Research Brief

Lake States
Fire Science Consortium

Restoration and Management of Forests for Future Climate Changes in Wisconsin, USA

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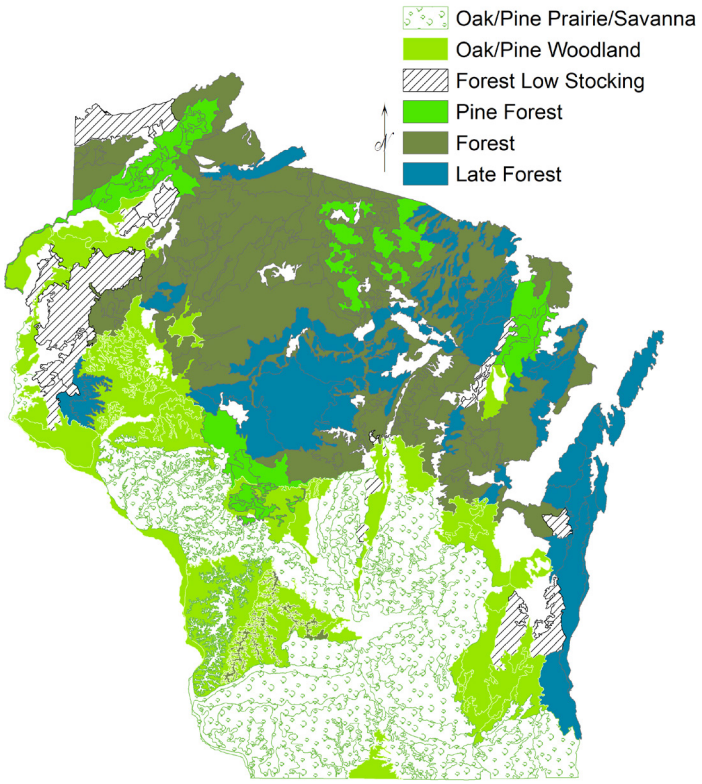
Accurate knowledge of the historical characteristics of forest ecosystems is important because it provides baseline information for research and management, and a reference point for guiding restoration treatments. Wisconsin forests have undergone drastic changes in structure after Euro-American settlement due to logging, selective cutting, and fire exclusion. Currently, no literature quantifies and maps forest density and other structural metrics at scales for restoration of historical forest ecosystems. Therefore, Hanberry and Dey (2019) used historical surveys to reconstruct historical forests of Wisconsin along ecological divisions (Eastern Broadleaf Forest division — Southern Wisconsin and Northern Mixed Forest division — Northern Wisconsin) and sectional land type scales and compared them to the current forest ecosystem.

Data from surveys conducted by the United States General Land Office (GLO) from 1830 to 1866 were used for determining historic structure and composition.



Management Implications

1. Historically open oak or pine forests (e.g., barrens, savannas, woodlands) in Wisconsin have shifted to more closed-canopy, dense forest conditions between 1812 to 2009.
2. Increased forest density and presence of early- and mid-successional tree species led to negative impacts on the plant and animal species that depend on open-canopy habitats.
3. Knowledge of historical forest structure and composition is important for providing reference conditions to help guide ecosystem restoration actions.
4. Restoring current forests to their historical structure and composition may improve their ability to be resilient to future climate conditions and diversify landscape structure enhancing its resilience to disturbance, including stress and threats from extreme weather, drought, insects and disease, and invasive species.
5. Active management is needed to restore and maintain open forest ecosystems such as oak-pine barrens, savannas and woodlands. Prescribed fire is key to successful restoration, and its use in combination with other silvicultural practices is essential in sustaining these highly valued ecosystems.

Figure 1: Historical forest types in Wisconsin, USA.

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Data from the USDA Forest Service Inventory and Analysis (FIA) surveys, conducted in the 2005 to 2009 cycle, were used as a measure of current forest ecosystem metrics. From the reconstructed historical forest, species trends were identified, forest types classified by functional traits (e.g., oaks, pines, early-successional northern mixed forest species of tamarack, birch, and aspen), and stocking and forest types were calculated. Density and basal area were calculated for historical and current forests. These data were used to evaluate how forests have changed between the time of the GLO surveys to the FIA surveys.

Changes in ecosystem structure

Current forests in the Eastern Broadleaf Forest division show more than a two-fold increase in density, relative to forests at the time of GLO surveys. However, there was only a small increase in basal area because although forests are denser today, trees from the GLO surveys were larger. The structural and density changes show a transition from open fire-tolerant oak and pine forests to dense forests.

Changes in ecosystem composition

Wisconsin forests were historically comprised of 46% oak savanna and oak or pine woodland, 6% pine forest, 16% primarily late-successional eastern broadleaf forest, and 33% a combination of late-successional eastern broadleaf forests and early successional northern mixed forests, with forest densities of 60 to 460 trees per hectare (24 to 186 trees per acre). Oak composition decreased from 65% to 23% in the Eastern Broadleaf Forest division, mainly due to the absence of fire and competition from early and mid-successional eastern broadleaf species (e.g., black cherry and red maple). In the Eastern Broadleaf Forest division, species trends showed an increase in percent composition of red pine (+8.5%), red maple (+9%), eastern white pine (+4%), but a decrease in white oak (-15%), black oak (-10%), and bur oak (-20%). In the Northern Mixed Forest, species trends showed an increase in percent composition of quaking aspen (+8%), red maple (+10% to +14%), balsam fir (+4%), northern white-cedar, black ash, and northern red oak (approximately +3%), but a decrease in eastern hemlock (-13%), eastern white pine (-6%), paper birch (-3% to -10%), American beech (-3% to -6%), American elm (-4%), and tamarack (-2% to -5%).

Implications

In the context of climate change and other anthropogenic land use changes, historical reference conditions provide a way forward for management and restoration in the present and for the future. The forest ecosystems of this region evolved under periodic climate warming and cooling periods and may be well-adjusted to survive the potentially dynamic conditions of the future. Furthermore, Southern Wisconsin represents the northern edge of oak forests, meaning that oak forests are an appropriate ecosystem to match future northward migration of ecosystems under climate change.

For Further Reading

Hanberry, B.B., Dey, D.C. Historical range of variability for restoration and management in Wisconsin. Biodivers Conserv 28, 2931–2950 (2019). https://doi.org/10.1007/s10531-019-01806-8

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