable of self-fertilization. Some plant species like those belonging to the Scrophulariaceae and Lamiaceae families (both represented on prairies) are completely dependent on bees for pollination (Neff et al., 1993). Bees, in contrast to other insect pollinators like butterflies and moths, do not have a larval stage where plant material is consumed. Most bees have an entirely mutualistic relationship to the plants they pollinate. The consequences of lack of pollinators for plants are lowered or absent seed set, unviable seed, and inbreeding. These can eventually lead to reduced fitness of populations (Reed, 2002).

Are restored areas suffering due to lack of pollinators?

Because of habitat destruction, the remaining intact prairies are often fragmented. Restored sites are sometimes similarly isolated. Restored areas could be lacking pollinators. There has been some evidence of pollen limitation in plants due to lack of pollinators in fragmented areas (Kearns et al., 1998). One study examined seed yields on an isolated prairie remnant in Iowa, where there is very little intact prairie left. Low yields of seeds in forb species were found on a prairie remnant due to lack of pollinators (Ingram et al., 1996). Low yields could also be a concern on restored sites where pollinators are not introduced along with the plants. It is unknown if this problem would apply to areas where there are more remnants and restored areas.

In a study of *Penstemon grandiflorus* on southwestern Minnesota prairies, Reed (2002) found that there was no evidence of pollinator limitation on restored or native sites regardless of population size. It would seem that for this species at least, there is no confirmed negative effect of restoration on pollination. Pollinator species diversity has been compared on remnant versus restored sites in Minnesota. Reed (1995b) investigated the diversity of prairie insects on restored and natural sites. She found that the remnants had only a slightly higher number of pollinators when compared to the restored sites and also that there was not a relationship to insect diversity and size of the site. This is evidence that restored prairies that are close to native prairies probably will be colonized by some native bees to receive adequate pollination. Isolated restored sites may be a different story.

There is some evidence that due to the high site fidelity of prairie bumblebees, isolated prairie remnants could be limited in pollination (Reed, unpublished). She found that the bees were loyal to their sites and did not leave them for foraging. Bees may be prevented from colonizing a site if they are too distant to travel to or if there are barriers. Bhattacharya et al. (2003) found that bumblebees may be restricted from travel by artificial barriers such as roads, fields or railroads. Although bumblebees are capable of traveling long distances, they tend to be loyal to limited sites (Bhattacharya et al., 2003). This may have repercussions for very small restored habitats. In a study involving bumblebees and habitat fragmentation of sub alpine meadows in Utah, Bowers (1985) found that workers in established colonies did not forage outside of their own meadows. Restorationists may have to discover ways to work with the behavioral tendencies of bees.

What would increase the rate of bee colonization on prairie restorations?

The proper conditions for bee colonization can be provided in a new restoration. It is obvious that bees require appropriate flowering plants that provide pollen and nectar. Two other requirements in the case of bumblebees are nesting cavities and nesting materials such as animal fur and/or dead vegetation (Michener, 2000). All three requirements must be within flying distance of each other. Other bees require the presence of mud, resins, and pebbles for their nest construction (Cane, 2001). An important aspect of bumblebee biology as it relates to restoration is their choice of nesting sites (Griffin, 1997). Bumblebee queens, having over-wintered from the previous season, must locate a new nest in the spring to start their colony. Appropriate sites will vary depending on the species, but some common choices are abandoned rodent or bird nests or other naturally occurring openings. Some other bee species will nest above ground or near logs (Michener, 2000). Some of these elements could be included on a newly restored site, especially smaller areas.

In Europe, where the threats to native bees are greater, scientists are considering options for optimizing habitat for bees. These ideas may be helpful for restorationists here in the U.S. Suggestions that apply to non-*Bombus* species include leaving small areas of open sandy ground in restorations for burrowing bee species and dead wood for those species that prefer that type of nest (Edwards, 1996). Ground-nesting bees avoid extremely recently disturbed habitat like plowed fields (Kearns et al., 1998) and so may not colonize an extremely recent restored site.

Longer-lived species like bumblebees need more than one plant species with sequential flowering times to persist to the end of the season (Cane, 2001). Therefore plant species diversity in restoration would then be a necessity to cover the entire season for bees from early spring to late fall. Bumblebee species have different peak population periods within the season. In Minnesota, *B. bimaculatus*, an early species peaks in mid-July, while *B. impatiens* has a later peak and will persist until fall (Reed, personal communication). Seed mixes should include a variety of bloom times to cover the whole season (Reed, 1993). There are also some forb species that are more valuable to pollinators (Reed, personal communication). A special effort could be made to include these species in restoration. Lead plant (*Amorpha canescens*) is an example of a plant that is utilized more by pollinators, while false sunflower (*Heliopsis helianthoides*) is an example of a less-used species (Reed, personal communication). Reed (1995b) found a slightly lower diversity of pollinators on restored prairies. She theorized that it may have been due to fewer fall-blooming species. While a diversity of plant species can lead to a diversity of bee species, what is beneficial for management of plants may not always be beneficial for bees.

Prescribed burns are usually part of the process of managing a prairie. The effects of burning can have differing results on the composition of insect populations (Reed, 1997). How an individual insect species responds to a burn is dependent on previous burns, the sensitivity to burns, the re-colonization ability and the biology (Reed, 1997). Overly frequent burns negatively affect some insect species. There has not been any evidence that bees are negatively affected, but research in this area is limited. Presumably, as native bees have been a part of the prairie ecosystem, they are adapted to fires similar to ones that occurred prior to European settlement. The needs of all the organisms in a restoration need to be considered. As has been mentioned, bees have not traditionally been considered in restoration. They are only now being considered in conservation.

Threats to bees

There are no bees currently listed on Minnesota's list of threatened and endangered species, nor are there any on the federal list. This may only be due to lack of awareness, not that there are not species that face the threat of extinction. An estimated 90% of all insect species unidentified (Samways, 1993) and some of those that are known can only be distinguished by a few experts (Reed, personal communication). Insect conservation efforts in our area are focused on butterflies, but they have yet to be introduced directly as part of a restoration (Reed, personal communication). In Europe, thirty-five species of bumblebees are considered threatened (Kearns et al., 2001). The U.S. does not lack in hazards to native bees.

Native bee populations can be negatively affected by pesticide use in agricultural areas, competition by non-native honey bees, and by habitat loss (Mayer et al., 1996; Buchmann, 1996; Kearns et al., 1998). Pesticides can cause bee poisoning by drift, dust adherence to their bodies, by drinking contaminated water or by collecting contaminated pollen or nectar (Mayer et al., 1996). Some pesticides can cause further harm to the whole colony when a contaminated bee returns to the hive. Examples of injurious pesticides, particularly during blooming periods, to bumblebees include diazinon, malathion and carbofuran (Mayer et al., 1996).

There has been some concern about the competition of cultivated and feral honey bees with native bees. Honey bees are generalists and utilize many different plant species. Their colonies are large and require substantial amounts of pollen and nectar compared to native bees. They may not be as effective of pollinators as the native bee species and could be affecting native plants' reproductive potential (Buchmann, 1996). The effect of honey bees on native bees has been difficult to determine since they were introduced to this country hundreds of years ago. Increased competition combined with habitat loss has most likely had an effect on the native bees in the past (Buchmann, 1996). The outbreak of Varroa and tracheal mites has decreased honey bee numbers in recent years, which could be benefiting native bees (Griffin, 1997). Native bees are not threatened by the parasites that infect honey bees (Reed, personal communication). Because of this fact, bees are useful in other systems besides natural ones.

How restored sites with their bee populations benefit other systems

Native bees provide benefits to more than native plants. They also pollinate crops. The value of native pollinators to agriculture in the U.S. is estimated to be in the billions of dollars (Kearns et al., 1998). Some scientists predict a crisis in agriculture due to lack of native bees pollination (Kearns et al., 1998). In places where pollination of crops is limited, there could be some sort of joint effort in native plant restoration. Restored sites adjacent to agricultural areas could provide habitat for nests and forage for times when crops are not in bloom. There would be a net economic benefit from restoration sites as an incentive. By using native pollinators, the potential cost savings of reducing the need for honeybee hives is in the tens of millions of dollars (Kremen et al., 2002). This should be an area for future investigation.

Areas for future research

There are many areas of research regarding prairie restoration and bees. Are there some rare bee species that need conservation or possible reintroduction? Are some plant species on restored sites being limited by lack of pollination? To answer these questions, research needs to be done on specific bee and prairie plant interactions. Research in the area could include investigating more individual prairie plant species for evidence of pollen limitation. Pollen limitation may be more of an issue with the restoration of endangered species that occur at lower population numbers. A study could be performed to investigate pollen limitation on extremely isolated restored prairie sites. A major goal in regards to conservation of pollinator-plant relations is recording what species are interacting (Sheffield et al., 2003). Investigating the relationships between prairie plants and bees may help prevent the losses of bees that have occurred in Europe with habitat loss. If it came to the point that there were demonstrable lack of pollinators in a restored prairie, the technology of captive rearing of bees could become useful. For the time being, it seems that human intervention is not necessary for reintroduction of native bees along with prairie restoration.

Conclusion

To maintain a high level of plant diversity in an ecosystem for the long term may require a high level of diversity of bee species (Neff et al., 1993). Restored prairie communities need efficient pollinators like native bees. Restoration efforts up to this point have not included the re-introduction of any insects. As Kline (1997) stated, "It is customary in restorations to establish plants and then wait for appropriate animals to take advantage of this new habitat". In some cases, bee species will colonize restorations naturally due to proximity. More research should be done in the area of bee-plant interactions and colonization to restored sites. Prairie restorationists can take steps to increase the rate of colonization on the habitat. There are dire consequences for restorations without bees. It could determine the success of a self-sustaining restored prairie and even to landscapes beyond.

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