
USDA
U.S. Department of Agriculture
Future Forests
of the
Northern United States

Suggested Citation

Shifley, Stephen R.; Moser, W. Keith, eds. 2016. Future Forests of the Northern United States. Gen. Tech. Rep. NRS-151. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northern Research Station. 388 p.

Quality Assurance

This publication conforms to the Northern Research Station's Quality Assurance Implementation Plan, which requires technical and policy review for all scientific publications produced or funded by the Station. The process included a blind technical review by at least two reviewers, who were selected by the Assistant Director for Research and unknown to the author. This review policy promotes the Forest Service guiding principles of using the best scientific knowledge, striving for quality and excellence, maintaining high ethical and professional standards, and being responsible and accountable for what we do.

Manuscript received for publication: May 2014

Published by:
USDA Forest Service
Northern Research Station
11 Campus Blvd, Suite 200
Newtown Square, PA 19073

February 2016

For additional copies:
U.S. Forest Service
Publications Distribution
359 Main Road
Delaware, OH 43015
Fax: 740-368-0152
Email: nrspub@fs.fed.us

Visit our homepage at: http://www.nrs.fs.fed.us

Future Forests of the Northern United States

Stephen R. Shifley and W. Keith Moser, editors

Chapter Authors

FRANCISCO X. AGUILAR, ASSOCIATE PROFESSOR
School of Natural Resources
203 Anheuser-Busch Natural Resources Building
University of Missouri-Columbia
Columbia, MO 65211
aguilarf@missouri.edu

J. M. BOWKER, RESEARCH SOCIAL SCIENTIST
Southern Research Station, U.S. Forest Service
320 Green Street
Athens, GA 30602
mbowker@fs.fed.us

BRETT J. BUTLER, RESEARCH FORESTER
Northern Research Station, U.S. Forest Service
160 Holdsworth Way
Amherst, MA 01003
bbutler01@fs.fed.us

PETER V. CALDWELL, RESEARCH HYDROLOGIST
Southern Research Station, U.S. Forest Service
Center for Watershed Research
Coweeta Hydrological Lab
3160 Coweeta Lab Road
Otto, NC 28736
pcaldwell02@fs.fed.us

RYAN D. DESANTIS, POSTDOCTORAL RESEARCH ASSOCIATE
Department of Forestry, University of Missouri and
Northern Research Station, U.S. Forest Service
1992 Folwell Avenue
St. Paul, MN 55108
Currently: Forestry/Natural Resources Advisor
University of California Cooperative Extension
1851 Hartnell Avenue
Redding, CA 96002
rdesantis@ucanr.edu

BRENT DICKINSON, FORMER RESEARCH FELLOW
Family Forest Research Center
University of Massachusetts Amherst
160 Holdsworth Way
Amherst, MA 01003
bdickinson@som.umass.edu

MARLA R. EMERY, RESEARCH GEOGRAPHER
Northern Research Station, U.S. Forest Service
Aiken Center, Room 303E
81 Carrigan Drive
Burlington, VT 05405
memery@fs.fed.us

JAMES D. GARNER, WILDLIFE BIOLOGIST
Northern Research Station, U.S. Forest Service
1992 Folwell Avenue
St. Paul, MN 55108
jamesdgarner@fs.fed.us

MICHAEL E. GOERNDT, POSTDOCTORAL FELLOW
School of Natural Resources
203 Anheuser-Busch Natural Resources Building
University of Missouri-Columbia
Columbia, MO 65211
Currently: Assistant Professor
Missouri State University
William H. Darr School of Agriculture
901 S. National Avenue
Springfield, MO 65897
mgoerndt@missouristate.edu

DALE D. GORMANSON, FORESTER
Northern Research Station, U.S. Forest Service
1992 Folwell Avenue
St. Paul, MN 55108
dgormanson@fs.fed.us

ERIC J. GREENFIELD, FORESTER
Northern Research Station, U.S. Forest Service
c/o SUNY ESF, 5 Moon Library
1 Forestry Drive
Syracuse, NY 13210
ejgreenfield@fs.fed.us

ROBERT J. HUGGETT, JR., RESEARCH ASSISTANT PROFESSOR
North Carolina State University
College of Natural Resources
Department of Forestry and Environmental Resources
Raleigh, NC 27695
Currently: 128 Benedict Lane
Raleigh, NC 27614
bobby.huggett@gmail.com

RUHONG LI, RESEARCH ASSOCIATE
North Carolina State University
College of Natural Resources
Department of Forestry and Environmental Resources
Raleigh, NC 27695
rnli@ncsu.edu

PATRICK D. MILES, RESEARCH FORESTER
Northern Research Station, U.S. Forest Service
1992 Folwell Avenue
St. Paul, MN 55108
pmiles@fs.fed.us

W. KEITH MOSER, RESEARCH FORESTER AND SCIENTIST-IN-CHARGE
Fort Valley Experimental Forest
Rocky Mountain Research Station, U.S. Forest Service
2500 South Pine Knoll Drive
Flagstaff, AZ 86001
wkmoser@fs.fed.us

MARK D. NELSON, RESEARCH FORESTER
Northern Research Station, U.S. Forest Service
1992 Folwell Avenue
St. Paul, MN 55108
mdnelson@fs.fed.us

DAVID J. NOWAK, RESEARCH FORESTER
Northern Research Station, U.S. Forest Service
c/o SUNY ESF, 5 Moon Library
1 Forestry Drive
Syracuse, NY 13210
dnowak@fs.fed.us

CHARLES H. PERRY, RESEARCH SOIL SCIENTIST
Northern Research Station, U.S. Forest Service
1992 Folwell Avenue
St. Paul, MN 55108
charleshperry@fs.fed.us

RACHEL RIEMANN, RESEARCH FORESTER/GEOGRAPHER
Northern Research Station, U.S. Forest Service
c/o U.S. Geological Survey
425 Jordan Road
Troy, NY 12180
rriemann@fs.fed

TITUS S. SEILHEIMER, FISHERIES SPECIALIST
University of Wisconsin-Manitowoc
705 Viebahn Street, Room F103
Manitowoc, WI 54220
tseilheimer@aqua.wisc.edu

STEPHEN R. SHIFLEY, RESEARCH FORESTER
Northern Research Station, U.S. Forest Service
202 Anheuser-Busch Natural Resources Building
University of Missouri-Columbia
Columbia, MO 65211
sshifley@fs.fed.us

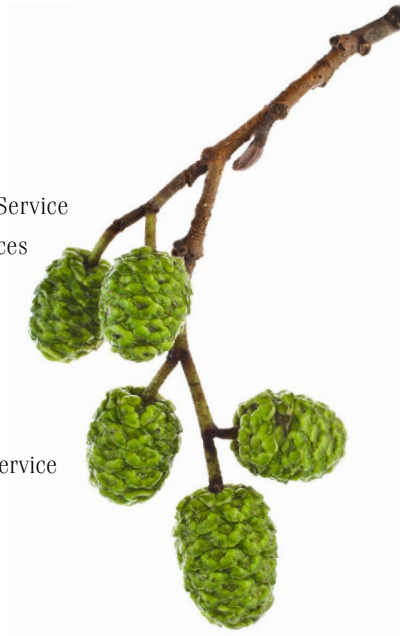
KENNETH E. SKOG, SUPERVISORY RESEARCH FORESTER
Forest Products Laboratory, U.S. Forest Service
One Gifford Pinchot Drive
Madison, WI 53726
kskog@fs.fed.us

NIANFU SONG, RESEARCH ASSOCIATE
School of Natural Resources
203 Anheuser-Busch Natural Resources Building
University of Missouri-Columbia
Columbia, MO 65211
songn@missouri.edu

AIMEE STEPHENS, FORESTER
Northern Research Station, U.S. Forest Service
21235 Alberta Avenue Suite 1
L'anse, MI 49946
alstephens@fs.fed.us

GE SUN, RESEARCH HYDROLOGIST
Southern Research Station, U.S. Forest Service
920 Main Campus Drive
Venture Center 2, Suite 300
Raleigh, NC 27606
gesun@fs.fed.us

BRIAN G. TAVERNIA, POSTDOCTORAL FELLOW
School of Natural Resources, University of Missouri-Columbia
and Northern Research Station, U.S. Forest Service
Currently: Spatial Scientist
The Nature Conservancy, Colorado Field Office
2424 Spruce Street
Boulder CO 80302
brian.tavernia@tnc.org



DAVID N. WEAR, PROJECT LEADER
Southern Research Station, U.S. Forest Service
PO Box 8008, College of Natural Resources
North Carolina State University
Raleigh, NC 27695
dwear@fs.fed.us

B. TYLER WILSON, RESEARCH FORESTER
Northern Research Station, U.S. Forest Service
1992 Folwell Avenue
St. Paul, MN 55108
barrywilson@fs.fed.us

SHERRI WORMSTEAD, SUSTAINABILITY AND PLANNING COORDINATOR
Northeastern Area, State and Private Forestry
U.S. Forest Service
271 Mast Road
Durham, NH 03824
swormstead@fs.fed.us

ABSTRACT

The U.S. North—the 20 states bounded by Maine, Maryland, Missouri, and Minnesota—have a greater forest cover (42 percent of land area) and population density (194 people per square mile) than other large regions of the nation. Ecological, social, and economic changes anticipated over the next 50 years will profoundly affect future forest management needs and opportunities in the North. This report draws on data from numerous sources to analyze 13 scenarios that consider future forest change in response to assumptions about land-use change, economic change, greenhouse gas emissions, climate change, forest growth, forest harvest, and other factors. Results are organized using the Montréal Process Criteria and Indicator framework. Important trends for the U.S. North over the next 50 years include the following:

- Forest area is projected to decrease between 3.5 and 6.4 percent with losses concentrated around existing urban and suburban areas.
- Forest area is currently concentrated in the 40-to-80-year age class and is expected to increase in mean age over time, resulting in a paucity of early-successional habitats and low structural forest diversity.
- Closed-canopy habitat classes are expected to gain acreage at the expense of open-canopy habitat classes.
- The historical trend of steadily increasing live wood volume over time is projected to level off or decline under all scenarios, with little variation attributable to differing assumptions about future climate conditions.
- The area of the maple-beech-birch forest-type group is expected to increase relative to nearly all other groups.
- Projected forest removals resulting from land-use changes are likely to average about 13 percent of total removals, with the remainder resulting from harvesting; in some populous Eastern States, removals resulting from land-use changes could exceed 50 percent of all removals.
- Forests are under the expanding negative influence of numerous invasive species including emerald ash borer, Asian longhorned beetle, spruce budworm, Sirex woodwasp, winter moth, hemlock woolly adelgid, beech bark disease, gypsy moth, and dozens of invasive plants.
- Across the North, 76 million people depend on public and private forests for high quality water supplies.
- On average, the amount of water needed to meet societal demands is projected to increase and the supply of

high quality water is projected to decline, but water supplies for most watersheds would remain adequate.

- Aboveground forest biomass is expected to increase by about 4 percent, but total carbon sequestered by northern forests (including soils) is expected to decrease by about 2 percent, primarily as the result of reduced forest acreage combined with slower tree growth that is typical for aging forests.
- By 2030, U.S. electrical power generated from all biomass is expected to increase 350 percent over 2010 levels, but in Northern States biomass will still be used for less than 6 percent of total electric production, often by co-firing biomass and coal.
- Forest-associated employment has declined in the past decade, and real-dollar wages in forestry have been relatively constant, but productivity per employee is increasing.
- The North is the location of nearly all commercial U.S. maple syrup production—about 2.5 million gallons valued at about $90 million annually.
- Projected population increases in the North are expected to cause Federal and State park land area per capita to decrease by 19 percent and non-Federal forest land area per capita to decrease by 26 percent.
- Of all tax policies, those governing property taxes have the greatest potential to influence the behavior of family forest owners. However, future tax policies will likely hinge on issues that are larger than forestry.
- Partnerships among various institutions and organizations have become increasingly common for addressing large-scale, complex issues. This trend is likely to continue.
- U.S. urban tree cover is estimated at 35 percent but is declining in many cities.
- By 2050, urban land is expected to increase to about 8 percent in the conterminous United States and to 14 percent in the North.
- Practices that can support future management for sustainable, resilient northern forests include strengthening connections between rural and urban forest habitats and people; developing mutually beneficial partnerships among all stakeholders to support shared conservation goals; developing measurable State and regional goals for forest diversity and monitoring progress toward achieving them; promoting forward-looking forest management across all forest ownerships; and working to understand the many dimensions of expected forest change.

Key Words: climate change, land use change, biodiversity, Montréal Process, forest health, forest industry, invasive species, biomass, bioenergy, sustainable timber products, nontimber forest products, private forest owners, watershed, urban forest

Acknowledgments

This document draws on data and maps from many sources. Principal among these sources is the U.S. Forest Service, Forest Inventory and Analysis data set, which spans 60 years of forest change. These data have been collected by numerous field-going personnel, often working in adverse conditions. We have drawn inspiration from the Southern Forest Futures Project of the U.S. Forest Service, Southern Research Station. We have utilized methods and data prepared by the many contributors to the Forest Service 2010 Resources Planning Act Assessment.

We owe special thanks to Michael Rains, Director of the Northern Research Station and the Forest Products Laboratory of the U.S. Forest Service. He is a visionary leader in the Forest Service and among the broader natural resource community where for nearly five decades he has been *caring for the land and serving people* where they live. It was his vision and drive that initiated the Northern Forest Futures Project—a collaboration that laid the foundation for this report and many associated products.

We have been the beneficiaries of encouragement, advice, and constructive reviews from the administrators of State forestry and natural resource agencies, including their expert staffs and the Northeastern Area Association of State Foresters. Tom Schmidt, Dennis May, and Deb Dietzman of the U.S. Forest Service Northern Research Station consistently provided financial support, insight, and encouragement over many years. Susan Wright, Carol Whitlock, Amy Scherzer, and Rhonda Cobourn provided the editorial expertise and polish necessary to turn our technical manuscript into an attractive, coherent, and highly readable finished publication. Jim Lootens-White developed the Web interface that elegantly provides interactive access to the data and results.

Publication design was by Red, Inc. Communications, Idaho Falls, Idaho.

We thank them all

CONTENTS