USDA
United States Department of Agriculture

RESOURCE UPDATE FS-115

Forests of Minnesota, 2016

This resource update provides an overview of forest resources in Minnesota based on an inventory conducted by the USDA Forest Service, Forest Inventory and Analysis (FIA) program within the Northern Research Station in cooperation with the Minnesota Department of Natural Resources. Estimates are based on field data collected during measurement years 2012-2016 with comparisons made to field data collected in 2007-2011. The 2012-2016 sample data consist of 6,176 field measured plots on forest land, with 20 percent collected per year. Data used in this publication were accessed from the FIA database in March 2017 based on methods described in Bechtold and Patterson (2005) and O'Connell et al. (2016).

Overview

The Minnesota forest land area estimate increased by 221 thousand acres (1.3 percent) from 2011 to 2016 (Table 1). Just under 35 percent of Minnesota's land area is classified as forest land. The number of live trees on Minnesota's forest land in 2016 was estimated at 14.7 billion trees, an increase of 7.3 percent from 2011. Live tree aboveground biomass and net volume increased on both forest land and timberland. Annual mortality of live trees on forest land is approximately 1.8 percent of the 2016 forest land live tree volume. The 2016 harvest removal rate of growing-stock on timberland is 14.8 percent below the 2011 harvest removal rate. Harvest removals were 1.3 percent of timberland growing-stock volume in the 2011 report but are now just 1.0 percent of the timberland growing-stock volume.

Table 1.—Minnesota forest statistics. Current and previous sampling errors and error bars shown in tables and figures represent 68-percent confidence intervals.

	2016 Estimate	Sampling error (percent)	2011 Estimate	Sampling error (percent)	Change since 2011 (percent)
Forest Land					
Area (thousand acres)	17,591.7	0.5	17,370.4	0.5	1.3
Number of live trees ≥ 1 in diameter (million trees)	14,727.7	1.1	13,731.6	1.2	7.3
Aboveground biomass of live trees ≥ 1 in (thousand oven-dry tons)	507,912.5	0.9	473,792.4	1.0	7.2
Net volume of live trees ≥ 5 in diameter (million ft^3)	20,035.6	1.1	18,626.4	1.2	7.6
Annual net growth live trees ≥ 5 in (thousand ft^3/yr)	445,452.8	3.2	405,010.7	3.4	10.0
Annual mortality of live trees ≥ 5 in (thousand ft^3/yr)	357,510.5	3.0	352,163.0	2.5	1.5
Annual harvest removals of live trees ≥5 in (thousand ft3/yr)	214,518.3	6.6	233,270.8	6.2	-8.0
Annual other removals of live trees ≥5 in (thousand ft3/yr)	10,995.1	23.8	9,295.8	26.9	18.3
Timberland					
Area (thousand acres)	15,815.4	0.6	15,621.4	0.6	1.2
Number of live trees ≥ 1 in diameter (million trees)	13,180.3	1.2	12,389.6	1.2	6.4
Aboveground biomass of live trees ≥ 1 in (thousand oven-dry tons)	463,884.7	1.0	431,577.1	1.1	7.5
Net volume of live trees ≥ 5 in diameter (million ft^3)	18,226.7	1.1	16,868.2	1.3	8.1
Net volume of growing stock trees (million ft^3)	15,820.2	1.2	14,434.6	1.3	9.6
Annual net growth of growing stock trees (thousand ft^3/yr)	412,935.8	2.4	359,883.9	2.9	14.7
Annual mortality of growing stock trees (thousand ft^3/yr)	221,986.3	2.8	244,260.1	2.6	-9.1
Annual harvest removals of growing stock trees (thousand ft^3/yr)	177,874.3	6.9	208,657.9	6.2	-14.8
Annual other removals of growing stock trees (thousand ft^3/yr)	13,093.2	22.1	13,099.1	19.3	0.0

Forest Area

Minnesota's presettlement area of forest land was estimated to be 31.5 million acres (Marschner 1930). By the time of the first forest inventory in the mid-1930s, the area of forest land had declined to 19.6 million acres (Fig. 1). For the most part, the area of forest land declined over the next 70 years. Over the past 13 years (from 2003 to 2016), the area of forest land has increased by 1.4 million acres. Some of the increase in estimated forest land area is due to improved digital imagery and remote sensing techniques (Miles and VanderSchaaf 2012) rather than actual reversion to forest land.

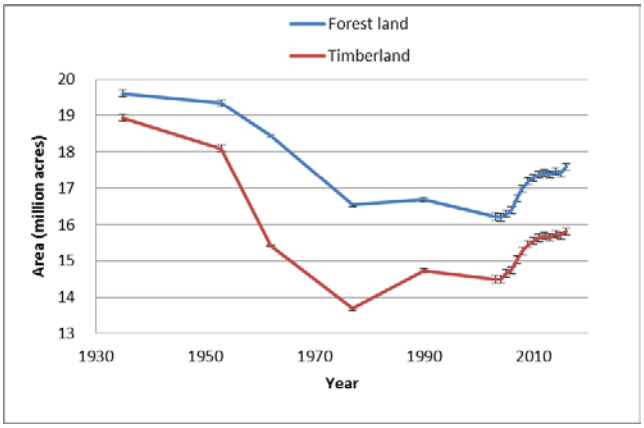

Figure 1.—Area of forest land and timberland by year, Minnesota 1935-2016.

Most of the forest land in Minnesota is in the northern and eastern parts of the State (Fig. 2). The western and southern parts of Minnesota were primarily in prairie and oak savannah in presettlement times.

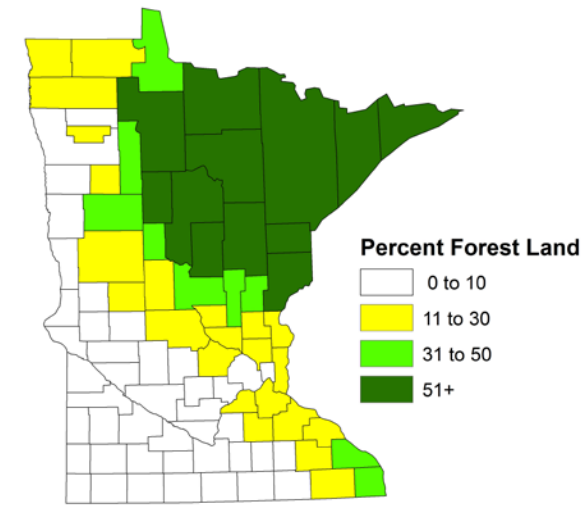

Figure 2.—Percent forest land by county, Minnesota, 2013.

The aspen/birch and spruce/fir forest-type groups occupy the largest proportion of forest land in Minnesota at 6.4 and 4.3 million acres respectively (Fig. 3). Approximately 42 percent of the aspen/birch forest-type group is currently in the small diameter stand-size ensuring continued growth in the aspen/birch type. Conversely only 8 percent of the oak/hickory forest-type group is in the small diameter stand-size raising concerns about the adequacy of oak regeneration.

Over half (54 percent) of the spruce/fir forest-type group is in the small diameter stand-size class but this is generally because of poor site conditions. Only 20 percent of the spruce/fir forest-type group acreage is capable of producing 50 cubic feet/acre/year as compared to 58 percent for the other type groups. Most of the small diameter spruce/fir acreage (73 percent) has a stand age of over 40 years and 16 percent of the small diameter spruce/fir forest-type group has a stand-age of over 100 years.

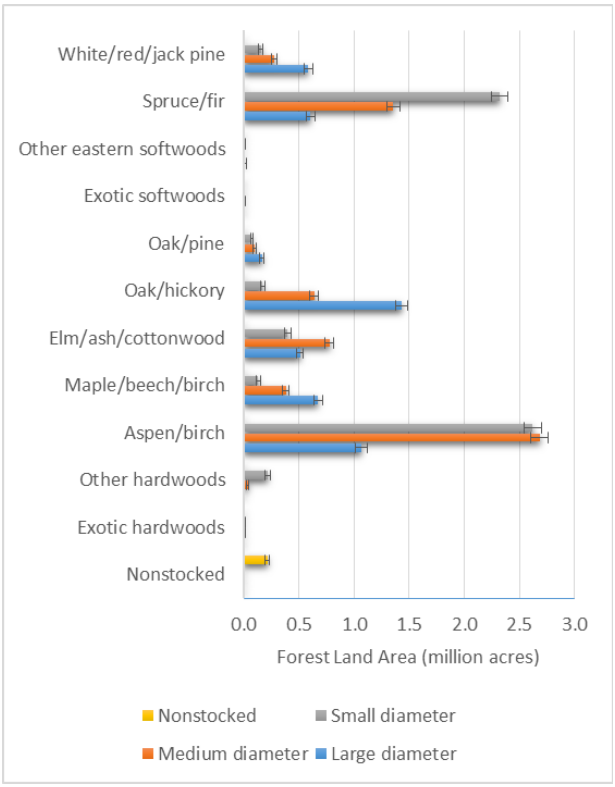

Figure 3.—Area of forest land by forest-type group and stand-size class, Minnesota, 2016.
Note**:** Large-diameter stands: a plurality of stocking is in hardwoods 11 inches d.b.h. and larger and softwoods 9 inches d.b.h. and larger
Medium-diameter stands: a plurality of stocking is in softwood trees from 5 to 9 inches and hardwood trees from 5 to 11 inches d.b.h.
Seedling-sapling stands: a plurality of stocking is in trees less than 5 inches.

Volume, Biomass, and Trends

FIA field crews recorded trees of 71 species on Minnesota forest land during the 2016 inventory. Two-thirds of Minnesota's 20.0 billion cubic feet of live tree volume on forest land is represented by just 10 species (Table 2). Quaking aspen (*Populus tremuloides*) has a plurality of the volume in Minnesota followed by northern white-cedar (*Thuja occidentalis*) and red pine (*Pinus resinosa*). The growing-stock volume of paper birch (*Betuala papyrifera*) decreased by 6.5 percent from 2011 to 2016 while the volume of red pine increased by 13.0 percent over the same period. Paper birch is a short-lived species while red pine has a much longer life span, so these volume changes are plausible, especially given the high rate of paper birch mortality and the large amount of red pine planting in the 1970s and 1980s.

The aboveground live tree biomass on forest land increased from 473.8 million short tons in 2011 to 507.9 million short tons in 2016. Most aboveground tree biomass is in the bole (64 percent), followed by saplings (16 percent), tops and limbs (16 percent), and stumps (4 percent).

Annual net growth is equivalent to annual gross growth less annual mortality. Therefore, because annual net growth of growing-stock on timberland exceeds annual removals of growing-stock on timberland, we expect that the volume of growing-stock on timberland would have increased over the remeasurement period; and that is indeed the case. Growing-stock volume on timberland increased from 14.4 billion cubic feet in 2011 to 15.8 billion cubic feet in 2016.

Table 3.— Average annual net growth, annual mortality, and annual removals of growing stock on timberland as a percentage of current growing-stock volume on timberland, Minnesota, 2016.

Major species group	Average annual net growth (%)	Annual mortality (%)	Annual removals (%)
Pines	3.1	0.5	1.1
Other softwoods	2.1	1.7	0.9
Soft hardwoods	2.6	1.8	1.4
Hard hardwoods	2.0	0.7	0.4
Total	2.4	1.4	1.1

Annual net growth of growing-stock on timberland exceeds removals of growing-stock on timberland for all four major species groups in Minnesota. Growth, removals, and mortality are often expressed as a percent of current volume to facilitate comparisons (Table 3). Higher mortality rates in the soft hardwoods major species group are partially due to the short-lived nature of pioneer species such as aspen and paper birch.

Harvest removal rates, as a percent of growing-stock volume on timberland, vary by ownership. Rates are highest (1.8 percent) on State and county lands, followed by private ownerships (0.9 percent). Harvest removals are lowest on National Forest and other Federal timberland (0.3 percent).

Mortality rates as a percent of growing-stock volume are nearly identical for all three ownership groups at 1.4 percent. Mortality rates for hardwoods (1.5 percent) are slightly higher than softwoods (1.3 percent).

Table 2.—Top 10 tree species by statewide volume estimates on forest land and timberland, Minnesota, 2016.

Rank	Species	Volume of live trees on forest land (million ft^3)	Sampling error (%)	Change since previous inventory	Volume of sawtimber trees on timberland (million board feet)	Sampling error (%)	Change since 2011 (%)
1	quaking aspen	3,679.4	2.5	6.4	6,714.7	4.0	9.1
2	northern white-cedar	1,321.6	5.8	16.4	3,379.3	7.5	20.0
3	red pine	1,303.6	6.5	13.0	5,107.0	7.2	17.9
4	bur oak	1,177.3	4.5	14.0	2,449.5	6.5	22.9
5	paper birch	1,092.1	3.4	(6.5)	1,238.6	5.9	6.8
6	black ash	1,069.0	4.4	5.3	1,642.0	6.6	17.5
7	American basswood	1,026.4	4.8	5.4	2,722.0	6.2	11.1
8	black spruce	948.3	4.6	1.6	906.9	7.8	4.6
9	northern red oak	931.1	5.3	(2.7)	2,857.4	6.4	1.8
10	balsam fir	776.9	3.2	10.3	1,187.0	5.4	3.0
	Other softwoods	2,352.9	3.7	9.2	6,121.8	4.7	12.1
	Other hardwoods	4,357.0	2.6	10.5	7,252.1	4.4	22.0
	Total	20,035.6	1.1	7.6	41,578.2	1.8	13.8

Native Bark Beetle Activity

An outbreak of eastern larch beetle (*Dendroctonus simplex*; ELB), which began in 2000, is currently impacting Minnesota's tamarack resource. There are an estimated 746.4 million tamarack trees (greater than 1 inch diameter) on forest land. Since 2000, mortality of tamarack growing stock has climbed, increasing fourfold by 2013 (Fig. 4). Tamarack largely occurs on wetland sites and in pure stands, thus continued spread of ELB has implications for watershed health and future species composition.

Introduction of mountain pine beetle (*Dendroctonus ponderosae*; MPB) from the western United States is a growing concern in Minnesota. Recent spread of MPB into northern Alberta, Canada, where hybrid and pure jack pine occur, suggests that MPB may have an available route into the State and that it could negatively impact eastern pine species (Clark et al. 2014). MPB could also be introduced via imported pine logs or firewood with bark containing MPB from western states.

Minnesota has an estimated 362.4 million trees (greater than 1 inch diameter) of its native pine specie, jack, red, and eastern white pine, and two exotic species, Austrian and Scotch pine. As pine species are important to Minnesota's forests and forest products industry, continued research and monitoring will help identify future impacts of this insect.

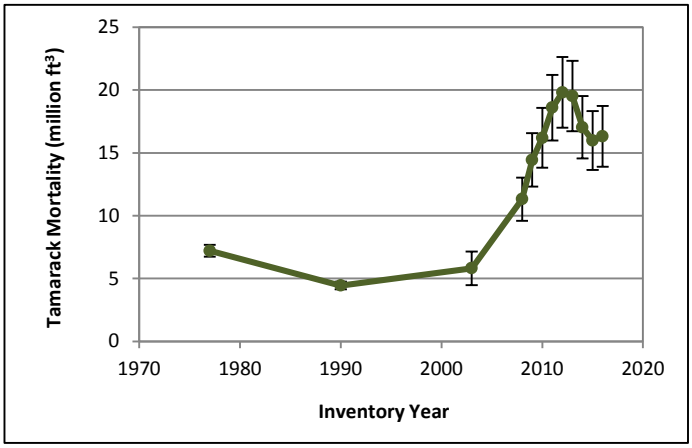

Figure 4.—Average annual mortality of tamarack growing-stock on timberland by year, Minnesota, 2016.

References

Bechtold, W.A.; Patterson, P.L., eds. 2005. **The enhanced Forest Inventory and Analysis program: national sampling design and estimation procedures.** Gen. Tech. Rep. SRS-80. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station. 85 p.

Clark, E.L.; Pitt, Caitlin; Carroll, A.L.; Lindgren, B.S.; Huber, D.P.W. 2014 **Comparison of lodgepole and jack pine resin chemistry: implications for range expansion by the mountain pine beetle, *Dendroctonus ponderosae* (Coleoptera: Curculionidae)**. PeerJ. 2:e240. https://doi.org/10.7717/peerj.240.

O'Connell, B.M.; Conkling, B. L.; Wilson, A.M. [et. al.]. 2016 **The Forest Inventory and Analysis database: database description and user guide for Phase 2 (ver. 6.1.1).** Washington, DC: U.S. Department of Agriculture, Forest Service. 870 p. https://www.fia.fs.fed.us/library/database-documentation/current/ver611/FIADB_User_Guide_P2_6-1-1_final.pdf.

Marschner, F.J. 1930. **The original vegetation of Minnesota.** Map derived from General Land Office field notes. Bureau of Agricultural Economics.

Miles, P.D., VanderSchaaf, C.L. 2012. **Minnesota's forest resources, 2012**. Res. Note NRS-175. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northern Research Station. 4 p.

Speight, M.R.; Wainhouse, D. 1989. **Ecology and management of forest insects.** New York, NY: Oxford University Press.

Metadata

Information published in this report and in related tables is based on the Forest Inventory and Analysis database (FIADB) version 1.7.0.00. FIADB data can be obtained from the FIA DataMart (https://apps.fs.fed.us/fiadb-downloads/datamart.html). Due to occasional changes to the FIADB, trend analyses should be made using FIA's online estimation tools, not by comparing published reports or tables. FIA estimates, tabular data, and maps may be generated at https://www.fia.fs.fed.us/tools-data/index.php

How to Cite This Publication
Miles, Patrick D.; Crocker, Susan J.; Walters, Brian F.; Kepler, Dennis. 2017. **Forests of Minnesota, 2016.** Resource Update FS-115. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northern Research Station. 4 p.

Contact Information
Patrick D. Miles, Research Forester
USDA Forest Service, Northern Research Station
1992 Folwell Ave.
St. Paul, MN 55108
Ph: 651-649-5146 / Fax:651-649-5140 / pmiles@fs.fed.us
Northern FIA: http://nrs.fs.fed.us/fia/
National FIA: http://fia.fs.fed.us

The published report is available online at http://treesearch.fs.fed.us