The Context For Great Lakes Silviculture In The 21st Century

Introduction

Great Lakes forests were subject to a severe pulse of disturbance from the mid-19th century through the early 20th century that resulted from extensive harvesting and subsequent fires following European settlement. Today's forest, in many ways, is exhibiting changes in area and demography that reflect recovery from this pulse of disturbance, as well as response to agricultural land abandonment in the region in the mid- to late-20th century. Management of these forests in the 21st century must take these trends into account, plus consider societal needs and expectations that are changing in response to population levels and other factors. Our knowledge base for managing these forests is limited, even with respect to such basic characteristics as productivity. We also have little historical reference on which to base new silvicultural systems designed to manage forests in response to emerging environmental issues such as global climate change.

The objectives of this paper are to review the current state and recent historical trends in area, growing-stock volume, and utilization of Great Lakes forests and to consider several issues and opportunities that will need to be addressed by silviculturists in the first few decades of the 21st century.

Regional Trends

Smith *et al*. (2001) present the most recently available, national information on the current state and historic trends in the forest resources of the United States. It is important to remember that the Great Lakes forest resource is responding to the same factors (earlier severe disturbance, increasing population, etc.) as forests in the remainder of North America, particularly in the Northeastern U.S. and southern Canada, although timing and extent vary by region. Great Lakes forests cannot be examined in isolation because many activities affecting future forests will be local manifestations of national and international trends.

The information presented here focuses on Michigan, Minnesota, and Wisconsin. This is not to shortchange other States, but these three States contain over 60 percent of the forest land in the North Central United States, and over a third of the forest land in the North Central and Northeastern U.S. (Smith *et al*. 2001). In these three States, forest area has been increasing in recent years (fig. 1), accompanied by a large increase in growing-stock volume (fig. 2).

About The Author:

David D. Reed, Dean of the Graduate School and Professor, School of Forest Resources and Environmental Sciences, Michigan Technological University, Houghton, MI; e-mail: ddreed@mtu.edu.

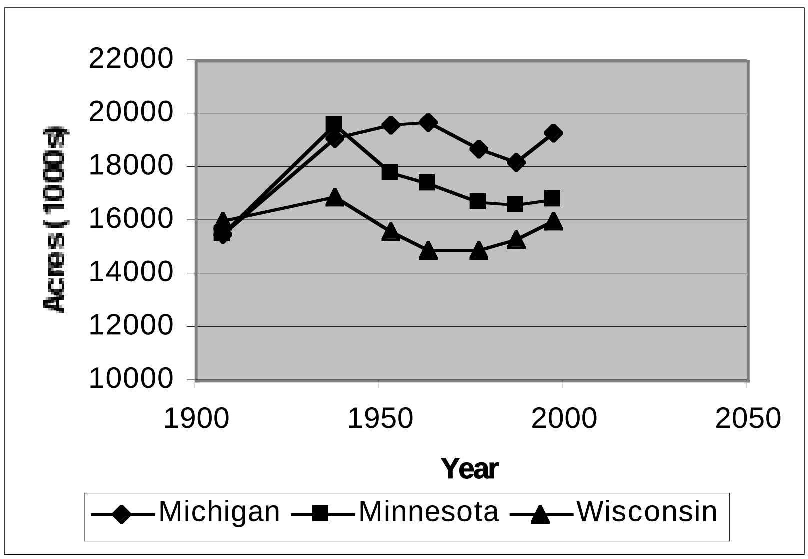

Figure 1.—Forest area (in millions of acres) in Michigan, Minnesota, and Wisconsin from 1907 through 1997 (source: Smith *et al*. 2001).

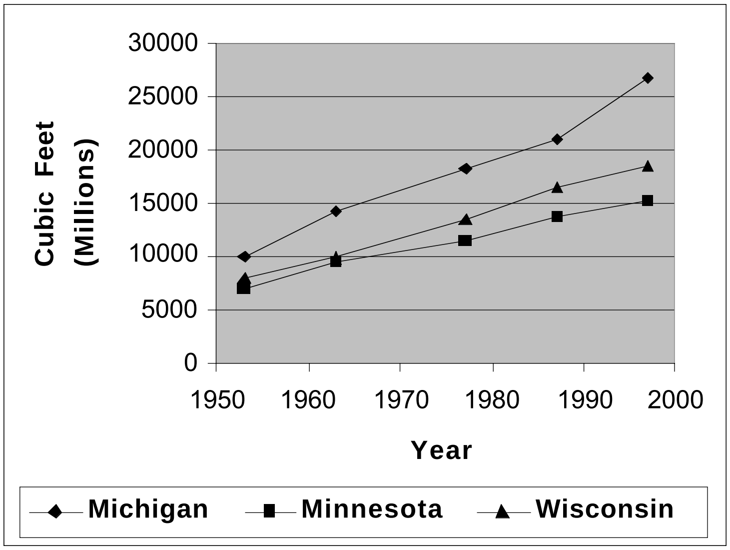

Figure 2.—Net volume of growing stock (in millions of cubic feet) in Michigan, Minnesota, and Wisconsin, from 1953-1997 (source: Smith *et al*. 2001).

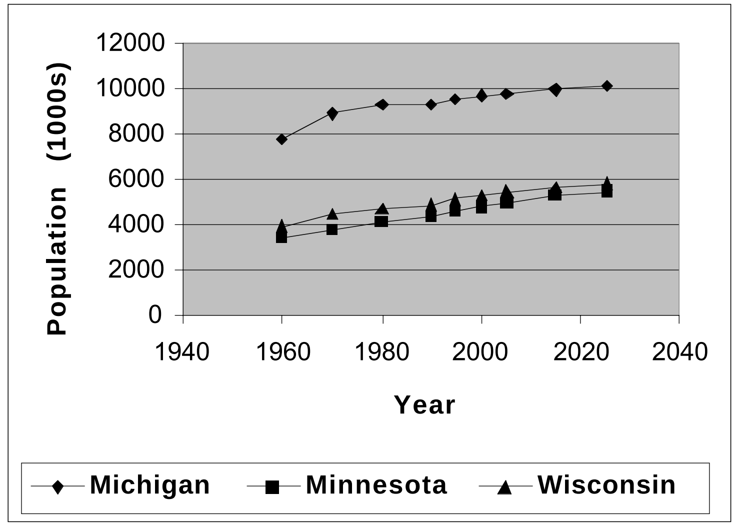

Figure 3.—Population trends in Michigan, Minnesota, and Wisconsin since 1960 with projections through 2025 (source: U.S. Census Bureau).

Of the over 52 million acres of forest land in these three States, over 49 million acres (94%) is timberland[1], and 1.9 million acres (3.7%) is reserved, or withdrawn from timber utilization (Smith *et al*. 2001). Of the approximately 49 million acres of timberland, 5.9 million acres (12%) is federally owned, 13 million acres (26%) is in other public (State, county, and municipal) ownership, 3.4 million acres (7%) is owned by forest industry, and 27 million acres (55%) is owned by nonindustrial private landowners (Smith *et al*. 2001).

The national trends affecting the commercial utilization of wood produced on national forest lands have impacted these three States, but probably to a lesser extent than the rest of the country. The one area where the Great Lakes region is relatively unusual is in the amount of land in State, county, and municipal ownership. This largely can be traced to the means by which these three States handled land that reverted to them through the failure of landowners to pay taxes during the depression in the 1930s. With the increasing population of the Great Lakes region (fig. 3), it remains to be seen whether there will be increasing controversy over commercial utilization from forestland in State, county, and municipal ownership.

From figure 2, it is reasonable to assume that an increase in net growing-stock volume will continue into at least the early decades of the 21st century. Population in this region is increasing and is expected to continue increasing in the coming decades; the impact of this increase in population on land use and societal expectations from Great Lakes forests is unknown, but could be great. It is clear that pressure on the Great Lakes forest resource is increasing, although it has not yet reached the levels experienced in other regions of the U.S. except possibly in Minnesota (table 1).

Forest Productivity

In such an environment, Great Lakes forest managers need to thoroughly understand forest productivity and ecosystem behavior to design and implement silvicultural systems to meet these challenges. Although the Great Lakes region was a pioneer in silvicultural research in the early and mid-20th century, it has lagged behind other regions in the last half of the last century.

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[1] Timberland is defined as forest land that is producing or is capable of producing crops of industrial wood and not withdrawn from timber utilization by statute or administrative regulation; areas qualifying as timberland are capable of producing in excess of 20 cubic feet per acre per year of industrial wood in natural stands. Currently inaccessible and inoperable areas are included Smith et al. (2001).

Table 1.—Annual net growth, removals, and mortality in millions of cubic feet for Michigan, Minnesota, and Wisconsin compared to the Pacific Northwest, South, and South Central United States (source: Smith *et al.* 2001)

Growth component	State/Region					
	MI	MN	WI	PNW	South	South Central
Net growth	756	370	489	3,472	4,731	10,712
Removals + mortality	551	540	360	2,617	5,694	12,421
Difference	205	- 170	129	855	- 963	- 1,709

Around 1980, several large industrial corporations maintained research centers in the Southern and Western U.S. and university-industry research cooperatives were very active in other regions, including cooperatives focused on issues of forest productivity or growth, and yield. Cooperatives focused on such issues as spacing and thinning to maximize yield and studied the effects of such treatments on wood quality (e.g., the Loblolly Pine Growth and Yield Cooperative at Virginia Tech). At the same time, Forest Service research laboratories that focused on silviculture were being closed or consolidated in the Great Lakes region and university-industry research cooperatives were very small and struggled to maintain members and activity levels in the region. Many forest managers believed that everything necessary to manage Great Lakes forests was already known and available in publications such as Arbogast's (1957) marking guide or the management guides published in the 1970s by the USDA Forest Service, North Central Research Station.

As a consequence, investment in Great Lakes silvicultural research declined to the point today where, basic knowledge of such things as the potential productivity of Great Lakes species is not known because we have not conducted the fundamental research necessary to understand productivity of Great Lakes forest species. Results from elsewhere indicate that there is a great deal of unrealized potential in these forests, but we need to perform the basic experimental work to understand these dynamics.

In northern Europe, for example, studies such as the experiment at Flakaliden (http://www.spek.slu.se/forskning/flakaliden_en.htm#Näring, Bergh *et al.* 1999) in northern Sweden demonstrate that northern species have a great deal of unrealized productive potential. In that experiment, located at 64°N latitude, manipulation of water and nutrient availability led to an approximate tripling of yield in unthinned Norway spruce to a level roughly equivalent to 3.3 cords per acre per year. In southern Sweden, at 57°N latitude, similar treatments led to yields of 6-7 cords per acre per year. Similar experiments have simply not been conducted for Great Lakes species, and the yield potential of Great Lakes forests is unknown.

Carbon Cycling and Sequestration

Basic knowledge of the role of forests in the global carbon cycle is limited, and detailed knowledge about C cycling within given forest systems is only beginning to be developed. We do not know how to inventory ecosystem C content with known precision and certainly do not know how to conduct such inventories in cost-efficient ways. It is not clear what forests managed to sequester carbon should look like or how they should be structured. Table 2 presents some data from two European forests of similar species composition (Scots pine overstory, *Vaccinium*-type understory) and soil morphogenesis. In these two forests, one located north of the Arctic Circle and one in

Table 2.—Stand characteristics and carbon content for two European Scots pine forests separated by 16° latitude (source: Reed and Nagel, unpublished data)

Characteristic	69°N	53°N
Age	178	90
Trees (ha^{-1})	442	292
Basal area (m^2 ha^{-1})	11.2	24.5
Average height (m)	10	26
Average diameter (cm)	17	32
Overstory carbon (t ha^{-1})	1.2	7.2
Total carbon (t ha^{-1})	22.6	23.3

central Europe, structure of the overstory and sizes of individual trees vary dramatically while total ecosystem carbon content is virtually the same. A great deal of work is needed in developing methods to efficiently estimate ecosystem C content. Much additional work is needed to develop silvicultural systems that will allow us to still extract fiber while increasing C sequestration. Because most C in northern forests is belowground, the investigation of belowground processes, along with decomposition, is needed to develop management methods that can be used to meet society's need for reducing atmospheric carbon while still producing needed fiber. We should not forget that if such methods can be developed and if methods to rapidly assess total system C with known precision can be developed, there may be great potential for managers to obtain increased income through C storage credits. Today, though, such potential is limited by uncertainty and the inability to verify such storage levels.

Population Genetics of Managed Forests

North American forests have been actively managed for only a relatively short time, even though human impacts on forest structure and composition extend back to the beginning of the Holocene. Silviculturists have conjectured about the impacts of various treatments on forest population genetics. Dysgenic selection, for example, refers to the loss of "good" genotypes that could result after repeated diameter-limit harvesting. To date, this understanding has largely been based on reasoned conjecture, not on actual genetic composition data. Now, with the advance of molecular genetic technologies, it is possible to collect and interpret data to directly test such concepts and to improve our understanding of the impact of various silvicultural treatments on forest population genetics. This requires interdisciplinary collaboration between molecular geneticists, population geneticists, and silviculturists, and is extraordinarily difficult. This capability, though, opens up an entire new frontier in our ability to understand forest structure and composition and will lead to greatly increased understanding in the coming years. New technology can lead to new conceptual advances, and the design of future silvicultural systems will inevitably begin considering such information as we progress through the 21st century.

Conclusion

To conclude, the above discussion has three major points:

- Great Lakes forest growing stock is increasing, but so is utilization and regional populations, leading to both increased opportunities for economic development and increased pressure on the land and resource base.
- The true productive capacity of Great Lakes forests is unknown, and a great deal of fundamental knowledge is needed to develop silvicultural systems to satisfy a wide range of rapidly evolving management goals.
- We do not understand forest ecosystems sufficiently well to design management systems to address emerging issues such as

carbon sequestration, although emerging technologies offer a great deal of promise if interdisciplinary teams can be developed to investigate and translate scientific findings into management recommendations.

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