The Outlook for Northern Forests

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Introduction

THE FORESTS OF the Northern United States have been remarkably resilient to nearly four centuries of immigration and settlement with associated anthropogenic disturbances caused by farming, logging, burning, urbanization, trade, and many other factors. Although resilient, forests conditions have been significantly impacted by humans as is illustrated by the extent of forest land-use changes or the introduction of exotic, invasive species. Unquestionably, society has shaped the composition and structure of Northern Forests and will continue to do so in the future. The future holds many uncertainties, but identification of clear trends and analyses of alternative future scenarios can help managers, decisionmakers, and the public at large prioritize the most pressing challenges to sustaining healthy, resilient forests that produce a desirable blend of commodities and ecosystem services.

In many respects, northern forests are faring better than they did a century ago when widespread, exploitive logging was common. Although there are many reasons to celebrate the current conditions of northern forests, significant challenges lie ahead. This chapter focuses on the potential threats to northern forests and the opportunities that society has to shape these forests for the future. Large-scale, strategic analyses of future conditions can help focus attention on improving the resiliency, health, and diversity of northern forests, making them more economically, socially, and ecologically sustainable and able to continue supporting the quality of life for the 125 million people who live in the region now, as well an additional 15 to 50 million people expected by 2060.

Chapters 3 through 10 report details of projected forest conditions for future alternative scenarios. The material is organized using the Montréal Process Criteria and Indicators (Montréal Process Working Group, n.d.) in an effort to provide substantial breadth in the material presented and consistency with many other State, regional, and national assessments. Breadth of information, although essential, does not necessarily lead to clarity in identifying necessary management actions or policy decisions. That requires additional work by society.

ANTICIPATED CHANGES IN FORESTS AND SOCIETY

Previous chapters of this report analyzed future scenarios projected for northern forests. The scenarios were based on assumptions about changes in population, land-use patterns, public policy, demand for wood resources, and emissions of greenhouse gases and associated climate effects. The projections are not certainties, and to emphasize that point, alternative scenarios were compared. The future reality will differ from all the projections, and the further we look into the future, the more uncertainty we face from events that cannot be foreseen. Consider that 50 years ago, in the early 1960s, personal computing and cell phones were unknown, gasoline was about 30 cents a gallon, homes were commonly heated with coal, no one was concerned with greenhouse gas emissions, and the National Environmental Policy Act did not exist.

Drivers of Change

The next 50 years will be greatly affected by expected and unforeseeable changes in societies, economies, technologies, and regulations that will influence the interactions of people and forests. Populations in the United States and around the world are expected to increase, and the cumulative demand for forest products and services will accordingly grow. Despite many uncertainties, based on historical and recent tendencies, some dominant trends emerge for northern forests.

Relative to today, these projected trends and their consequent effects presented next seem fairly certain for the North over the next several decades.

More people, but a slower rate of population growth than for the United States as a whole, leading to:

- A larger proportion of people, up to 85 percent, living in urban areas
- Greater energy demand and likely more greenhouse gas emissions
- Increased fuelwood and energy consumption (even though per capita energy consumption is decreasing)
- More urban and suburban expansion into private forest land
- More forest fragmentation and parcellation, especially near urban areas
- Decreased size of private forest ownerships and increased number of owners
- Greater threat for the spread of invasive species
- A fundamental shift from the prior century-long trend of gradually increasing forest area to a trend of gradually decreasing forest area
- Fewer acres of forest per person with increased pressures on forests to provide ecosystem products and services, including recreation opportunities, diverse wildlife habitats, and watershed protection.

Increased attention to the effects of climate on forests and forests on climate, leading to:

- Increased emphasis on carbon sequestration as an ecosystem service provided by forests
- Improved methods to quantify forest carbon dynamics
- Increased emphasis on sustainable forest management though certification and other stewardship programs for private landowners
- Policy changes that reduce per capita greenhouse gas emissions, although total greenhouse gas emissions may continue to increase with increasing population
- Greater attention to managing forests for resilience to climate change impacts, including extreme weather events

Less emphasis on timber production for the majority of private forest owners and privately owned forest acres, leading to:

- Modest changes in forest tree species composition
- Increased global trade in wood products, with more reliance on imports
- Fewer jobs in the forestry, logging, wood products, and paper products industries, especially as productivity per worker increases
- Stagnant, slow, or even declining economic activity associated with wood product manufacturing, particularly in rural areas
- An aging forest resource resulting from low harvesting rates and limited capacity for private forest management
- Limited timber-derived revenues available to support proactive management goals such as increasing forest diversity and improving resilience to threats such as climate change

Forest growth and succession along with relatively low rates of management, leading to:

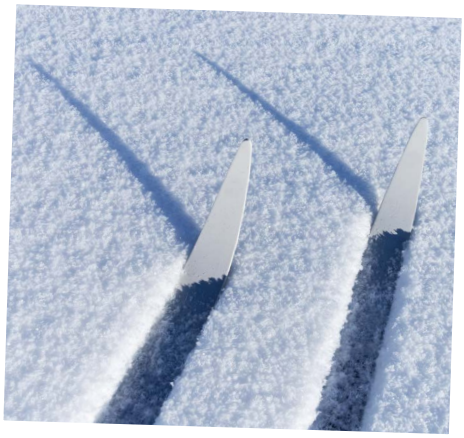
- Aging forests, with most forest area falling in the 60- to 100-year-old age class
- Low forest age-class diversity resulting in reduced habitat diversity for wildlife
- Fewer issues with water quality and quantity compared to other U.S. regions because of large water yields coupled with low rates of forest disturbance; localized water issues, particularly near urban areas or in watersheds with substantial loss of forest cover
- Reduced growth rate of wood volume and biomass
- Reduced net rate of carbon sequestration annually, since older forests accumulate carbon at lower rates than younger forests

Less Certain Future Outcomes

Impacts of a changing climate—Despite the broad scientific consensus that increased greenhouse gas emissions are changing the climate, uncertainty continues as to what the local and regional impacts will be on forests, wildlife, and people. Concern continues to mount about the potential for climate change—including increased frequency of extreme weather events—to cause declining forest health, increased tree mortality, decreased growth of wood, reduced output of timber and nontimber products (such as maple syrup), and loss of recreation opportunities (such as those due to loss of vibrant foliage from autumn landscapes and reduced snowpack for skiing).

How bioenergy and emerging wood-using industries will affect resource use—The North has high potential for future utilization of biomass for energy and advanced bio-based products (ranging from co-firing woody biomass with coal to cellulose nanotechnology); however, forest conditions, and social, financial, and logistical barriers have hindered large increases in wood-based energy production. Wood is a relatively low-value, widely-dispersed energy feedstock, and options for using it for energy production are unevenly distributed across the North. Electricity generation could use millions of tons of low-value wood annually, but the number of locations where electric production infrastructures coincide with economically advantageous supplies of woody biomass is limited.

Moreover, burning biomass to generate electricity is not the most efficient energy conversion path for woody biomass unless used in high efficiency systems (such as combined heat-and-power plants). In contrast, opportunities to use wood for residential and commercial heat are spatially dispersed (Song et al. 2012) and contemporary wood stove designs have energy conversion efficiencies that rival the best electric utilities (Alliance for Green Heat 2014). Residential wood heating in the United States has declined in recent years with little to no indication that consumption will grow in the future, but foreign markets could sustain local bioenergy projects as has been the case for wood pelletized and exported to Europe. The amount of woody biomass harvested for energy production or other products affects the amount of carbon retained in forests, the level of carbon emissions from competing fossil fuels, the associated quantity of roundwood harvest, and future forest age structure. The three scenarios with greatly increased woody biomass utilization for energy (A1B-BIO, A2-BIO, and B2-BIO) all predicted large reductions in forest volume by 2060.



How other factors will affect future forest conditions—Many other factors have the potential to affect the future trajectory of forest change or to be affected by future forest conditions, but the magnitude of those interactions is uncertain. Some of these uncertainties include:

- How expanding urban areas along with changes in tree cover will impact the ability for urban and community trees and fragmented forests to meet life-supporting ecosystem services of an increasing population
- How the forest products industry and forest-based rural economies will fare if rates of forest volume growth decrease as predicted; any significant changes in growth rates could accumulate to cause significant disruption in the current supply of wood resources to the industry
- How macroeconomic conditions will change and impact domestic and global demand for wood and other forest products
- How public policy changes and cumulative management decisions or indecision by millions of private forest owners will affect future forest diversity, fragmentation, and the impact of invasive species
- How attitudes and management priorities directed toward urban and rural forests will change; for example, a majority of all land area will be urban in several eastern States by 2060
- How effective public land managers and private conservation organizations, such as land trusts, will be in addressing landscape-scale conservation issues such as maintenance of forest biodiversity
- How forest certification will affect stand-scale and landscape-scale forest management practices
- How new or migrating invasive insects, diseases, and plants will affect tree composition and forest structure

Effects of Spatial and Temporal Scales on Findings

Projected (and past) forest changes are not uniform across the North. Differences among subregions and among states occur in:

- Forest area, vegetation types, and product utilization
- Forest resource policies, programs, and attention to forest-resource issues
- Spatial patterns of population density and land-use change (especially forest versus urban)

Thus, the forest resource problems anticipated for the North must be considered in the context of subregional, State, and local conditions as policy makers, landowners, and managers work to identify appropriate on-the-ground management actions. Throughout this report State-level and regional summaries are provided, because State natural resource agencies and legislatures will be at the forefront of coping with many of the potential problems and opportunities associated with northern forests. The appendices provide additional details. The Northern Forest Futures database (Miles and Wear 2015) and guide (Miles et al. 2015) (available on the DVD included with this book and available online) provide maximum flexibility to summarize projected forest conditions at State and subregional scales, for a number of scenarios, including those discussed in this report.

The natural processes of forest growth, mortality, regeneration, species succession, nutrient cycling, and water cycling are dominant forces that drive forest change. However, those processes can be greatly modified by human choices about forest land conversion, harvesting, habitat restoration, fire management, energy use, greenhouse gas emissions, forest policies, energy policies, economic policies, and more. Across large spatial scales, forests and the processes within them are subject to great inertia. Clear evidence that forests are responding to policy or management changes can take decades to become evident in State or regional statistics, simply because so many acres are involved. Nevertheless, current forest conditions in the North clearly bear the imprint of past human choices, and northern forests will gradually come to bear the imprint of future human choices.

Actions to Consider

- **Strengthen people's connections to rural and urban forests**
- **Develop mutually beneficial partnerships among forest owners, managers, industry, and the larger society to support conservation goals**
- **Develop measurable state and regional goals for forest diversity and monitor progress toward achieving them**
- **Promote forward-looking forest management across all forest ownerships**
- **Estimate the types and number of forestry jobs that could be sustainably supported, now and in the future**
- **Work to understand the many dimensions of forest change**

ACTIONS TO CONSIDER

The challenges facing northern forests are large, complicated, intertwined, and enduring. New challenges will emerge in the coming decades. The following actions (Shifley et al. 2014) are among many that will be needed to move from thoughtful consideration of the issues to on-the-ground management:

Strengthen people's connections to rural and urban forests

Forests and cities are intertwined across the northern landscape. Over time, the region is expected to become more populous and more urbanized; by 2060 urban areas will be the primary habitat for 85 percent of residents. Clearly, attention to the health and sustainability of urban trees and forests is important to human well-being. Rural forests near urban land will be heavily impacted by inevitable urban expansion. These forests provide critical ecosystem services to large numbers of people and can serve as places to foster greater appreciation for natural resources.

Nearly 12 million acres of forest land will likely be converted to urban uses by 2050. Although an enormous area, this still amounts to a loss of only about 7 percent of the region's current forest land. By 2060, rural forests will likely still cover about 40 percent of the land. Since there are already indications where urbanization will take place, it might be important to focus less on how much forest will be converted and more on how to accentuate potential benefits and mitigate undesirable consequences in the specific places where urbanization is most likely to occur.

By definition urban areas are heavily populated, but many also contain substantial tree and forest resources. Trees cover an estimated 38 percent of urban land in the North and are an essential component of human habitats. Current forest inventories separate rural forest descriptions from those for urban trees and forests, even though rural and urban forests fall along an ecological continuum that is characterized by a changing ratio of the number of trees to the number of people. Tree inventory, monitoring, and valuation methods that span the gradient from rural to urban areas could evolve with increasingly sophisticated, standardized, and informative forest resource inventory systems.

Urban forest managers have excelled in estimating the value of the ecosystem services that trees provide in terms of cooling neighborhoods, mitigating pollution, sequestering carbon, providing habitat, and contributing to overall human well-being. Valuation of those and other ecosystem services can be extended to rural forests where commodities have been the primary indicators of value. The net result would be better knowledge of the spatial distribution of the multiple values derived from rural and urban trees.

Develop mutually beneficial partnerships among forest owners, managers, industry, and the larger society to support conservation goals

Collaboration is required for planning and management to create forest landscapes that are diverse, that are resilient, and that are economically, socially, and ecologically sustainable. The long-term trends of an increasing number of forest owners coupled with decreasing forest parcel size adds to the complexity of managing for landscape-scale forest health and diversity across multiple ownerships. Large, publicly owned forest tracts with long-term management plans can serve as focal points for forest landscape management, but significant progress in landscape-scale management ultimately requires participation of private forest owners who collectively control 74 percent of the North's forest land. State forestry agencies, in cooperation with the U.S. Forest Service and other agencies, are leaders in identification of state-scale forest management priorities, but actual on-the-ground management demands the cooperation of public and private owners. Conservation easements can be effective mechanisms to coordinate management among private owners. Those instruments are well suited to implement forest management plans that will survive through ownership changes, intergenerational transfers, and parcellation. Other collaborative partnerships, such as the migratory bird joint ventures (USDI FWS 2014) and corporations that choose sustainably produced forest products or ecosystem services, are expected to continue to be highly influential in the future.

Some of the most widely applied practices used to regenerate, restore, or increase resilience in forest landscapes include monitoring and planning, writing prescriptions, harvesting, burning, planting, applying herbicides, controlling deer, and controlling invasive species. All management practices cost money and require labor to implement. Consequently, market values of forest products and services are an essential consideration in management decisions. Traditionally, the sale of forest products has been an economic engine that helped offset management costs for nontimber conservation goals. Shifting the management focus from forest products to other ecosystem services can alter the economic balance. Failure to adequately measure and monetize the value of ecosystem services can be a barrier to managing them. Forests that are valued for multiple commodities and services, such as timber, water, soil, carbon sequestration, and wildlife habitat, will be better positioned to cope with disruption in a single market (such as a housing slump) and therefore will more likely be sustainably managed and conserved over time. Effective partnering with foresters, loggers, and other woods workers will be essential to design and implement economically viable management prescriptions for ecosystem services as well as for forest products.

As a natural resource community, we are getting better at understanding how to manipulate forest ecosystems to favor a particular plant community or wildlife species. In addition, best management practices are available to guide protection of forest-associated soil and water resources during management activities.

We know much about restoring degraded habitats and adding diversity to forest landscapes. Still, the best laid plans for conservation can fail if they are not also socially acceptable and economically viable. As a natural resource community we need to ask new questions, such as:

- What configuration of forest products industries can effectively implement the on-the-ground forest management required to sustain healthy, diverse, and resilient urban and community trees and rural forested landscapes?
- What is the role that publicly owned forests should play to support timber markets in addition to nonconsumptive activities?
- What are the associated implications for economic sustainability of rural communities?
- Will society in general, and private forest land owners in particular, participate in collaborative management practices that result in desirable cumulative effects across large forest landscapes?
- How can we build stronger support for forward-looking forest management from the 5 million private forest owners and the 120 million other residents of the North that derive products and services from forests?

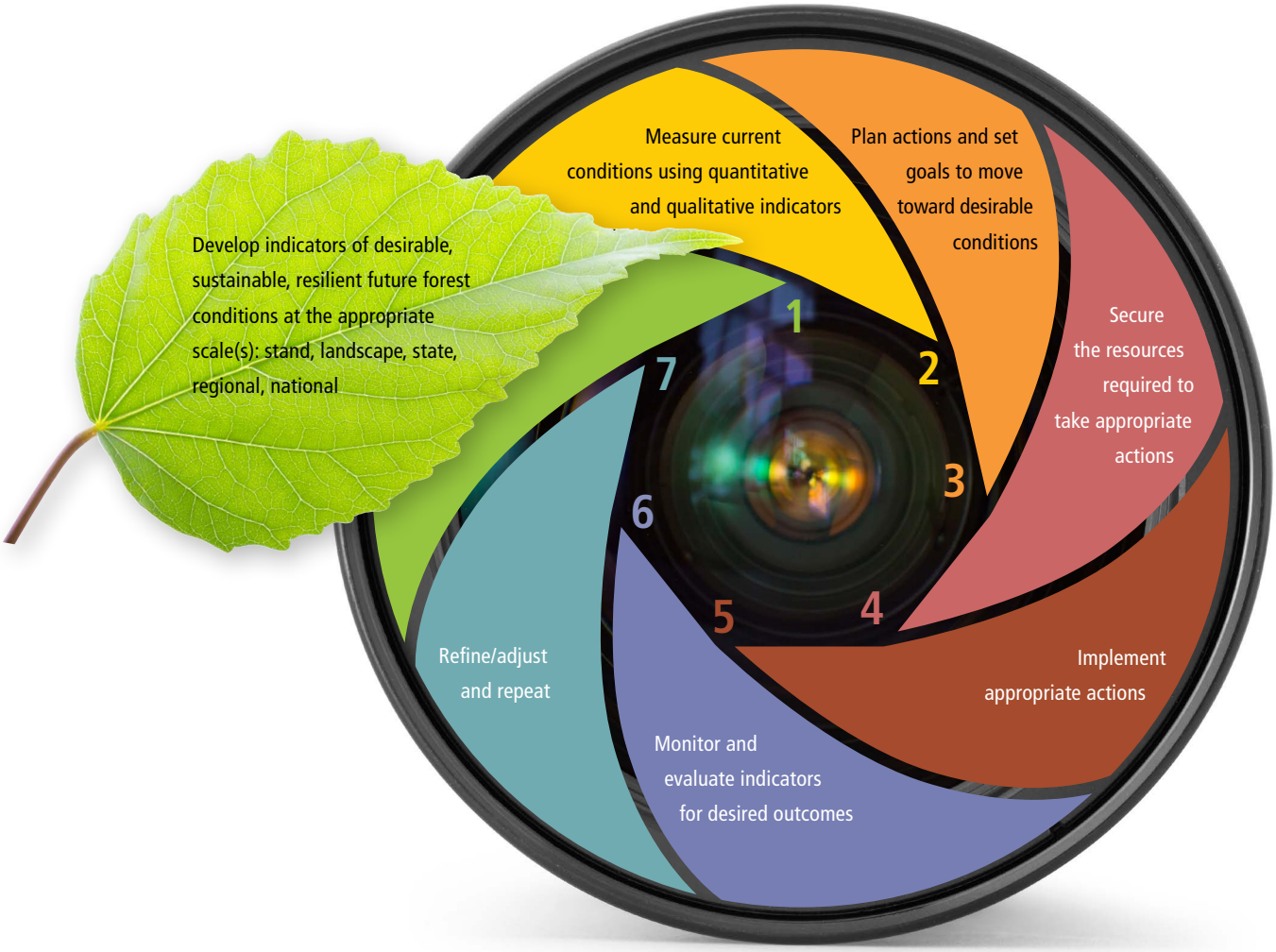
Develop measurable state and regional goals for forest diversity and monitor progress toward achieving them

Diversity of forest age classes is fundamental to sustaining resilience and long-term forest habitat diversity (Hunter and Schmiegelow 2011). Past disturbance history has resulted in low age-class diversity in northern forests with the majority of acres clustered in the 40- to 80-year age classes (Shifley et al. 2012, 2014). This is true for forest land in each State, as well as for the North as a whole. Efforts directed at increasing forest age-class diversity would increase other measures of forest diversity, expand habitat diversity for wildlife, and increase forest resiliency to undesirable consequences from stressors such as climate change and invasive species. Failure to address this issue has long-term implications for future forest diversity and resilience. Current deficits in the 10-year-old age class will eventually become deficits in the 20- and the 30-year-old age classes—creating a trend that will persist for decades. Although forests >100 years are also underrepresented in the North, the proportion of area in this age class would increase as existing forests mature if current disturbance regimes continue. Many other indicators of forest diversity are important, but forest age-class diversity is a simple indicator that provides a good starting point for discussions about increasing all aspects of forest diversity and resiliency. Forest age class diversity is typically evaluated at the scale of tens of thousands or even millions of acres. Making changes at those scales requires shared goals across multiple ownerships.

Promote forward-looking forest management across all ownerships

As is true for much of the United States, active forest management is a low priority among northern private forest owners, and management intensity is low on much—but not all—of the public land. Northern forests face significant challenges over the next 50 years: climate change, invasive species, decreasing diversity, decreasing productivity, decreasing area, and increased demands for commodities and ecosystem services. Some, like the infestation of emerald ash borer (*Agrilus planipennis*), present an immediate crisis; others, including declining diversity and species responses to climate change, build gradually but often inexorably.

The processes for dealing with future forest resource issues, individually or collectively, in forest ecosystems usually follow the same pattern (see diagram below):



This is forest management, plain and simple. The details of how to tailor management activities to achieve a desired outcome acre-by-acre may be complex and will certainly differ from place to place, but management procedures can generally be designed to avert or reduce the undesirable consequences of multiple stressors. Often, the limitation will not be a lack of understanding about which prescriptions will be successful in the woods, but rather the challenges of developing societal consensus and finding practical ways to invest in the selected treatments, monitor the outcomes, and repeat as needed. Many of the major stressors that will affect northern forests over the next 50 years—climate change, introduction of invasive species through global trade, and population growth—are largely outside the control of the natural resource community, but managing northern forests to be sustainable, productive, and resilient in the face of whatever comes along is squarely within the influence of the region's forest owners and the broader natural resource community.

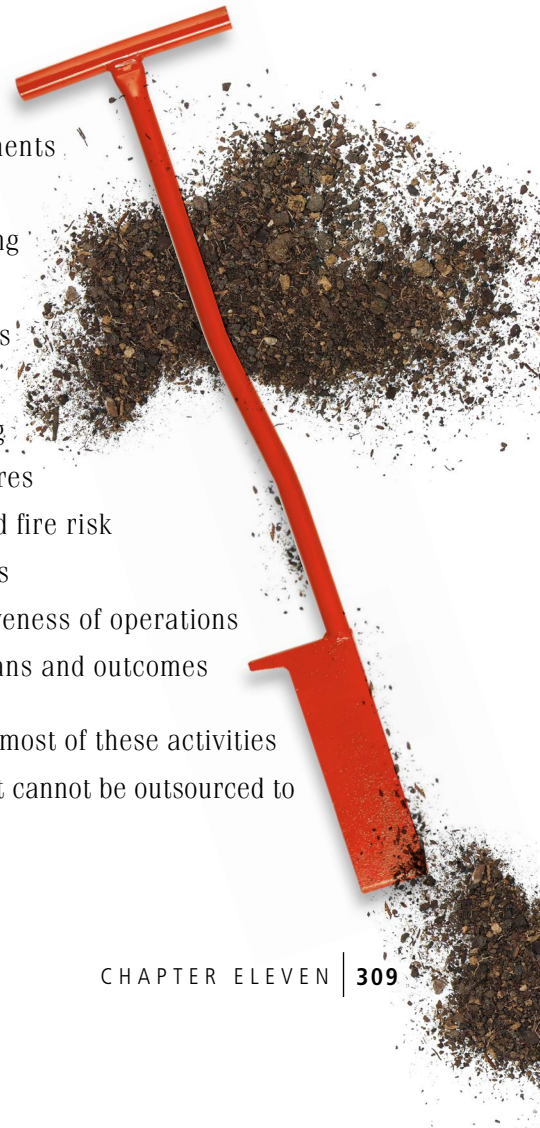
Estimate the types and number of forestry jobs that can be sustainably supported, now and in the future

The number of jobs has been decreasing steadily in the traditional fields of forestry and logging, wood products production, and pulp and paper production—in part caused by higher production efficiency of the remaining employees, either through technological enhancements or higher skilled workers—but the nature of woods work is also changing, as attention increasingly shifts to management of ecosystem services (including the provision of wildlife habitat), certification of sustainable timber production, and urban-tree management.

Despite centuries of timber harvesting in northern forests, there is a lack of understanding about the number of new jobs that would be supported for every additional 10 million cubic feet of timber that is sold and processed. Even less is known about the capacity of other rural and urban forest management activities to create jobs and generate economic activity. For example, how many people with what skills would be required for restoring and maintaining each additional 10,000 acres of woodland, or for managing the latest invasive species? The types of work activities would likely include:

- Planning
- Inventorying
- Prescribing treatments
- Planting
- Cutting and thinning
- Pruning
- Applying herbicides and pesticides
- Prescribed burning
- Suppressing wildfires
- Managing fuels and fire risk
- Managing invasives
- Monitoring effectiveness of operations
- Communicating plans and outcomes

By their very nature, most of these activities support local jobs that cannot be outsourced to other locations.



The forest products industry and public land management agencies in the northern region appear to be undergoing a period of realignment. Despite two decades of increased emphasis on landscape-scale conservation and decreased emphasis on timber production from public lands, the demand for raw materials and processing capacities of local forest products companies does not always align with the vegetation manipulation prescribed by forest managers. Woodland restoration is a case in point. Early stages of restoration can require harvesting of many small-diameter, virtually unmarketable trees, thereby creating an overwhelming management expense. In addition, repeated prescribed burning is used to encourage vegetation diversity but can degrade the quality of merchantable timber that could otherwise be sold to traditional timber markets. The forest management community is extremely adept at prescribing on-the-ground activities required to bring a stand or a landscape to a desired future condition, but less adept at forecasting the related implications in terms of jobs and economic activity.

Work to understand the many dimensions of forest change

Following the general outline of the Montreal Process Criteria and Indicators in this report forced a broad examination of the current conditions and expected changes for many elements of northern forests: biodiversity; productivity; health; soil and water resources; biomass and carbon; socioeconomic benefits; legal and institutional frameworks for sustainable management; and urban forest resources.

Our comprehensive format for reporting and discussing results provides a broad base for thinking about future forest conditions. Moreover, the modeling described in this report specifically addresses potential impacts of a changing climate. Given the broad consensus that climate will change in the North, the scenarios we examined were designed to capture the potential effects of those changes on northern forests in a way that complements past research conducted by U.S. Forest Service researchers and partners (e.g., Iverson et al. 2008, Prasad et al. 2007, Vose et al. 2012) and summarized by the Northern Institute of Applied Climate Science (USDA FS 2012).

One of the surprising results of the scenario analyses is the similarity of the projected forest outcomes for the three storylines developed by the Intergovernmental Panel on Climate Change (IPCC 2007) to estimate climate change associated with relatively low (B2), medium (A1B) or high (A2) greenhouse gas emissions. Differences were found to be modest until at least 2040 among the scenarios that continued with current rates of harvest, and there was no evidence that over this period the effects of climate change would overwhelm the changes resulting from forest aging, species succession, harvest, and land-use conversion. However, results from the scenarios assuming large increases in the amount of woody biomass that could be needed to satisfy increased demand for bioenergy (A1B-BIO, A2-BIO, and B2-BIO) confirmed that human influence through harvesting could substantially alter the trajectory of forest change in future decades.

Climate change will affect forest diversity, health, and ecosystem services in the North, but so will forest aging, species succession, logging, weather, fire, insects, disease, invasive plants, land-use change, recreation use, and management actions or inaction. Successful forest management requires society to consider which of these forces are most influential in the short-run and which are the most amenable to manipulation in pursuit of long-term, large-scale forest conservation objectives. We will learn more about climate effects on forests in the coming years and more about management practices necessary to increase resiliency and reduce unwanted consequences. Climate change appears to be a factor that will complicate—rather than dominate—change in northern forests over the next 50 years.

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