The Vanishing Present:
Wisconsin's Changing Lands, Waters, and Wildlife

Edited by Donald M. Waller and Thomas P. Rooney

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31 The Potential Futures of Wisconsin's Forested Landscapes

Robert M. Scheller and David J. Mladenoff

As you learned in chapters 5–7, Wisconsin's forests have changed in many different ways, reflecting shifts in climate, variable soils, the migration of species following glaciation, natural disturbances, past and current logging, fragmentation from roads, and continuing shifts in human land use. Forest ecologists, historians, and sociologists use data from many sources to infer how Great Lakes states forests have changed and how these changes reflect broader geographic and historical contexts. In this era of global environmental change, can we use the past to anticipate and understand the future? Or will future changes be unique and unpredictable? We grapple with these questions as we try to imagine Wisconsin's forests 100 years from now, exploring the consequences of factors like population growth and climate change.

People Intentionally Change the Forest

A significant obstacle to understanding the future of Wisconsin's forests—and, by extension, its rivers, lakes, and wetlands—lies in understanding how humans will use, reduce, or even expand forests in the future. In the past, patterns of human settlement and resource use shaped the forests (chapter 5). In northern Wisconsin, most lands deforested during the great cutover were slowly replaced by second-growth forest; others became homes or farms. After World War II, new groups began joined the resident farmers, loggers, and miners. These new arrivals often came for recreation rather than employment in extractive industries (Radeloff et al. 2001). In southern Wisconsin, settlement and land use changed drastically with the farms that arrived prior to the 20th century (chapters 2 and 8). Since then, change slowed, and then land use patterns changed direction as rapidly expanding cities and suburbs began to consume more land. Most farmland remained in crop or pasture (often intensified; chapter 21), but some of the most marginal, erosion-prone fields have been reforested (Heasley and Guries 1998).

The forests and lakes continue to draw more people into northern Wisconsin. Many of these new residents are seasonal, maintaining a cabin or vacation home (Clendenning et al. 2005). This population shift is directly affecting Wisconsin's forests and is indirectly changing the sociological and political context in which these forests exist. Seasonal residents from nearby urban centers, for example, often have very different values and attitudes toward forest management than permanent residents. The new urbanites often oppose intensive extraction, while favoring larger preserved areas and greater government regulation of land use (Clendenning et al. 2005).

Can we predict where and how future development will occur? Research shows clear links among housing density, land cover, and property ownership (Radeloff et al. 2000, 2001). As one might expect, housing density is increasing fastest near bodies of water but is limited by large tracts of publicly owned land. How housing density has developed over the last 60 years has also been used to project likely changes in housing density over the next 20 years (Radeloff et al. 2001). Inferring how this future housing development will affect forests is more difficult. Clearly the type and magnitude of disturbances have changed greatly since European settlement (chapter 5). Increasing numbers of seasonal and permanent residents in northern Wisconsin will further shift disturbance regimes as they impose their own values and cultural perspectives on this landscapes. Higher housing density will likely limit the amount of intensive timber management (Ward et al. 2005). We therefore expect areas with higher housing density to experience declines in the dominance of early successional aspen and birch and a shift toward older, more shade-tolerant trees. This, in turn, could increase rates of tree mortality in populated areas, biasing perceptions of forest health.

People Unintentionally Change the Forest

While alterations of the land such as farms, residential tracts, and timber harvests are local and obvious, people also generate more subtle, unintentional changes at much larger scales. Shifts in atmospheric composition and climatic change, for example, are difficult to see when viewing particular forest stands over periods of a decade or two but become clear when we expand our frame of reference (chapters 3 and 4). Wisconsin's forests will surely change in response to shifts in climate and carbon dioxide levels, and these changes may be enormous. We know that fossil fuel combustion is driving up the concentration of carbon dioxide and other heat-trapping gases in the atmosphere dramatically. Computer models ("global circulation models") predict how these increases in greenhouse gases will alter global climate in coming years (Intergovernmental Panel on Climate Change 2001). We know that climate change is already under way (Magnuson et al. 2000). Annual average temperatures have already increased by 1°C–2°C (2°F–4°F) in Wisconsin, compared with the 30-year (1961–90) average, and are expected to increase another 1°C–4°C (2°F–7°F) in the winter and 3°C–11°C (5°F–20°F) in the summer (Wuebbles and Hayhoe 2004). These numbers are alarming. They also indicate that what we once imagined to be a distant problem confronts us now and in the immediate future (chapters 3 and 4).

Climate and soils form the template upon which all plants depend. If the temperature warms, some tree species will thrive, growing faster and increasing their reproductive output. Other species adapted to a cooler climate will suffer. Here, history can be a valuable guide for understanding forest change. During past climate changes, all temperate tree species have undergone dramatic and often unique shifts in their geographic range (Delcourt and Delcourt 1988). Many populations went extinct in portions of their range, contracting their range, while others thrived, extending their range. Soils and climate patterns modulate these shifts. The hemlocks persist in small refuges in the Baraboo Hills where steep north-facing cliffs create cool, moist microclimates that resemble sites hundreds of kilometers north.

Do not expect our existing forests to die suddenly. Some species may die out quickly, but this will probably reflect invading diseases (chapter 30). Other changes will be more subtle. Some tree species are likely to benefit from climate change, including aspen and sugar maple. Beech may continue its postglacial expansion westward. However, other important species will likely lose their ability to reproduce and compete (Scheller and

Mladenoff 2005). Even during a warming period, climates still vary from year to year. A species that cannot reproduce due to high temperatures for a decade may reproduce well during a cool year. In addition, not all age groups are equally vulnerable to climate-related mortality. Conditions severe enough to kill seedlings and saplings may not affect older trees. Thus, there will be considerable inertia to overstory composition. The ability of each species to adapt to changing climates also depends on human influences, including logging and fragmentation (Scheller and Mladenoff 2005).

With climate change, we use the past as a guide to what the future may hold. For other kinds of change, we often lack any clear analogy to the past. For example, the chemical makeup of the atmosphere is changing rapidly. Air pollutants such as nitrogen oxides and ozone are increasing (Vitousek et al. 1997). There are now more deer in northern Wisconsin than ever. Hungry deer are eliminating the ability of many trees, shrubs, and wildflowers to persist and reproduce (chapters 6 and 19). We also see increasing numbers of nonnative, invasive plants, pathogens, and insects (chapter 30) including gypsy moths, which are currently spreading across Wisconsin causing extensive defoliation and mortality (Sharov et al. 2002). European buckthorn and garlic mustard outcompete native wildflowers. European earthworms are changing forest floor conditions by eliminating much of the forest floor litter critical for the germination of many native herbs (Bohlen et al. 2004). As nonnative species continue to proliferate, we can expect more new species to appear in coming decades (Mills et al. 1994).

All of these changes will interact with each other and with human dimensions of landscape change. Currently, we have almost no information on how and how strongly these various factors will interact. As scientists seek to study these various agents of change and their interactions, both scenarios and experiments should prove useful (chapter 28).

Projecting Wisconsin's Future Forests

To project long-term forest change in response to climate change, land use change, and other expected ecological drivers, forest ecologists often use computer models. They typically begin by first attempting to represent the current-day landscape, including soil types, species locations, dominant forest cover, and climate. These models seek to represent a very complex system often via a large set of interrelated processes including photosynthesis, tree growth, leaf fall, plant reproduction, fire occurrence, and windstorm damage. Each process is represented by mathematical formulas. After determining what they hypothesize to be the right set of processes for a given question, ecologists test the resulting model on whether it produces reasonable results. Ecologists then use such models to study research questions like how natural, intentional, and unintentional future changes will affect forests. These models simulate the changes forests are likely to experience in response to changing climate, human development, and invasions by exotic species and pests. Models invariably include at least one (but never all) of the various drivers of forest change (Scheller and Mladenoff 2007).

Our computer models suggest that Wisconsin's forests will face disturbing trends as they respond to climate warming. One model predicts that many species now commonly found in northern Wisconsin (including red pine, jack pine, paper birch, white spruce, and balsam fir) will cease to reproduce and eventually disappear from the state (Scheller and Mladenoff 2005). Where loamy and silty soils soils hold enough water, species like sugar maple, red maple, and white pine are likely to grow faster and to larger sizes. Other species like aspen may not respond at all. We often lack enough information to predict how species will respond (as with tamarack). Climates are now changing faster than tree species can adapt and evolve. Forests show a lot of inertia, reflecting how long most tree species live. This inertia, plus limited dispersal, may limit how quickly many tree species can shift their ranges, particularly for the southern oaks and hickories whose climate is predicted to change quickly (plate 16). Shifts in climate may therefore reduce tree diversity and forest growth for decades to centuries. Logging and natural disturbances will also interact with these changes and the climate/soil/disturbance template to influence what can grow where across our landscapes.

Although history and models can inform our expectations of forest change, there are still many unknowns (Stainforth et al. 2005). Of the dozens of available climate models, some predict an increase in precipitation in Wisconsin, others a decrease. Changes in precipitation will greatly affect how our forests change and where. Even if we could predict precipitation patterns, we would still face uncertainty regarding our models and their ability to make accurate predictions. Despite these uncertainties, models still help us anticipate forest change. We can test how different processes are likely to interact under various circumstances, simulating controlled experiments. These projections help us to identify areas of uncertainty and which assumptions matter the most in projecting how forest change depends on climate change. Thus, both models and the scenarios that Carpenter describes (chapter 28) provide tools to help us anticipate, and prepare for, the future.

Summary

We live in an age of great change, and our landscapes reflect these changes. We cannot know precisely how land use, climate, pollution, and invasive species will change in the future, nor do we fully understand how forests will respond to every potential cause or combination of change (see sidebar). Our greatest limitation lies in not knowing how people will continue to use and change the landscape. For example, if climate changes, will people move? Will they harvest more trees or less? How will further dispersed development enhance invasions of new exotic species? These and similar questions will continue to challenge both scientists and society as we enter an era of unprecedented change. Our ability to anticipate the risks and challenges ahead will require that we understand past changes, that we research how forests respond to change, and that we use every tool available to understand how the future may unfold.

The Future of Forest Conservation

Thomas P. Rooney and David J. Mladenoff

Traditionally, foresters managed forests for specific end points. By identifying a desired future condition of tree species and ages for a stand, they could select the most appropriate management tools to bring about that condition and move the stand in that direction. For example, a forester can designate the desired future condition of a 70-year-old, 40-acre red pine plantation as a stand that continuously produces high-quality sawtimber (logs of 12 inch diameter or greater) over the next 50 years. To move the stand in that direction, a fraction of the smaller trees might be removed at 10–15-year intervals using a management tool called “thinning,” improving the growth of the remaining trees.

But, the world is changing. Efforts to manage forests in the next century are likely to be thwarted by climate change, habitat fragmentation, new diseases, and insect pests (chapter 30), as well as interactions among these factors. Returning to our red pine example, suppose that a new strain of a fungal canker disease of Scots pine began infecting red pines and, within 5 years, most red pine stands Wisconsin are dead. The desired future condition becomes impossible to attain, so the stand is salvage logged, removing all trees. In another 10 years, new pathogens rapidly eliminate red oak, sugar maple, and white ash. While salvage logging can recover some quality timber, it will fail to satisfy the demands of the growing population and economy for forest products. The idea that we can reliably manage for specified end points during an era of rapid environmental change is unrealistic.

How should we manage our forests, given likely increases in both environmental uncertainty and demand for wood and fiber? Any viable strategy should rest on diversity and flexibility. Landowners and managers would be wise to maintain a diversity of species and management approaches. Single-species plantations may be appropriate where we have a narrow focus on timber production, but relying on one species (like red pine) or genotype (like a new hybrid poplar) poses clear risks. Emerging diseases could wipe out both in the next 50 years. Instead, it would be wiser to establish more mixed species stands and experimental plantations of other species, including ash, oak, walnut, and valuable softwoods like white pine.

Where production is not the primary goal, maintaining diverse, mixed stands will likely meet more objectives, particularly in light of shifts in climate and threats from new pests. We now face the real possibility that many of the tree species that have thrived for millennia in northern Wisconsin may lose their ability to persist here in the next 200 years! This is less than the normal life span of many trees. Combining a diversity of silvicultural treatments and rotation ages with a diversity of species provides the safest way to manage forests with so much uncertainty. Additionally, management plans need to be flexible, perhaps with built-in contingencies for improbable (but inevitable) events.

If conditions become warmer and drier, it makes sense to establish stands with more southern species. However, it may also be risky to assume that southern species will thrive in a warming climate or further north. Pathogens or interactions with other species may limit their success. It would also be a mistake to ignore ecologically important northern species like hemlock and white cedar. We do not know what the future holds for these species—they may adapt to and thrive in new conditions. We are frequently surprised by the actual behavior of tree species in nature. We often see species growing in locations we assumed were unsuitable or where we believed they could not persist. If we assume that hemlock and white cedar will not persist in a warmer drier Wisconsin, we may take actions that make this a self-fulfilling prophecy.

The past and present are at best imperfect guides to the future. Given the complexity of forest ecosystems, we would be wise to prepare for multiple futures instead of trying to manage for specific outcomes.

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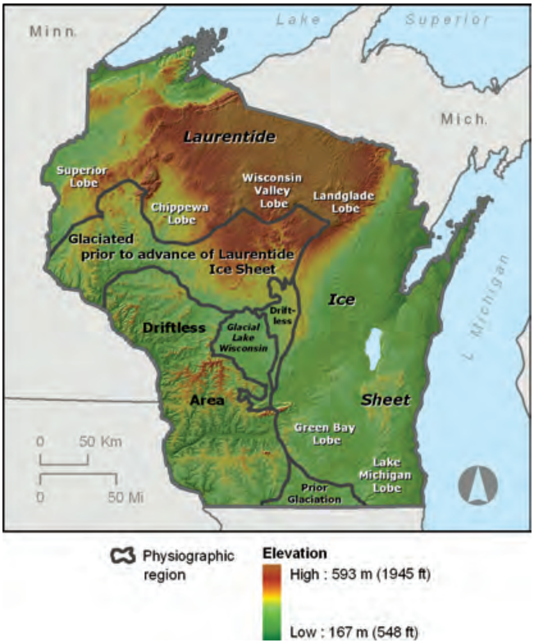

PLATE 1 The physiographic regions and glacial landscape of Wisconsin. (© D. Mladenoff. Maps in plates 1–8 by T. Sickley, Forest Landscape Ecology Lab, University of Wisconsin–Madison.)

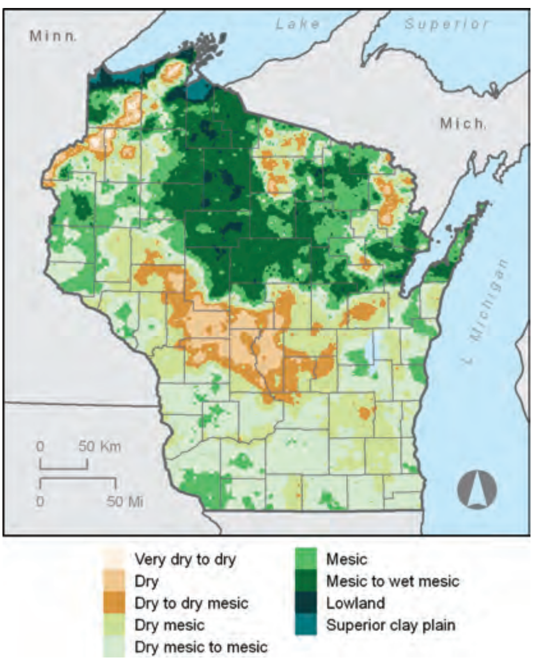

PLATE 2 A generalized classification of Wisconsin, by soils, temperature, and precipitation. Classification is based on the combined influence of soils, temperature, and precipitation on susceptibility of habitats to fire and drought, as interpreted through the presence of forest understory plant species. (© D. Mladenoff, modified from S. Dahir, Wisconsin Department of Natural Resources.)

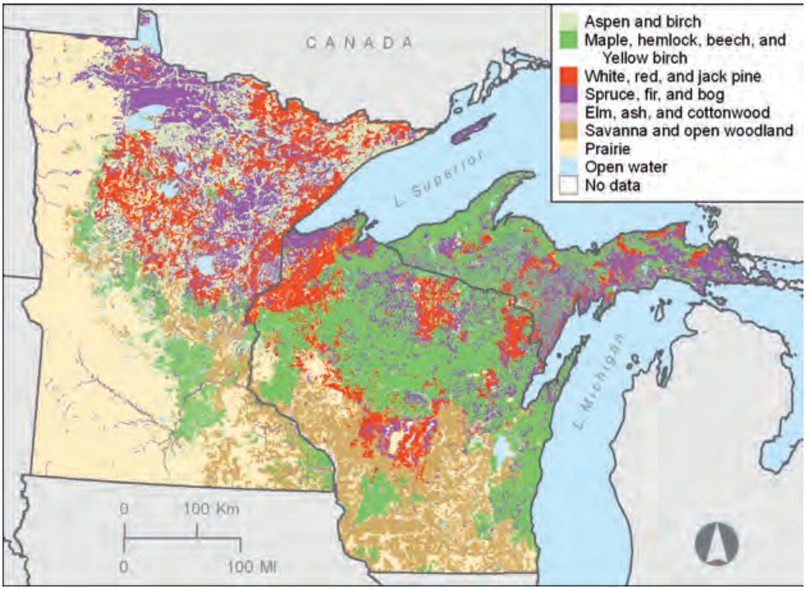

PLATE 3 Pre-European settlement vegetation of the northern Great Lakes States. (Courtesy of U.S. Forest Service Great Lakes Assessment.)

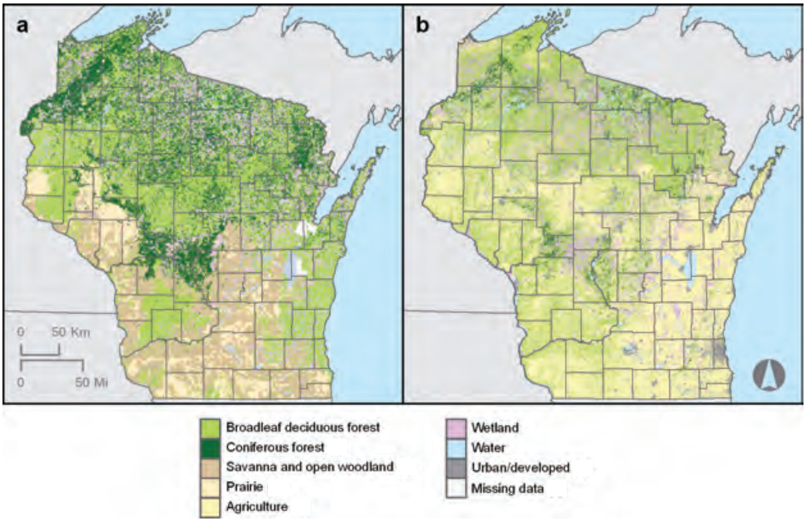

PLATE 4 Vegetation and land cover change in Wisconsin, from the mid-1800s to the 1990s. *a,* Generalized pre-European vegetation classes derived from U.S. Government Land Office Survey data (1832–65). (© D. Mladenoff.) *b,* Current generalized vegetation and land cover classes derived from Landsat satellite data (Data from Wisconsin Department of Natural Resources, Wisconsin Initiative for Statewide Cooperation on Landscape Analysis and Data, 1996.)

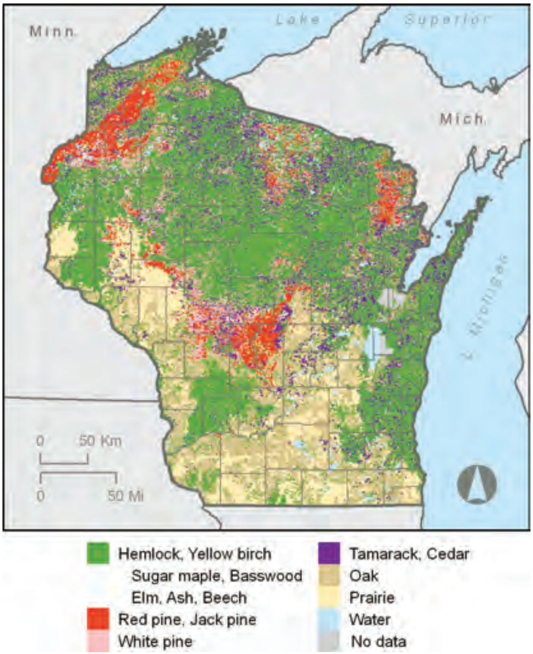

PLATE 5 Forest type classes, from U.S. Government Land Office Survey data (1832–65). (© D. Mladenoff.)

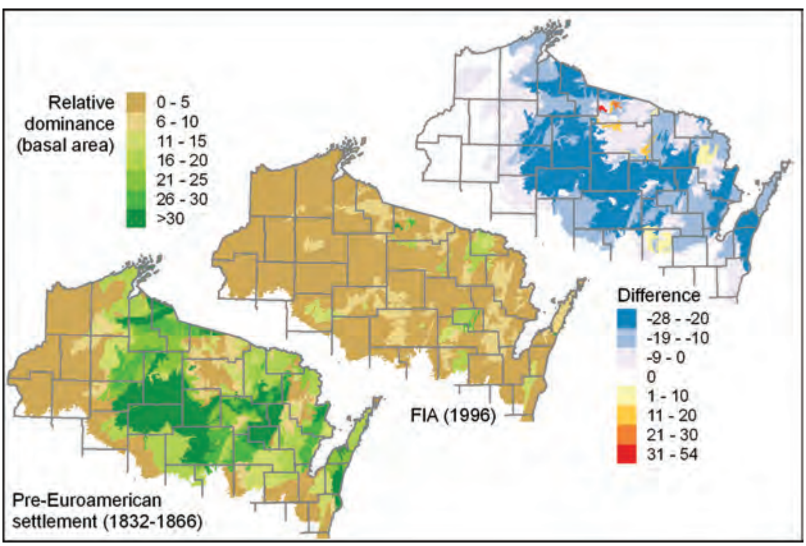

PLATE 6 Changes in the distribution and abundance of eastern hemlock, from the mid-1800s to the 1990s. (© D. Mladenoff.)

PLATE 15 An undeveloped lake shoreline in northern Wisconsin. Deadfalls, emergent and floating-leaved plants, and undeveloped shoreline provide critical habitat for many species of wildlife, including amphibians and nongame fish. (Photo by T. Rooney.)

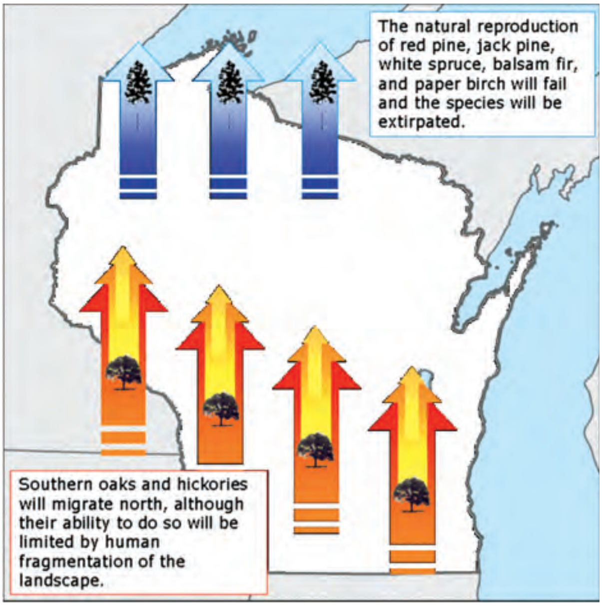

PLATE 16 Projected impacts of climate change on Wisconsin forests. (Courtesy of R. Scheller.)