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Science FINDINGS

INSIDE

"Science affects the way we think together."
Lewis Thomas

Beyond the Bloom: Creating Opportunities for Healthy Ecosystems and Native Bees

Scientists prepare to net native bees in the Starkey Experimental Forest and Range in eastern Oregon to learn more about the interactions among pollinators, native plants, livestock grazing, foraging wildlife, and timber management. USDA Forest Service photo by Mary Rowland.

IN SUMMARY

Native bee populations are declining worldwide, threatening both natural ecosystems and agriculture as these insects pollinate about 80 percent of all flowering plants. Research at the Starkey Experimental Forest and Range, managed by the U.S. Department of Agriculture, Forest Service, points to strategies for supporting native bees while maintaining grazing and timber production.

Scientists with the Forest Service's Pacific Northwest Research Station and Oregon State University identified more than 300 native bee species at the study site in eastern Oregon. They found that bees rely heavily on flowering shrubs in early spring, even though the shrubs represented less than 7 percent of available blooms. They also found a 60- to 64-percent overlap between the plants that bees forage and those that mammals such as deer, elk, and cattle graze.

To address this potential resource conflict, scientists evaluated the potential benefits of delaying livestock grazing until after peak wildflower bloom. Their findings suggest that this strategy would decrease the effects of cattle grazing on flowers in early summer, when bee communities are most diverse, and thus minimize potential negative effects on bee populations.

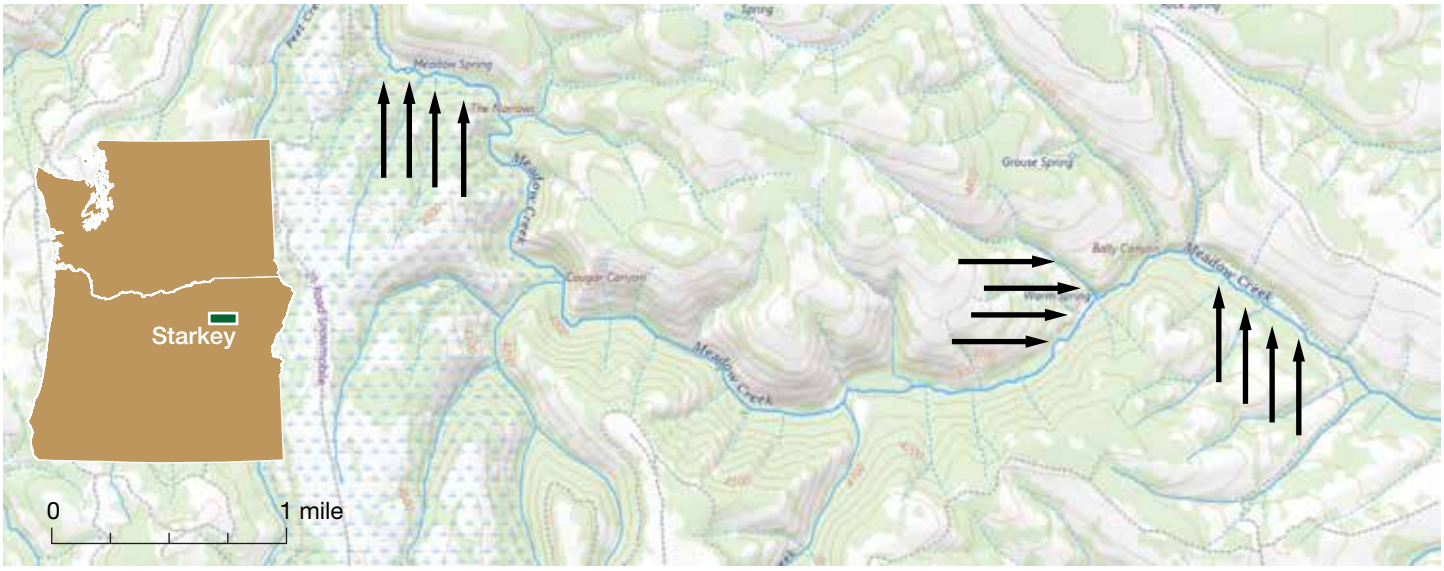
The study found that small management adjustments can significantly benefit native bee populations, including rotating grazing based on flowering cycles, protecting flower-rich areas until after peak bloom, and planting diverse plants that bloom throughout the growing season as part of restoration efforts.

"By the precise and delicate timing that is nature's own, the emergence of one species of wild bee takes place on the very day of the opening of the willow blossoms."

—Rachel Carson, marine biologist, writer, and conservationist

When spring's first wildflowers emerge, they signal the beginning of a complex seasonal relationship that underpins ecosystem health—the ancient partnership between flowering plants and one of their primary pollinators, native bees. Native bee populations have been declining worldwide at disturbing rates, raising concerns about the future of both natural ecosystems and agricultural systems that depend on pollination. These small but mighty insects are responsible for pollinating about 80 percent of flowering plants, including many that provide food for wildlife and humans alike. Yet, much remains unknown about their habitat requirements and responses to land management.

Public lands in the Pacific Northwest face a complex management challenge: supporting land uses such as livestock grazing, recreation, and timber production, while simultaneously



Long-term research area and study sites (black arrows) along Meadow Creek in the Starkey Experimental Forest and Range, Oregon.

conserving biodiversity and ecological functions. Recent research at the Starkey Experimental Forest and Range, managed by the U.S. Department of Agriculture, Forest Service in eastern Oregon, offers insights for integrating pollinators into restoration planning and grazing management.

"Without too much of a heavy lift," says Mary Rowland, "we can provide benefits to native bees just by being more cognizant of flowers that are especially attractive to them."

Rowland, an emeritus research wildlife biologist with the Forest Service's Pacific Northwest (PNW) Research Station, partnered with Sandra DeBano, an invertebrate ecologist and associate professor at Oregon State University, and graduate students Scott Mitchell and Katherine Arstingstall to initiate a long-term study of native bees.

"Native bees are an important cog in the wheels of managed and natural environments," says DeBano. "We want to make sure we're paying attention in order to understand the best ways to enhance their pollination activities."

While there's no question that honey bees (which are not native to North America) are important for pollinating crops, native bees also play a role and are estimated to contribute more than $3 billion annually to crop pollination nationwide. One advantage that native bees offer is that they are already present in the environment, while honey bees need to be brought in to pollinate crops.

DeBano says there are estimated to be more than 700 native bee species in Oregon. At the Meadow Creek study site in the Starkey Experimental Forest and Range, the scientists identified more than 300 species along an 8-mile stretch of riparian area and nearby forested sites. Among these were 15 species of bumble bees, including the western bumble bee––a candidate species for protection under the federal Endangered Species Act. Bumble bees are particularly adept at pollinating early blooming plants like berries. Their fuzziness, for example, allows them to be active during cooler temperatures when honey bees are not.

Understanding Bee and Plant Relationships

Understanding how native bees interact with their floral resources is essential for effective conservation strategies. The relationships between bees and plants can range from highly specialized to remarkably generalized and vary seasonally. Throughout a growing season, both bee and plant communities undergo dramatic shifts. In eastern Oregon, the scientists noted that flowering diversity peaked in May and June and declined steadily through the summer months. This pattern coincides with the emergence and activity of different bee species, each with its own timing and plant preferences.

Early spring is a critical period for native bees. When they first emerge from winter

*Yellow avalanche-lily (*Erythronium grandiflorum*) in bloom at a pollinator sampling site. The blue vane trap at the center of the site collects bees. USDA Forest Service photo by Mary Rowland.*

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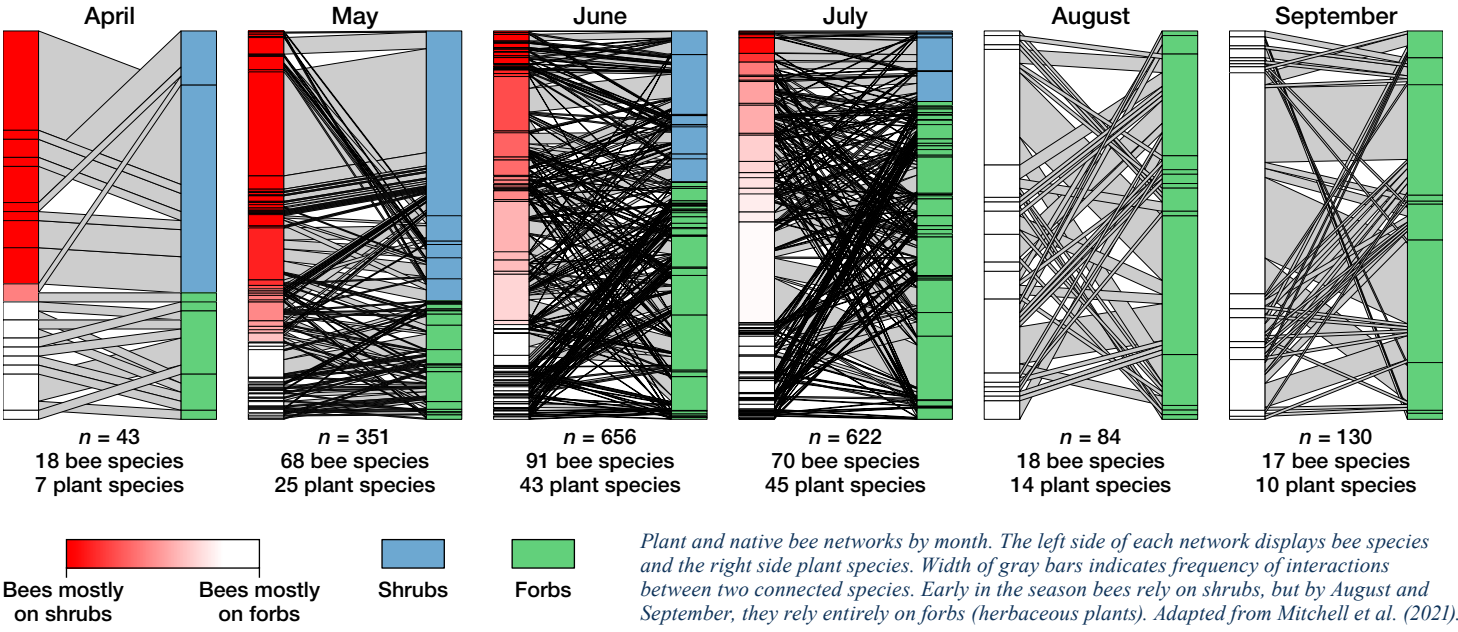
KEY FINDINGS

- Early blooming shrubs are disproportionately important to native bees in spring. Although shrubs represented less than 7 percent of available blooms in April, they attracted 57 percent of all bee visitors during this time.
- Native bees, deer, elk, and cattle forage on many of the same plants (60 to 64 percent), creating potential competition for resources, especially in early to midsummer when more bee species are active.
- Delaying livestock grazing in bunchgrass prairie and riparian meadow ecosystems by a few weeks, until after peak wildflower bloom (seasonal targeted grazing), ameliorated the negative effects of grazing on bee populations that was noted in previous research.
- Bee abundance in grazed areas remained stable later in the summer despite reduced flower abundance and diversity, suggesting resilience because the community was dominated by generalist bee species at that time.
- Different shrub species support diverse bee communities throughout the growing season. Black hawthorn (*Crataegus douglasii*) supported the highest diversity of bee species, followed by mallow ninebark (*Physocarpus malvaceus*), whereas willow (*Salix* spp.) and wax currant (*Ribes cereum*) proved most valuable as early-season resources.
- DNA metabarcoding revealed that bees visit twice as many plant species as previously documented through field observations, challenging assumptions about specialized foraging behaviors and revealing previously undetected interactions with rare flowers.



Plant and native bee networks by month. The left side of each network displays bee species and the right side plant species. Width of gray bars indicates frequency of interactions between two connected species. Early in the season bees rely on shrubs, but by August and September, they rely entirely on forbs (herbaceous plants). Adapted from Mitchell et al. (2021).

dormancy, they depend heavily on whatever flowers are available. One surprising finding was that during this time in riparian areas, shrubs appear to be more important for native bee communities, even though they are less abundant than herbaceous plants. Flowering shrubs such as willows (*Salix* spp.) represented less than 7 percent of available blooms in April, yet they attracted 57 percent of all bee visitors during this time. This underscores the disproportionate importance of certain plants during key seasonal windows. The fraction of bees collected on shrubs was highest in May, but in June and July, forbs were a more important floral resource.

Diet Overlap

The native bee story grows more complex when considering their relationships with other animals. Substantial overlap in the diets of native bees and mammals such as deer, elk, and cattle can spell trouble for pollinators. About 60 to 64 percent of flowering plants consumed by these large mammals have also been documented as important food sources for native bees. Ungulates primarily consume grasses, but they also eat significant amounts of flowering herbaceous plants (forbs). Previous research in the region showed that bumble bee abundance and richness decreased in response to increased livestock use. Diet overlap creates a potential resource conflict, particularly earlier in the summer when bee diversity is highest.

Time-based Options

To ease negative effects observed in the past, one option is to delay livestock grazing by just a few weeks so that it occurs after peak wildflower bloom. This targeted grazing approach acknowledges the seasonal patterns of both plants and pollinators and works within natural cycles rather than against them.

In their study across two distinct ecosystems in eastern Oregon—a bunchgrass prairie in The Nature Conservancy's Zumwalt

*A bee on wax currant (*Ribes cereum*), a valuable early-season source of pollen. Photo by Scott Mitchell.*

*A bee on black hawthorn, (*Crataegus douglasii*), a species that blooms in midsummer and supported the highest diversity of bee species in the study. Photo by Scott Mitchell.*

Prairie Preserve and riparian meadows at Starkey Experimental Forest and Range—the scientists tested whether delayed grazing (after the peak flowering period) would reduce previously observed negative effects of grazing on native bee populations. The results were promising. Grazing after peak bloom resulted in no significant negative effects on bee populations in either ecosystem, a result that contrasted with previous work that showed earlier season grazing had negative effects on bees.

Interestingly, even though delayed grazing did reduce flower abundance and diversity later in the summer in riparian areas, bee populations remained stable. This unexpected resilience may be explained by the composition of the late-season bee community which was dominated by generalist bees that can adapt to varying floral resources. The study also found no evidence of cumulative negative effects from previous years of grazing, suggesting these ecosystems can maintain their function under moderate, well-timed grazing pressure.

For ranchers and land managers, implementing this approach requires flexibility. Possible strategies include:

- Rotating livestock through areas based on flowering phenology, grazing less diverse areas earlier and delaying access to floristically rich habitats
- Using visual assessments of bloom abundance to determine when to introduce livestock to sensitive areas
- Utilizing alternative early-season grazing locations such as old fields or managed pastures while allowing wildflower-rich habitats to complete their bloom cycle

A key advantage of targeted livestock grazing is that it doesn't necessarily reduce total grazing opportunity—it simply redistributes it during the season and across the land to minimize its effect on pollinators. Although deer and elk cannot be managed this way, understanding their seasonal patterns of use and selecting species for restoration plantings that are not preferred forage can help mitigate the effects of wild ungulates on bee resources.

Plant Selection

Beyond timing adjustments, plant selection can create win-win solutions for ecosystem restoration. This is particularly evident in riparian restoration efforts where the traditional focus has been on planting shrubs and trees to stabilize streambanks, provide shade for water temperature regulation, and create wildlife habitat. These same woody plants can provide crucial resources for native bees. Bee communities visiting shrubs at Meadow Creek were distinct from those visiting herbaceous plants. Thirty bee species were found exclusively on shrubs in one study. However, different shrub species support diverse bee communities throughout the growing season.

- Early spring: Willows (*Salix* spp.) and wax currant (*Ribes cereum*) provide critical forage for emerging bees
- Late spring: Black hawthorn (*Crataegus douglasii*), wildrose (*Rosa* spp.), and redosier dogwood (*Cornus sericea*) become important nectar and pollen sources
- Midsummer: Common snowberry (*Symphoricarpos albus*) and blue elderberry (*Sambucus nigra*) support late-season pollinators

Overall, black hawthorn supported the highest diversity of bee species, followed by mallow ninebark (*Physocarpus malvaceus*), while willow and wax currant proved most valuable as early-season resources.

Uncovering Hidden Connections with DNA Technology to Reveal Bee Foraging Secrets

Until recently, scientists studying bee foraging relied primarily on direct field observations to determine what flowering species were visited by bees. Now, by using DNA metabarcoding, researchers can analyze the pollen carried by bees and identify all the plant species represented.

Researchers working at the Starkey Experimental Forest and Range in eastern Oregon compared traditional observations with DNA analysis. They discovered that bees visit roughly twice as many plant species as field observations suggest. Some bee species thought to specialize on a single plant family were actually collecting pollen from diverse sources. The technique also detected interactions with small or rare flowers that went unnoticed in field observations, providing a more nuanced understanding of plant-pollinator networks.

A researcher nets bees at a study site along Meadow Creek. USDA Forest Service photo by Mary Rowland.

DNA metabarcoding, while powerful, has challenges. Follow-up research showed that the number of DNA sequences detected didn't reliably reflect the actual amount of pollen from each plant species. Additionally, analysis methods significantly affect results. More inclusive approaches capture all plants in the samples but may include trace contaminants, while stricter approaches avoid false positives but might miss rarer plant visits. In one study, a liberal analysis suggested bees visited an average of 16.5 plant species, while a conservative analysis indicated bees visited an average of 2.7 species.

Despite these challenges, DNA barcoding remains valuable for pollinator research as long as data users consider the research methodology. For conservation efforts, these findings emphasize the importance of maintaining diverse plant communities to support pollinators whose resource needs are more complex than previously believed.

"I know ranchers would rather avoid hawthorn, which can turn into cattle-trapping thickets," Rowland says. "But including them in the planting mix provides an early flower resource for bees that you can count on not to be chomped down by deer and elk the way willows and cottonwoods planted for riparian restoration are."

Some plants offer multiple advantages in restoration settings. By selecting plants that simultaneously benefit stream health, resist browsing damage, and support pollinators, restoration practitioners can achieve multiple ecological goals with the same investment.

LAND MANAGEMENT IMPLICATIONS

- Including diverse flowering shrubs in riparian restoration projects can support different bee communities throughout the growing season.
- In areas of high-quality bee habitat, shifts in livestock grazing dates or temporary pasture fencing can help moderate negative effects of grazing on bee and plant communities, fostering the integration of sustainable pollinator communities and grazing systems.
- Delaying grazing until shortly after peak wildflower bloom can benefit native bee populations without significantly reducing total grazing opportunities.
- Protecting flower-rich areas during critical blooming periods minimizes competition between grazing or browsing animals and native bees.

*Western bumble bee (*Bombus occidentalis*) on lupine (*Lupinus *sp.). Photo by Scott Mitchell.*

As an entomologist with the Oregon Department of Forestry, Christine Buhl shares information such as the findings from the Starkey bee research project with landowners and land managers as part of the Oregon Bee Project. The multiagency group, created by the Oregon State Legislature in 2015, is tasked with enhancing and protecting pollinator habitat and health.

"I want to emphasize to landowners that it's not hard to integrate bee habitat into a landscape locally," Buhl says. "You don't have to have acres and acres that you're planting for pollinators, you can just plug it in here and there wherever you can."

At the same time, Buhl stresses that timberland owners can enhance or reduce losses to native pollinator habitat alongside objectives that include even intensive forest management.

"For many situations," Rowland says, "it's a matter of tweaking management in ways that wouldn't necessarily require a big effort or be more costly."

Writer's Profile

Sylvia Kantor is a science writer and editor based in Seattle, Washington. See her portfolio at https://www.sylviakantor.com.

Working Landscapes

In addition to the effects of grazing and riparian restoration on native bees, Rowland, DeBano, and Scott Mitchell, a graduate student in DeBano's lab at Oregon State University, are also evaluating the effects of forest thinning and of grazing and trampling by elk on floral resources for bees.

The emerging research on native bee ecology and land management offers a promising vision for maintaining working landscapes that support both human livelihoods and biodiversity. By understanding the seasonal patterns of plants and pollinators, managers can time interventions to minimize their effects during critical periods. By selecting plants that serve multiple functions, restoration projects can efficiently address several ecological goals simultaneously.

Science-driven approaches offer solutions that honor both ecosystem complexity and human land uses. Through continued research, adaptive management, and collaborative approaches, it is possible to create multifunctional landscapes that support the pollinators that sustain ecosystems and the human activities that depend on public lands.

"Listen to the bees and let them guide you."

—Brother Adam, Benedictine monk, beekeeper, author

Further Reading

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SANDRA DEBANO is an invertebrate ecologist and associate professor at Oregon State University. Her research focuses on how human activities affect terrestrial invertebrate communities and the ecosystem services they provide, with a special interest in riparian and grassland ecology, food webs, native bees, and invertebrate predators.

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