

## Appendix A: Ecological History of Wisconsin's Forests

### Introduction

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Between 1832 and 1866, United States government contractors surveyed lands that would become the State of Wisconsin for the purpose of subdividing and selling land to timber companies, speculators and settlers. The survey also was needed to make land grants to railroad and canal companies to finance construction.

Over 100 surveyors worked in Wisconsin over the survey period. The survey was systematically carried out, with survey posts (wooden posts or stones) set every half mile along a grid of one mile square blocks of land called sections. Surveyors were joined by chainmen who stretched out and the measuring chain, and sometimes by axmen, flagmen or markers and general laborers. Surveying crews carried tools, camping supplies and sometimes even canoes.

Although this was a land survey rather than a botanical survey or inventory, at each section surveyors noted the location, species and size of between two and four “witness trees” (or bearing trees). These trees were scribed with the corner identification, and vegetative information for each mile surveyed. In areas without trees such as prairies and marshes, mounds of earth or stone were constructed to mark the corners location. With each section corner, a brief description of the vegetation, soils and other noteworthy observations including fire and windthrow locations were summarized for the last mile of survey run.

The original surveyors’ notebooks, which are about 150-years-old, are held by the Office of the Commissioners of Public Lands for Wisconsin in Madison. From microfilms of these notebooks, University of Wisconsin researchers have extracted ecological information and compiled a computerized, statewide tabular database of Wisconsin's 19th century vegetation. David Mladenoff began the project in 1994 with a graduate student, GIS scientist Ted Sickley, and hired students.

The Wisconsin DNR produced a geographic information system (GIS) database of statewide PLSS corners, to which the tabular data could be attached. This then allowed for information mapping and spatial analysis as represented in Map A1. This was a more than 12 year ongoing project with several partners including DNR Science Services and Forestry programs staff.

Changes during the last 150 years due to logging, farming, reforestation and development have made it difficult to otherwise assess what the pre-settlement ecosystem looked like in Wisconsin. Cessation of prairie fires occurred in southern Wisconsin as early as the 1830s, which allowed open landscapes to quickly revert to brush and forest. Logging started around 1850 and loggers were followed by catastrophic fires and settlers changing the landscape in a period known as the Cutover.

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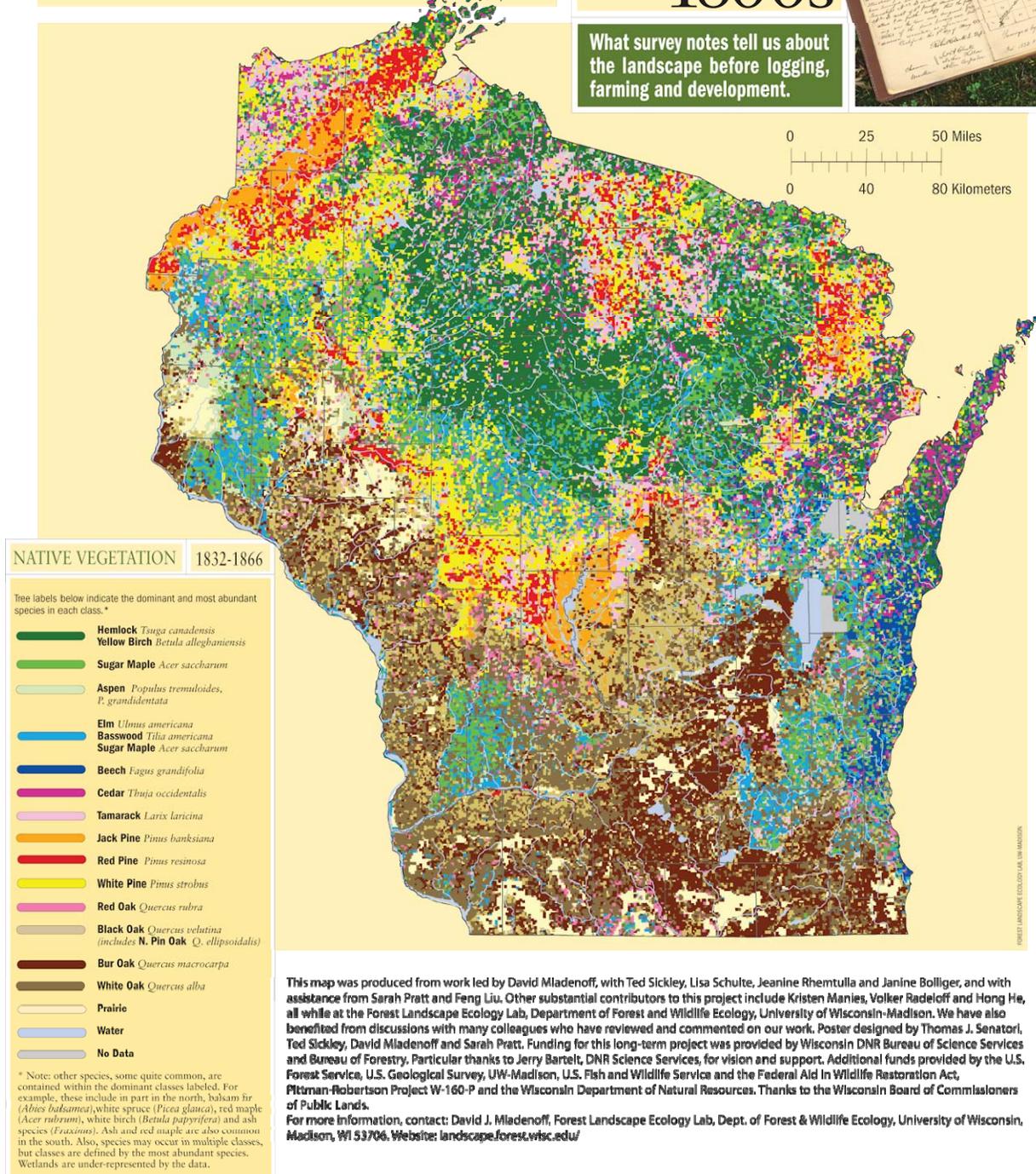
<sup>1</sup> Natasha Kassulke is creative products manager for *Wisconsin Natural Resources* magazine. This article is adapted from a special insert on pre-settlement vegetation that was published in August 2009.

# WISCONSIN'S

## Land cover IN THE 1800s



What survey notes tell us about the landscape before logging, farming and development.



**Map A.1: Wisconsin's Native Vegetation 1832-1866**

The big advantage of the current GIS database is that it can be analyzed with many other mapped data sets, or classified at different levels of detail. Large or small areas can be selectively mapped and analyzed for many uses such as understanding the relationship of vegetation to soil type and understanding how landscape patterns, forests and wildlife habitats have changed over time, as well as identifying priorities and locations for restoring ecosystems. For example, looking at this map, it is clear that vegetation is not randomly distributed statewide. The vegetation pattern is a product of interaction among climate, soils, and Native American use. Disturbances such as natural fires, and especially windstorms, also occurred and were important in shaping the forests.

This database development project was primarily funded by the Wisconsin Department of Natural Resources and the U.S. Fish and Wildlife Service to understand relationships between locations of historical vegetation and potential wildlife habitat management. However, the data have much broader implications and contributions were also received from the U.S Forest Service, U.S. Geological Survey, and the UW-Madison.

The goal of the project was never to suggest restoration of the state to pre-settlement conditions. That is not desirable or possible. The goal was to understand where in the state are the best places to manage different habitat types based on where they occurred naturally in the past. Management plans will be most effective when they respect the natural variability of the area and work within its boundaries and constraints.

### Interpreting the Map<sup>2</sup>

David J. Mladenoff

Vegetation changes constantly; slowly with gradual climate change, or faster with fire or human use. Wisconsin's vegetation has changed constantly since de-glaciation approximately 10,000 years ago, as climate warmed, cooled, and warmed again, and plant species migrated north at different rates.

Wisconsin vegetation of the 1800s was the product of climate interaction, soil types, topography and Native American activity. Euro-American activity existed for 200 years before this, but was highly localized at a few Great Lakes and major river sites.

While any vegetation map from one period is static, there is some constancy to the picture of the 1800s in Wisconsin. All tree species had migrated into the state by about 3,000 years ago. Change occurred during warmer and cooler periods, and with the different amounts of fire. For example, we know that the extent of prairie varied with warm and cool periods, as did the relative amounts of pine and oak on the northwest sand plain. But studies of fossil pollen show that the basic pattern we see at the scale of this map had been relatively constant, with some shifting abundance, for several thousand years.

Climate is the broadest gradient, warmer to the south and southwest, and colder to the north. Lakes Michigan and Superior modify extremes. Warmer climate and more frequent dry

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<sup>2</sup> Technical scientific publications on these issues and other research using the data can be found at Mladenoff's Forest Landscape Ecology web site <http://landscape.forest.wisc.edu/>

conditions contributed to conditions suitable for burning, likely largely due to greater Native American populations in the south.

Resulting vegetation was largely a gradient of open prairie to savanna, to open woodland in the southern part of the state. A noteworthy mesic<sup>3</sup> forest island, predominately sugar maple, basswood, oak, and other species, occurred in the southwest along the Kickapoo River, which served as a fire break from fires being driven by prevailing southwesterly winds. Black oak was most abundant in the central areas on sandy soils. White oak and bur oak were more abundant to the west and east, respectively, but common throughout.

More closed canopy mesic forest, with beech a major component, occurred along Lake Michigan, with sugar maple and other species, and more northern white cedar and hemlock on the Door County peninsula in Lake Michigan. Beech abruptly reaches its western range limit just a few counties in from Lake Michigan.

Especially away from Lake Michigan, this mosaic in the south was the result of dominant use of fire, interacting with climate, soils and topography.

Wetlands do not map well in the south based on the Public Land Survey System data because of the density of the PLSS survey points on the landscape, and because wetlands are often small and patchy, or long and narrow and were missed by survey points.

While we usually think of the prairies as being more southerly, there were several noteworthy large open prairie areas in west central Wisconsin. Survey notes suggest that these likely differed somewhat in vegetation with those further south having more brush and aspen.

In the north, cooler climate with less frequent drought favored more conifers species, and less fire than in the south. Lightning fire, and likely more commonly, fire caused by Native Americans, was most frequent in the sandy outwash plains in the north. These can be located by noting the concentration of pines in these plains in the northwest, north central and northeast, as well as the sandy former glacial Lake Wisconsin lakebed in the central part of the state. Red oak was common with pine.

Pine concentrations also can be seen along the border of the southern oak savannas and northern forests, where fires were also more common than generally in the north, and along the major river valleys, which often have glacial outwash channels with sandier soils. The three species of pines generally indicate a gradient of greater fire frequency and poorer, sandier soil, from white, to red, to jack pine. This is visible in the variability of the three northern sand plains. The north central and northeast plains also had more variable topography and more lakes to act as fire breaks than the northwest plain. Aspen (often with paper birch) occurred most often with pine on the fire prone sand plains and along the savanna border in the west central area.

The PLSS data have shown that white pine especially was more common than we had thought along Lake Superior, often on clay soils with a mix of boreal conifers and white birch. Similarly, yellow birch was even more common than believed, and often the leading dominant, in the mesic

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<sup>3</sup> Moderately moist

forest region with sugar maple and hemlock. Hemlock and yellow birch reach the edge of their range east of the northwest sand plain, except for a few scattered infrequent occurrences further west and in the western edge of Minnesota.

Many areas of lowland forested wetlands were often dominated by tamarack and white cedar, with spruce, fir, and black ash, also visible. Many more, smaller areas also occurred in the north, but are too small to be mapped well by the density of the survey points on the landscape.

In a wide arc around and in between the pine plains, the northern mesic forest of sugar maple, hemlock, and yellow birch constituted the largest and most abundant forest type, on better soils and very infrequent fire. Again, contrary to common assumptions, this was the most abundant forest type in northern Wisconsin, followed by pine. In fact, sugar maple, yellow birch, and hemlock trees were all more abundant than white pine, though white pine was a close fourth.

### Vegetation Change

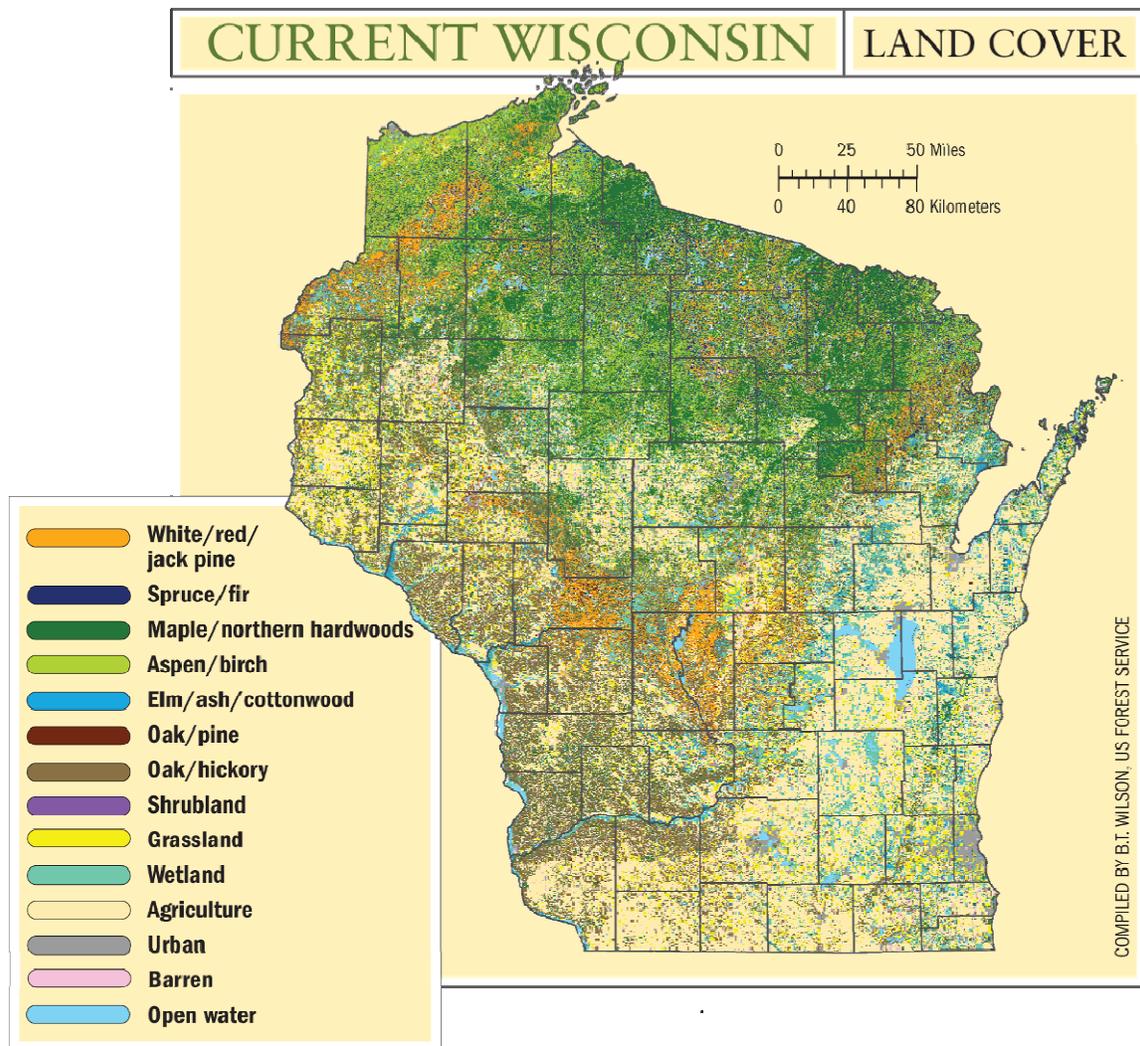
While vegetation change is indeed constant, the change from the 1800s to the present has been unprecedented. Besides elimination of most prairie, savanna and pine ecosystems, fossil pollen studies show us that relative abundances of species changed about five times as much since the 1800s as changes in the preceding 3,000 years.

The most striking change in the 19th century map and the present vegetation map (Map A2) is due to agriculture. Nearly all prairies, savanna, and the eastern mesic forest with beech have been replaced by agriculture. Those remnant areas of oak savanna not converted to agriculture grew into closed forest following fire suppression. The majority of wetlands in the south, poorly mapped with this data source, have been eliminated by agricultural drainage and development.

In the north, the big change has been large declines in the evergreen conifers in the uplands, the pines and hemlock. White pine is only five percent of its level in the 1800s, and hemlock less than 0.5 percent. In the north the major cause of these declines is logging that occurred from the mid-1800s to the early 1900s, followed by extreme, repeated slash fires. Significant agriculture followed logging and still exists in the south central area of northern Wisconsin.

On the other hand, the cessation of more varied, natural and Native American caused fires has eliminated the open pine savannas and open pine woodlands that occurred in the 1800s, largely on and around the three outwash plains. These are probably among the ecosystems with the greatest loss, even more than the closed pine forests.

Research shows that contrary to common belief, less agriculture was attempted than often assumed in the north. Following the fires, aspen was favored in the north and became the dominant forest type for the first half of the 20th century, and the most important commercial species. Those areas in the north that did not burn, largely on the better soils, became dominated by a simplified mesic forest of predominantly sugar maple. This also increased slowly, replacing some aspen, since the 1950s, but has stopped increasing. Yellow birch was largely lost from these forests as a dominant, as was hemlock.



**Map A.2: Current Wisconsin Land Cover**

Ironically, the satellite map of today's vegetation cannot show the detailed species and genus level forest changes that we can derive from the survey data. Commonly available Landsat satellite data while of detailed spatial resolution, cannot distinguish tree types well, beyond evergreen and broadleaved deciduous.

Wetlands have not been lost in the north to the degree they have in the south, especially forested wetlands. However, northern wetlands dependent on frequent fire have likely declined significantly.

Less visible with maps of this coarse scale, are continuing changes to the vegetation of the state due to very high deer abundance. This continues to affect both understory plants, as well as browse sensitive tree species, inhibiting their recovery. These include hemlock, northern white cedar, yellow birch, and white pine, especially in the north. In the south, oak regeneration is affected by browsing as well as the lack of fire, which favors maple invasion.

Overall, changes have been driven by human use that directly eliminates ecosystems, such as agriculture and development, especially in the south, and logging followed by extreme fire in the north. Commercial forestry is more important in the north, but also can either maintain types, such as aspen, or prevent forest succession to other types. Recent forest inventory data suggest though, that white pine is notably increasing in the north. The end of varied, natural fires has affected ecosystems in both north and south.

#### Future change

Future changes are perhaps less likely to be characterized by recovery than we have assumed. Loss of seed sources for trees such as pine, hemlock, yellow birch and cedar, along with deer browsing, will be the reason for some of this. Climate warming directly, and broader global change-caused effects, such as new insect and disease pests arriving due to global commerce, will undoubtedly have an effect and already are. Research using computer modeling also suggests that northern forest species may decline with warming and some at the southern edge of their range may be lost over the next century. Our biggest challenge now is uncertainty associated with what future changes will be from climate to land use change.

Interestingly, even with great change in the recent past and likely in the future, the data on the vegetation of the 1800s continue to be of great value. First, because of high future uncertainty and concern for biodiversity loss, a conservative approach to conserve what we have had is prudent. Second, as paleo-ecological research continues to increase our knowledge about past climates that produced the vegetation of the 1800s, it helps us to better understand species-climate relationships in general.