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Restoring Pine Barrens Habitat: Optimizing Soil Conditions with Prescribed Fire

Pine barrens are unique plant communities that occur on sandy, infertile soils with poor water-holding capacity and are characterized by low tree density with an understory of grasses, ericaceous plants, and fire-dependent species. Scattered throughout the Midwest and elsewhere in North America, these plant communities are important for recreation and cultural values, including gathering blueberries. They are also key to the health of many plant and animal species, including threatened, endangered, and sensitive species such as sharp-tailed grouse (*Tympanuchus phasianellus*) and pollinators such as the Chryxus artic (*Oeneis chryxus*) and tawny crescent butterflies (*Phyciodes batesii*). According to Northern Research Station research ecologist Kathleen Quigley, many pine barrens have disappeared or have been degraded due to human development, fire exclusion, and the creation of cropland and pine plantations.

KEY MANAGEMENT CONSIDERATIONS

- Studying soils in natural, remnant barrens helps land managers understand specific conditions that favor barrens vegetation relative to other cover types.
- Soil conditions such as nutrient status and water-holding capacity are influenced by a variety of factors, including current and historic vegetation cover and prescribed fire management.
- Management practices such as brush-cutting and prescribed fire are necessary to restore encroached areas to a barrens state. Research suggests that repeated fire is needed to consume the accumulated soil organic horizon and convert stored nutrients to ash, which then leaches through sandy soils.
- Restoring glacial outwash sandy soil conditions to a lower nutrient status may improve future barrens restoration efforts by limiting tree growth and woody encroachment into open barrens habitat.

While their soil is relatively infertile, Midwestern pine barrens boast a species diversity that belies their name. Photo by Kathleen Quigley, USDA Forest Service.

The Moquah Barrens in northwestern Wisconsin are a prime example of a pine barrens ecosystem. Through ongoing ecological monitoring, combined with on-the-ground restoration activities conducted by the Chequamegon-Nicolet National Forest, Quigley and others are studying soils to help land managers understand specific conditions that favor barrens vegetation relative to other cover types. By assessing soils in natural, remnant barrens and linking fire-behavior data to soils and vegetation data, Quigley and colleagues are helping forest managers understand how they can optimize burn conditions to meet specific restoration goals, such as reducing shrub cover and increasing native plant diversity. The team's data collection efforts link research to land management and demonstrate how research can support habitat restoration.

Restoring Fire

Quigley's pine barrens research was recently described in a 2020 journal article entitled, "Prescribed Burn Frequency, Vegetation Cover, and Management Legacies Influence Soil Fertility: Implications for Restoration of Imperiled Pine Barrens Habitat." According to the article, fire is needed to restore pine barrens by helping to control hardwood regeneration and facilitating the return of soils to pine barrens-type conditions.

Following more than a century of fire exclusion, the soil in many pine barrens has changed due to organic matter and nutrient accumulation and increased water retention, which allows trees to encroach, shade out, and outcompete the understory plants that are adapted and crucial to pine barrens ecosystems. Quigley explains that conditions such as soil nutrient status and water-holding capacity are influenced by a variety of factors, including current and historic vegetation cover and prescribed fire management. Management practices such as brush-cutting and prescribed fire are necessary to restore encroached areas back to a barrens state. With repeated fire, nutrient-rich ash percolates through the soil, which maintains the nutrient-poor status in the topsoil and prevents encroachment by woody plants. "We conducted field campaigns from 2015 to 2019 to study fire behavior, soils, and plant communities before, during, and after controlled burns and other management actions," Quigley said.

Landscape-wide Restoration

This research is helping to answer many questions about an often-overlooked ecosystem that forms part of the Midwest's complex mosaic of plant and animal communities. "We knew going in that these habitats had been lost, trees are encroaching, and fire is an essential restoration tool," Quigley explains. "What we don't know is how intense and how frequent fires should be and when they should be implemented. We wanted to find out how fire affects a healthy or restored site versus a site that we want to restore. We visited 140 sites throughout the Moquah Barrens and measured fuels, fire behavior, and soil heating and then tracked the changes that occurred above and below ground."

Restoring soil conditions to a lower nutrient status can improve future restoration efforts by limiting tree growth and woody encroachment. But the research has wider implications. According to Quigley, "Our work will help land managers optimize the use of fire as a tool for landscape-wide restoration—especially in pine barrens, but in other ecosystems as well."

Forest Service researchers assess postfire conditions to optimize future pine barrens restoration efforts. Photo by Kathleen Quigley, USDA Forest Service.

Research Team

This project represents a partnership between the Northern Research Station (NRS) (Brian Sturtevant, lead) Michigan State University (Jessica Miesel, lead), and the Chequamegon-Nicolet National Forest, and funded by the Joint Fire Science Program. Kathleen Quigley is an NRS research ecologist in Rhinelander, WI. Read more about Kathleen and her work at www.nrs.fs.fed.us/people/Kathleen.Quigley.

FURTHER READING

Quigley, K.M.; Kolka, R.; Sturtevant, B.R.; Dickinson, M.B.; Kern, C.C.; Donner, D.M.; Miesel, J.R. 2020. Prescribed burn frequency, vegetation cover, and management legacies influence soil fertility: Implications for restoration of imperiled pine barrens habitat. Forest Ecology and Management. 470–471: 118163. 12 p. https://doi.org/10.1016/j.foreco.2020.118163.

Quigley, K.M.; Kolka, R.; Sturtevant, B.R.; Dickinson, M.B.; Kern, C.C.; Miesel, J.R. [In press]. Repeated prescribed burns correspond with increased soil hydraulic conductivity in pine barrens and woodlands under restoration management. Science of the Total Environment.

Sturtevant, B.R.; Miesel, J.R.; Dickinson, M.B.; Kolka, R.K.; Kern, C.C.; Donner, D.M.; Quigley, K.M.; Bushman, M.M. 2020. Manipulating soil heating patterns to optimize barrens restoration. Final Report to the Joint Fire Science Program, September, 2020. 74 p.

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