PRIORITY RESEARCH TO SUSTAIN MINNESOTA'S FOREST RESOURCES

MINNESOTA
FOREST
RESOURCES
COUNCIL

Minnesota Forest Resources Council

The Minnesota Forest Resources Council (MFRC) is a 17-member board created under Minnesota statute 89a to develop policy recommendations to the Governor and federal, state, and local governments and to encourage the adoption of sustainable forest management policies and practices. Council members are appointed by the Governor and represent a wide range of forest resource interests.

Representing:

Commercial Logging Contractors	Indian Affairs Council
Conservation Organizations	Labor Organizations
County Land Commissioners	Nonindustrial Forest Landowners
Minnesota Department of Natural Resources	Research and Higher Education
Environmental Organizations	Resort and Tourism Industry
Forest Products Industry	Secondary Manufacturing
Game Species Management	USDA—Forest Service

Report prepared by Robert A. Slesak, Director of Applied Research and Monitoring

Content

The forest resources research priorities presented in this report identify critical information and technology needs and provide a path forward in sustaining Minnesota's forest resources.

Executive Summary

The economic and ecological benefits from forests are tremendous and serve as an engine for Minnesota's economy and the overall health and well-being of all of our communities. Managing forests for multiple benefits and uses is complex. Therefore, it is important that we have science-based information available to make informed decisions on sustainable forest management. Information needs are constantly growing, and research prioritization is essential to target our efforts to those needs with the biggest impact. This report outlines priority forest resources research needs that are most pressing, of broad impact, and are practical for application to address real time issues.

Forests cover over a third of Minnesota and span a range of ownerships, so coordinated forest management is essential to addressing changing conditions and forest health threats. Overall, most of our critical research needs relate in some way to changing forest conditions and how

they will influence resources in the future. We know that climate change, invasive species, and forest fragmentation are going to alter how our forests function, but there is still much to learn on what will occur and – more importantly - what can be done about it with options for a resilient response. Research will provide the foundational knowledge to practitioners and policy makers to ensure we make the best choices and implement them in a sensible way.

Broad research areas and priorities were identified following a comprehensive process that involved evaluation by a team of technical experts with input from many people who work in forests and care passionately about them and the resources they provide. The priorities broadly encompass a coordinated, integrated approach that involves greater understanding of forest functions, practices to maintain those functions, and increased economic and ecological benefits that will occur as a result.

The identified priority research needs presented in this report are organized around the following three themes:

Maintaining forest health and function—research priorities related to base functions of forests (e.g., clean water supply, biodiversity, wildlife habitat) and how they vary across scales and conditions.

Forest management for the 21st century—research priorities related to development of new silvicultural practices; acquisition and use of new technologies and data sources; social aspects of forest management.

Enhancing forest economies (industry and communities)—research priorities related to increasing forest products and forest use; supporting existing industries and the emerging bioeconomy; and aiding forest-dependent communities and minimizing their vulnerability to future conditions.

Minnesota's forests face many challenges in the years ahead. At the same time, there is great potential for research to guide new approaches to forest management and drive innovation of forest-based economies that can address many of these challenges and provide greater benefit to all. The forest resources research priorities presented in this report identify critical information and technology needs and provide a path forward in sustaining forest resources. Minnesota must continue its legacy of investment in sustaining support for forest-related research to reap the benefits of these renewable resources into the future.

Minnesota's Forests

Minnesota's commitment to maintaining healthy and resilient natural resources is reflected in the laws and policies established to manage our forests responsibly. Notably, the Sustainable Forest Resources Act adopted into Minnesota Statute in 1995 requires that forest management activities be conducted in a sustainable manner that maintains all forest resources including timber, recreation, wildlife, biodiversity, water, soils, and aesthetics. Minnesota's forest resource community continuously works to achieve this charge by using the most updated science-based information available, but there is still a significant information need that can only be addressed with sound research. This report continues that effort by presenting those research needs that are of highest priority in order to address those most pressing issues faced in the management of our forest resources.

There are over 17 million acres of forest in Minnesota, covering almost a third of the state. These forests range from the hardwood forests in the southeast to the broad expanses of aspen and spruce across the northern portion of the state. Forest ownership is roughly split between private landowners and public entities (federal, state, county, tribal), and management encompasses a broad range of objectives including timber production and recreational activities.

The values that forests provide are tremendous. From a purely economic view, forest-based industries such as paper mills and sawmills are the fifth largest manufacturing sector in the state, providing more than $9.1 billion in total output and 32,000 direct jobs. When adding in other economic benefits associated with recreation, hunting, fishing, and tourism, our forests become one of the most significant engines of the state's economy. Healthy forests also provide an abundance of invaluable products and services including clean water, forest habitat, and biodiversity. When done properly and with collaboration across ownerships, forest management is able to simultaneously provide all of these benefits that exist in the wide range of conditions across the state.
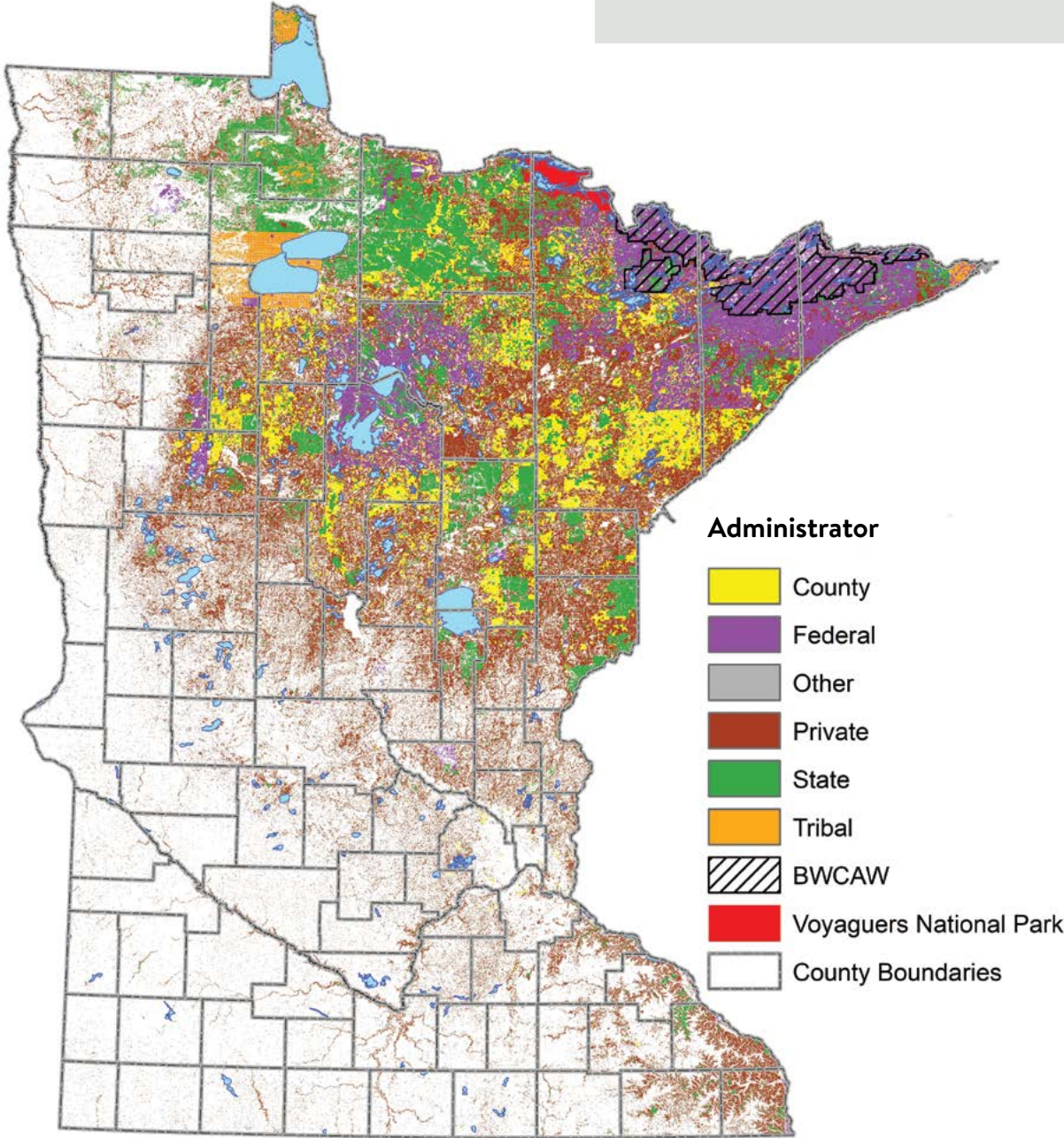
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Minnesota Forestland Ownership

Forest ownership in Minnesota is a blend of state and private entities concentrated in the northern portion of the state. Each ownership has a unique set of management objectives and conditions that create challenges for coordinated management of our forest resources. Prioritization of information and research needs can help coordination of multi-ownership efforts.

Total acres by landowners

Private	7,984,438
County	2,526,907
Federal	2,828,030
State	3,981,827
Tribal	422,942

Administrator

- ⬛ County (yellow)
- ⬛ Federal (purple)
- ⬛ Other (grey)
- ⬛ Private (brown)
- ⬛ State (green)
- ⬛ Tribal (orange)
- ▨ BWCAW
- 🟥 Voyaguers National Park
- ⬜ County Boundaries

Map by David Wilson

Research Need

Forest resources research provides a foundation for sustainable management.

Minnesota has a wealth of forest resources that benefit each of us on a daily basis.

From wildlife habitat to clean drinking water, and recreation to timber, our forests provide a multitude of resources that benefit all Minnesotans. Forests and the resources they provide are integral to the functioning of our society whether in the neighborhoods of St. Paul or in towns "up north". Consider that our forests are home to the headwaters of the Mississippi River, a national treasure to the country, but also an important source of drinking water and recreation to many across the state and country. Maintaining forest resources in areas such as the Mississippi River headwaters is essential to support our way of life.

Clean water is one of the greatest resources provided by forests.

Our forests and the economies dependent on them face challenging pressures.

Changing conditions are creating unique challenges in maintaining forest resource benefits into the future. Invasive species, changing climate, changing land use and ownership, and declining forest-based markets all threaten our ability to maintain healthy forests into the future. At the same time, forested communities are increasingly reliant on the economic benefits that forests provide including jobs in industrial and recreational sectors. This combination of increased threats and reliance on our forests has created an urgent need to innovate forest management across the state.

Invasive and native wood-boring beetles are some of the greatest threats facing Minnesota's forests.
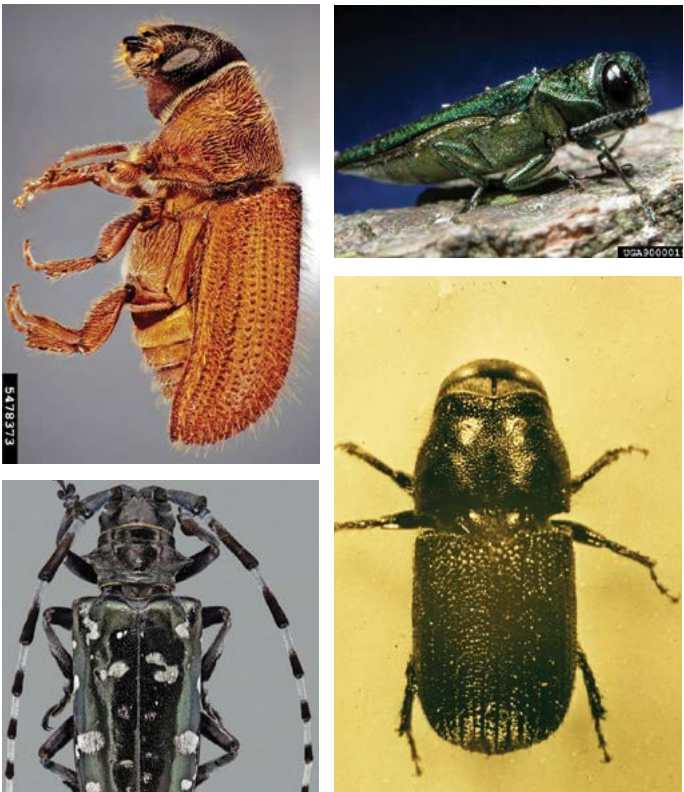
Forest resources research is needed to guide the complex management of our forest resources.

Management of forest resources often involves tradeoffs among resources and benefits. Finding the right blend of management to maximize forest benefits has always been challenging, and will become even more so with changing forest conditions. Research will provide the information needed to thoughtfully and effectively address complex forest resource issues, develop predictive tools, and formulate strategies to maintain healthy forests and the supply of resources society depends on.

Research will provide foundational information to address complex forest resource issues now and in the future.

It is time to invest for the future.

Minnesota's institutions have collaboratively conducted effective research in the past, but much more needs to be accomplished. Over the past decade, the invasive emerald ash borer arrived and spread in the state, forestlands have become increasingly fragmented, and Minnesota's forest industry has changed. Evaluating approaches to respond to these potential threats and changes now—while also identifying and developing opportunities for innovation—will position Minnesota to maintain healthy forests and the multitude of benefits they provide to all of us and the generations that follow.
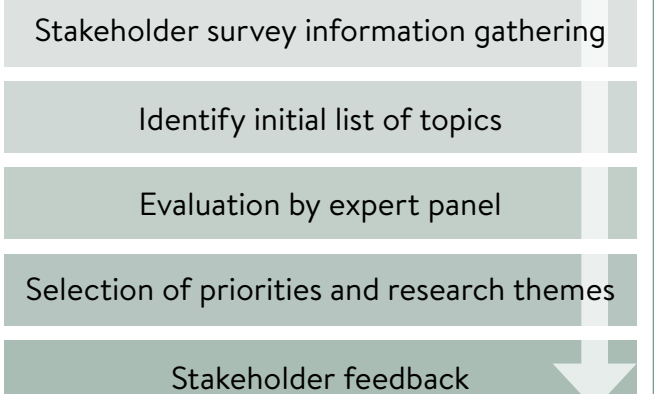
Forest Resources Research Prioritization

The Minnesota Forest Resources Council (MFRC) is charged with working across ownerships towards achieving sustainable forest management in Minnesota. The MFRC and its Research Advisory Committee (RAC) periodically conduct an assessment to identify important forest resource issues and prioritize forest research activities in Minnesota. RAC membership includes institutions that encompass both research and land management in Minnesota. Formation of the RAC and this prioritization are required under the Sustainable Forest Resources Act (MN 89a Subd. 08), which also requires efforts to initiate priority forest resources research by the MFRC (MN 89a Subd. 2).

Forest resources information needs are constantly expanding, and prioritizing research is essential to target efforts to information needs with the greatest impact. This prioritization focused on addressing practical information needs related to forest resource management so that the research can be rapidly incorporated into practice, action, and impact. Other important considerations for prioritization included the urgency of an issue or opportunity, the extent of applicability across Minnesota's forests, and the level of stakeholder support or interest.

Evaluation Process

The evaluation process was developed by RAC members and included a stakeholder survey, assessment of key topics by an expert panel, development of integrated research priorities, and selection of final priorities and related examples. The initial survey was conducted to gather input from stakeholders on key forest resource issues, and the responses were used in part to identify a list of 12 forest resource topics. Experts from various research entities (e.g., University of Minnesota, USDA Forest Service), land management organizations (MN DNR, county land agencies, tribal forestry), and interest groups were then identified to serve on an expert panel to evaluate each of the topics (Appendix). The panel used a defined process to identify key priorities for each topic area that included the use of prioritization criteria and ranking among the panel members. Top priorities for each topic were combined into integrated priorities that encompassed multiple disciplines and complementary issues. Integrated priorities were organized into research themes, and the top 2-3 priorities for each theme were selected based on ranking among both the evaluation panel and RAC members. Finally, a list of detailed examples was generated for each integrated priority based largely on the initial survey results and the detailed evaluation of the 12 topics conducted by the panel.

Evaluation Process Steps

- Stakeholder survey information gathering
- Identify initial list of topics
- Evaluation by expert panel
- Selection of priorities and research themes
- Stakeholder feedback

Recommendation structure

The research priority recommendations are organized into themes, priorities, and examples that are applicable across audiences.

Research themes are broad focal areas of research that encompass priority forest resources issues.

Integrated priorities are a set of associated research priorities for each theme that have similar focal areas and cross multiple disciplines. There are two or three priorities for each theme.

Research examples are more detailed project-level topics intended to provide additional context to the integrated priorities. There are three examples associated with each priority, which are not comprehensive of all important forest issues.

Research Advisory Committee Members and Affiliations

Greg Cuomo, Chair
Associate Dean for Research, College of Food, Agricultural, and Natural Resource Sciences, University of Minnesota

Robert Haight, Research Forester
USDA Forest Service, Northern Research Station

Ann Pierce, Deputy Director
Division of Ecological and Water Resources, Minnesota Department of Natural Resources

Peter Reich, Regents Professor
Department of Forest Resources, University of Minnesota

Erik Schilling, Director of Forestry Research, Southeastern U.S.
National Council on Air and Stream Improvement

Mark Weber, Land Commissioner
St. Louis County, MN Association of County Land Commissioners

Rolf Weberg, Executive Director
Natural Resources Research Institute

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🌲 **Theme:**

Maintaining Forest Health and Function

Photo above shows an example of forest disturbance.

For people who spend a lot of time in the woods, it's clear that forest conditions are changing. We understand many of the causes of these changes, but we still do not have a firm grasp on how changes will impact our forest resources, and which aspects of forests may be most susceptible or which changes will have greatest effect on society. Making the issue more challenging is that many of our most important forest resources are influenced by conditions that span large geographic areas and by factors that span even larger areas such as regional climate. For example, stream water quality is largely controlled by the conditions across the watershed that feeds it. Moose are dependent on habitat and resources across wide swaths of forest that often span multiple ownerships. Because of this, understanding how the arrangement of things like forest cover and type influence our resources is critically important for effective management. Addressing these issues together – changing conditions and complex resource interrelationships – is essential to maintaining important resources like high water quality and moose populations in Minnesota.

Forests are constantly changing, but the current complexity of change is unprecedented. Changing conditions associated with things like climate change and invasive species create challenges in how we manage forests for a wide array of resources, and are one of the primary issues underlying many of the research priorities presented in this report.

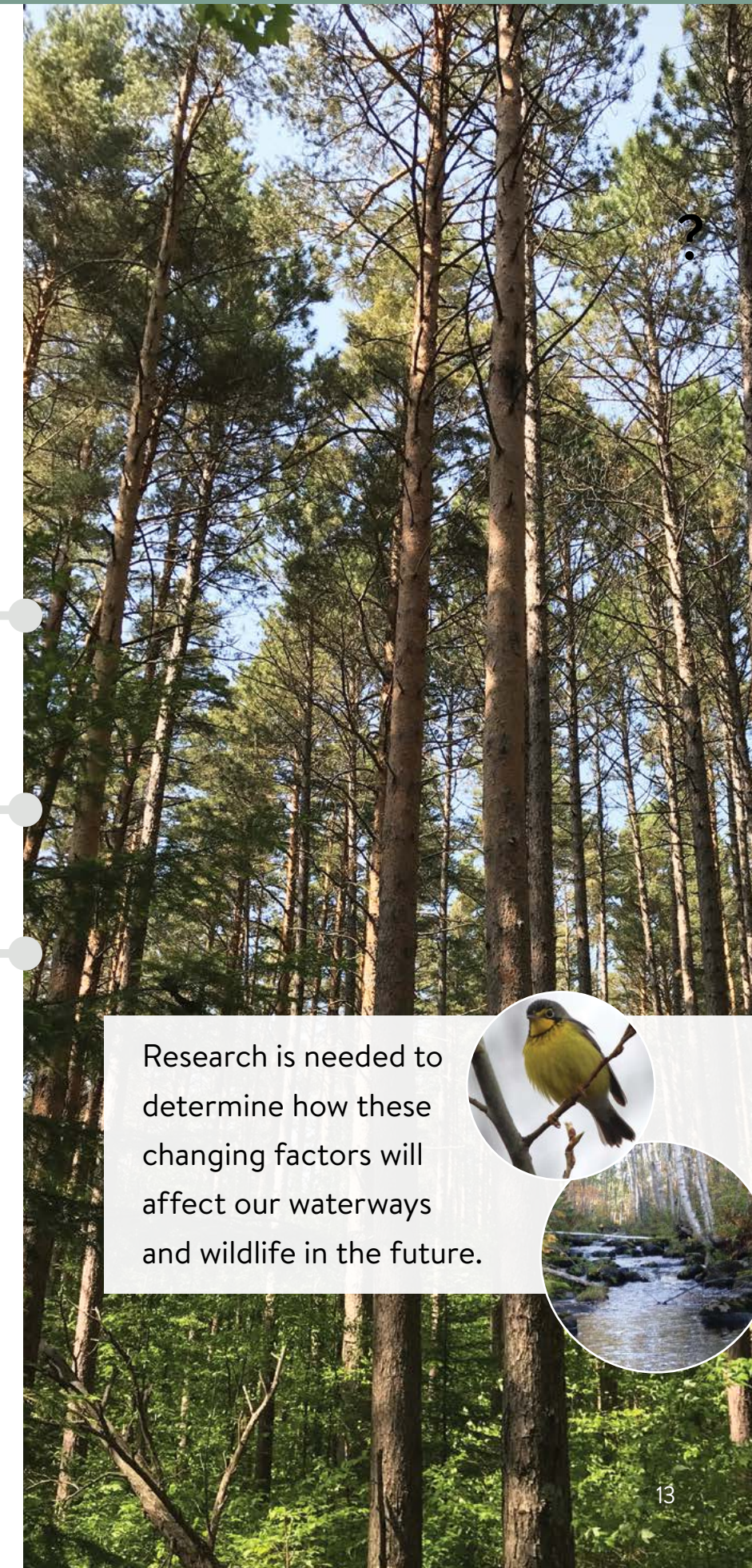## Factors Influencing Forest Change

Forest Fragmentation

- Roads and infrastructure
- Ownership patterns
- Parcelization

Changing Climate

- Storm severity
- Drought

Forest Disturbance

- Invasive species
- Storm events and fire
- Forest harvesting
- Growing conditions

Research is needed to determine how these changing factors will affect our waterways and wildlife in the future.

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Priority:

Management strategies to maintain the broad supply of resources most susceptible to changing conditions

Example topics:

- Strategies to address widespread ecosystem alteration associated with invasive species (e.g., emerald ash borer, mountain pine beetle, buckthorn, oak wilt)
- Identification of optimal spatial scale(s) for coordinated management of forest resources
- New methods of risk evaluation to identify forest ecosystems most susceptible to change
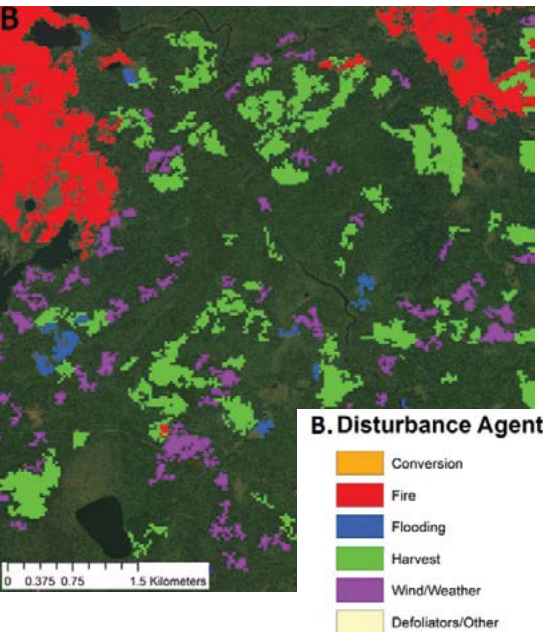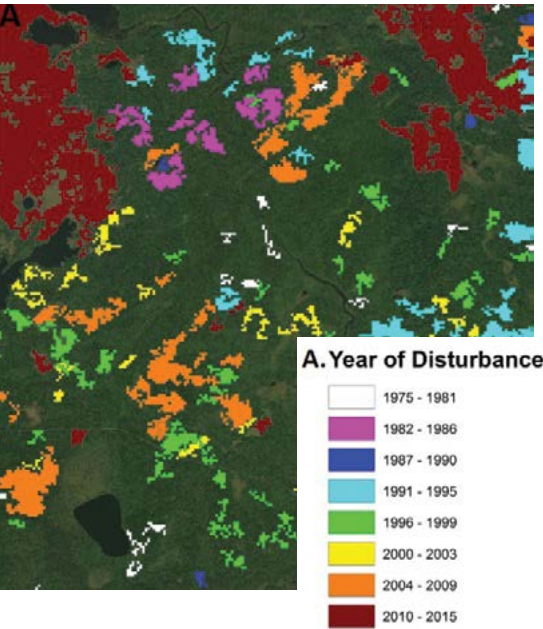
Priority:

Determining relationships between the spatial arrangement of forest conditions (age class structure, cover types, patch size distribution) and forest resources (e.g., fiber productivity, water, wildlife, biodiversity, soils, etc.)

Example topics:

- Optimal timber harvest arrangement to increase overall species-level diversity
- Thresholds of forest disturbance that cause changes in water quantity and quality
- Relationships between the number and size of forest gaps and wildlife (e.g., moose, early successional bird species)

Many of our natural resources are influenced by the conditions across the forested landscape. Determining how these conditions vary within a forest is possible with new technologies, but understanding how they influence resources requires more research. These figures show technologies for determining forest age and some of the factors driving overall forest condition. But our understanding of how those factors influence things like habitat, water, and timber are limited.

A. Year of Disturbance

	1975 - 1981
	1982 - 1986
	1987 - 1990
	1991 - 1995
	1996 - 1999
	2000 - 2003
	2004 - 2009
	2010 - 2015

B. Disturbance Agent

	Conversion
	Fire
	Flooding
	Harvest
	Wind/Weather
	Defoliators/Other

0 0.375 0.75   1.5 Kilometers

Theme:

Forest Management for the 21st Century

We have been managing forests in one form or another for a long time, using principles and practices developed over centuries. At the core of this knowledge is the practice of silviculture, which is the art and science of growing and managing a forest to achieve a defined set of outcomes or values. As our forests change, and new technologies become available for their assessment, there is a growing need to develop new approaches and techniques to guide silvicultural practices and achieve a wide array of resource benefits. Just as farmers adjust to new conditions and technologies, foresters must also adjust the way we manage our forests to effectively achieve sustainable resource supply into the future. The priority research areas below directly address this information need and will serve as a foundation for 21st century silviculture in Minnesota.

Priority:

Transformative methods for the collection and interpretation of forest and forest resources data (field and remotely–sensed) across ownerships and scales

Example topics:

- New methods for real-time assessment of forest change and its magnitude
- New techniques and systems for rapid, statewide forest inventory assessments
- New technologies for assessment of site-level conditions (e.g., soil nutrient status)

Priority:

Silvicultural approaches to address future conditions and traditionally underutilized or unmanaged species

Example topics:

- Novel silvicultural methods for lowland conifer ecosystems under multi-objective management
- Novel regeneration strategies to address unique conditions created by invasive species and changes in climate
- Development of adaptive Silvicultural systems for ecosystems most at risk to change
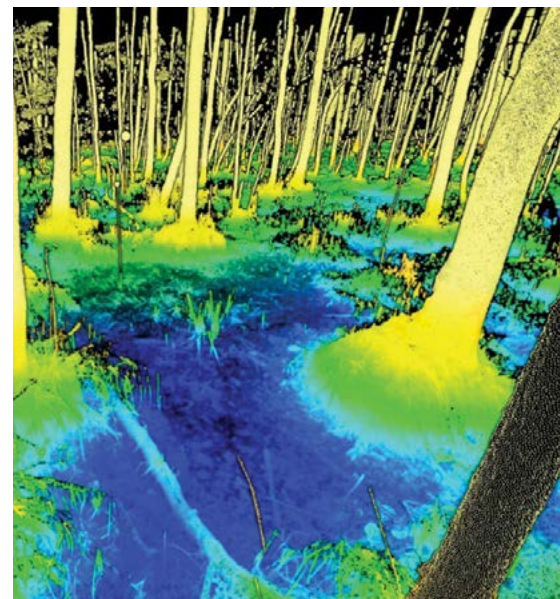
The advances in technology available to guide data collection and management are increasing, but knowledge of ways to translate the technology into implementation and impact need improvement. The image above shows how we can measure 3-D forest structure using new laser sensor technology. New research is needed to translate the imagery into information that can be used for forest management.

Changing climate is going to create many challenges for sustainable resource management including those related to tree regeneration and soil productivity. Evaluating how things like reduced snowpack influence soil productivity and regeneration are critical information needs to guide future management.

Priority:

Assessment and increased understanding of social systems and their integration in forest management.

Example topics:

- Collaborative approaches to multi-ownership management coordination (e.g., Shared Stewardship)
- Determine user values of forest landscapes and how management influences them
- Assess how future change in private land ownership will influence how private land is managed

Improved understanding of how we make the decisions that we make in natural resource management is needed to ensure that we are making the most informed decisions for the future.

Theme:

Enhancing Forest Economies: Forest Industry and Communities

Forest economies are an integral factor influencing why and how we manage our forests. Forest economies involve the production of forest products and forest industries, but also the communities that are directly dependent on forests and the jobs they support in mills, recreation, and tourism. Strengthening forest economies has great economic benefit to the state and forest-dependent communities, but it also allows us to effectively manage forests for resources and benefits other than wood fiber. Strong forest economies will provide the resources needed to manage forests and address the changing conditions that Minnesota forests face.

Strengthening forest economies is inherently dependent on the fundamental understanding of forest resources - their quality, quantity, and availability. Research can support forest economies by providing information to drive management decisions that are economical and also incorporate benefits such as clean water and biodiversity. Research can also help existing forest industries innovate and enhance their competitiveness in a global market, or promote the development of new technologies and the next generation of forest products. Targeted research will ensure that current and future forest economies, and the benefits they provide, are viable and grow into the future.

Priority:

Economic assessment of alternative management strategies to increase forest products, benefits, and use (situation-specific, small-scale)

Example topics:

- New approaches for cost-risk-benefit analysis of forest management strategies under current and emerging markets
- Advances in the valuation of non-market forest resources (e.g., carbon, water, cultural)
- Methods to promote financial investments in long-term forest productivity, benefits, and use

Priority:

Forest bioeconomy: approaches to strengthen current industry and create emerging value-added opportunities (broad drivers, macro scale)

Example topics:

- Increased utilization of traditionally non-merchantable wood
- Development of advanced biomaterials from forest biomass
- Utilization of regional species in advanced building applications

New markets and uses for underutilized species are essential to managing healthy forests. These black ash logs will be used for high-value wood products, but markets for ash are generally limited. Limited markets inhibit our ability to conduct management to mitigate the impacts of invasive species such as EAB. New market development based upon innovative approaches and technology is critical to have a future forest-based economy.

New forest products have potential to provide significant benefit to Minnesota's forest economies. Biochar (above), a product derived from wood that can be used to increase soil productivity and carbon sequestration, is one example of a new product that can benefit forest economies.

Determining essential ecosystem services provided to forest economies and their vulnerability to changes in future forest conditions

Example topics:

- Evaluate the susceptibility of aspen to changes in forest conditions and related implications for forest economies
- Identify tree species and genotypes best adapted to future climate conditions
- Determine how changes in forest cover and climate influence snowpack accumulation and related effects on water resources

Resilience Score

- 0 - 10
- 11 - 20
- 21 - 30
- 31 - 40
- 41 - 50
- 51 - 60
- 61 - 70
- 71 - 80
- 81 - 90
- 91 - 100
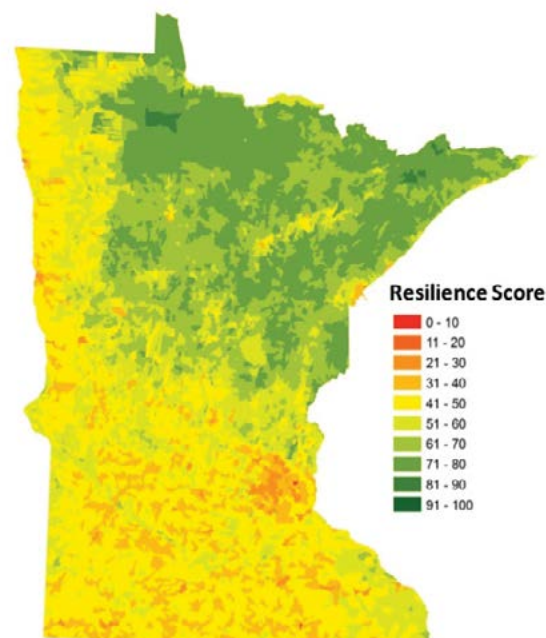
Depending on where they are, some forest dependent communities will be more susceptible to changing conditions than others. For example, evaluating potential changes to water resources can help us to identify at-risk forest communities and develop strategies for mitigation to maintain future water supply. Other factors, such as fire risk and fiber availability, are also likely to change in the future and influence community resilience.

Addressing Minnesota's Research Needs Together

Everyone can play a role in addressing our research needs, whether it be general vocal support for the work or more direct involvement in efforts to get it completed. Regardless the role each of us plays, working to maintain and expand the capacity for forest resources research is a fundamental need for success. The RAC feels strongly that research capacity can be increased with concerted efforts at improving collaboration among individuals, public and private organizations, and communities. Ensuring that existing research institutions and partners are consistently and sufficiently supported will promote collaboration by providing foundational resources and expertise to address our research needs. Support of these institutions and partners, combined with an inclusive start-to-finish commitment to collaboration, will position Minnesota for success in addressing the priority research needs and achieving a robust future.

Support for research institutions in Minnesota can lead to productive collaborations to address forest research priorities. For example, University of Minnesota's Cloquet Forestry Center can serve as a venue for research discussions and also provide infrastructure to support projects focused on forest research.

Key Research Entities

MN Invasive Terrestrial Plant and Pest Center

University of Minnesota

- Forest Resources
- Biosystems, Bioproducts, and Engineering
- Conservation Biology
- Institute on the Environment
- Extension

The Nature Conservancy

Natural Resources Research Institute

State of Minnesota

- Department of Natural Resources
- Pollution Control Agency
- Department of Agriculture

USDA Forest Service

- State and Private
- National Forest System
- Northern Research Station
- Experimental Forests

Wisconsin Department of Natural Resources

Closing

Our forests and the renewable resources they provide are critical to every Minnesotan, providing a host of benefits from clean water to renewable fiber and from wildlife habitat to clean air.

Research and the information generated from it drives responsible management of our forests, leading to informed decisions to address changing conditions and emerging forest threats related to climate change, invasive species, changing economies, and other factors. These challenges are not insurmountable. Sustained support for well-framed, focused research is critical now to be able to generate the information and technology needed to support tomorrow's healthy forests and evolving forest economies. The forest resources research priorities presented in this report identify critical information and technology needs and provide a path forward in sustaining forest resources into the future.

Appendix

Expert Panel Members and Associated Evaluation Topics

Topic: Native and invasive forest pests
Members: Brian Palik (USDA FS – Northern Research Station)
Rob Venette (UMN / USDA FS – Northern Research Station)

Topic: Water and forests
Members: Salli Dymond (UMN-D - Earth and Environmental Sciences)
Diana Karwan (UMN – Forest Resources)

Topic: Forest resources and climate change
Members: Stephen Handler (USDA FS – Northern Research Station)
Rebecca Montgomery (UMN – Forest Resources)

Topic: Silviculture and operational management
Members: Paul Dubuque (MN DNR – Forestry)
Sawyer Scherer (UPM – Blandin Paper)
Marcella Windmuller-Campione (UMN – Forest Resources)

Topic: Forest biodiversity
Members: Emily Peters (MN DNR – Ecological and Water Resources)
Mike Houser (Potlatch Corporation)

Topic: Wildlife habitat and management
Members: Alexis Grinde (Natural Resources Research Institute)
Mike Larson (MN DNR – Fisheries and Wildlife)

Topic: Soil and forest productivity
Members: Randy Kolka (USDA FS – Northern Research Station)
George Host (Natural Resources Research Institute)
Christian Nelson (Fond du Lac Resource Management)

Topic: Forest products, bio-based economy
Members: Shri Ramaswamy (UMN – Bioproducts Biosystems Engineering)
Eric Singsaas (Natural Resources Research Institute)

Topic: Topics related to forest economics
Members: Bonnie Keeler (UMN – Institute on the Environment)
Mike Kilgore (UMN – Forest Resources)

Topic: Social aspects of forest resource management
Members: Mae Davenport (UMN – Forest Resources)
Stephanie Snyder (USDA FS – Northern Research Station)

Topic: New technology for forest resource assessment
Members: Jennifer Corcoran (MN DNR – Resource Assessment)
Joe Knight (UMN – Forest Resources)

Topic: Forest recreation and tourism
Members: Nathan Heibel (Koochiching County Land and Forestry)
Ingrid Schneider (UMN – Forest Resources)

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