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RESOURCE UPDATE FS-119

Forests of Vermont, 2016

This publication provides an overview of forest resources in Vermont based on inventories conducted by the U.S. Forest Service, Forest Inventory and Analysis (FIA) program of the Northern Research Station. For annual inventory years 2003-2013, the sample length was equal to 5 years. Beginning in 2014, the cycle length was changed to 7 years. For the 2016 inventory, estimates for current variables such as area, volume, and biomass are based on 1,122 plot samples (926 forested) collected from 2011-2016. Change variables, such as net growth, removals, and mortality, are based on 961 samples (769 forested) collected in 2004-2010 and resampled in 2011-2015. Estimates from earlier annual and periodic inventories are shown for comparison. See Bechtold and Patterson (2005), O'Connell et al. (2013), and Gormanson et al. (2017) for definitions and technical details.

Overview

Currently, Vermont is home to over 4.5 million acres of forest land (Table 1), which make its land approximately 76 percent forested. Since the 1997 inventory, the forest land estimate has been relatively stable. However, the volume and biomass of trees has risen (Table 1; Morin et al. 2015). The sampling errors pertain to the point-in-time estimates only and are not indicative of the statistical significance of changes between two points in time. Average annual net growth, mortality, and removals have higher sampling errors than the other statistics, indicating higher uncertainty in trend estimates. A 4-year remeasurement period is presented for the estimates in Table 1 because 2012 was the first complete cycle available for growth, removals, and mortality.

Note: Net volume is defined as gross volume in cubic feet less deductions for rot, roughness, and poor form from a 1-foot stump to a minimum 4.0-inch top diameter. Biomass is defined as the aboveground weight of wood and bark in live trees 1.0 inch diameter and larger from the ground to the tip of the tree, excluding all foliage.

Table 1.—Vermont forest statistics, 2012 and 2016. Volumes are for trees 5 inches and larger in diameter. Number of trees and biomass are for trees 1 inch and larger in diameter. Sampling errors and error bars shown in tables and figures in this report represent 68 percent confidence intervals.

	2016 Estimate	Sampling error (percent)	2012 Estimate	Sampling error (percent)	Change since 2012 (percent)
Forest Land					
Area (thousand acres)	4,509	1	4,596	1	-1.9
Number of live trees (million trees)	3,424	2.8	3,486	2.6	-1.8
Aboveground biomass of live trees (thousand oven-dry tons)	285,050	1.6	284,117	1.6	0.3
Net volume of live trees (million ft^3)	10,535	1.8	10,514	1.8	0.2
Annual net growth of live trees (thousand ft^3/yr)	173,427	5.4	191,094	5.4	-9.2
Annual mortality of trees (thousand ft^3/yr)	119,833	6.1	111,203	5.7	7.8
Annual harvest removals of live trees (thousand ft^3/yr)	87,375	13.9	97,187	14.1	-6.8
Timberland					
Area (thousand acres)	4,279	1.2	4,340	1.2	-1.4
Number of live trees (million trees)	3,247	2.9	3,294	2.8	-1.4
Aboveground biomass of live trees (thousand oven-dry tons)	269,184	1.8	266,715	1.8	0.9
Net volume of live trees (million ft^3)	9,963	2	9,884	1.8	0.8
Net volume of growing stock trees (million ft^3)	8,683	2.1	8,749	2.1	-0.8
Annual net growth of growing stock trees (thousand ft^3/yr)	157,681	4	183,375	4	-14
Annual mortality of growing stock trees (thousand ft^3/yr)	77,151	6.3	68,572	6	12.5
Annual harvest removals of growing stock trees (thousand ft^3/yr)	71,355	14.2	78,054	14.2	-8.6

Forest Area

Although Vermont's current area of forest land has been relatively stable since the late 1990s, there has been a gradual decline in forest area since 2012 that has resulted in a 1.9 percent decrease (Table 1, Fig. 1). Timberland accounts for 95 percent of forest land or 4.3 million acres. Slightly less than 5 percent of forest land is reserved from timber production or is unproductive. Vermont's total land area is 5.9 million acres (excluding census water, e.g., Lake Champlain).

Vermont's area and proportion of forest land is nearly equal between the Northern and Southern FIA Units (Fig. 2). However the Southern Unit has more than double the proportion of forest land in public ownership (28 percent) when compared with the Northern Unit (13 percent).

Maple/beech/birch is the dominant forest-type group, covering 71 percent of the forest land (Fig. 3). In fact, the maple/beech/birch group makes up over 50 percent of the forest land area in every county except Grand Isle.

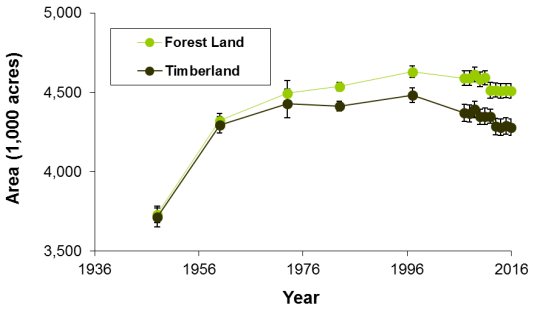

Figure 1.—Forest land and timberland by year, Vermont.

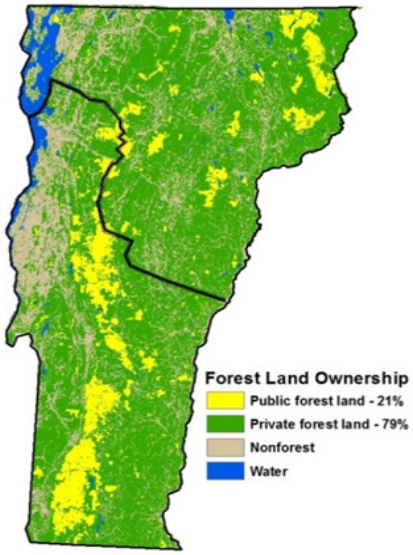

Figure 2.—FIA unit boundary and area of forest/nonforest with forest identified by major ownership group, Vermont, 2013. The boundary between the North and South FIA Units is shown with a heavy black line.

White/red pine and spruce/fir are the most abundant softwood forest-type groups. Together they account for 16 percent of the forest land in the State. The white pine and oak/pine forest type-groups have the highest levels of private ownership at 93 and 92 percent, respectively.

Families and individuals, corporations, and other private entities own most of the forest land (61, 16, and 3 percent, respectively). The State of Vermont, federal government, and local public entities own the remainder (8, 10, and 2 percent, respectively).

Vermont's forests have been maturing as illustrated in the distribution of timberland by stand-size classes (Fig. 4). Since the 1960 inventory, the acreage of large-diameter stands has been increasing. Until the 1983 inventory, the acreage in small-diameter stands was declining and has since been stable. The acreage of medium-diameter stands has been declining since the 1983 inventory.

Figure 3.—Forest land by stand-size class (based on small, medium, and large trees) for top five forest-type groups by acres, Vermont, 2016.

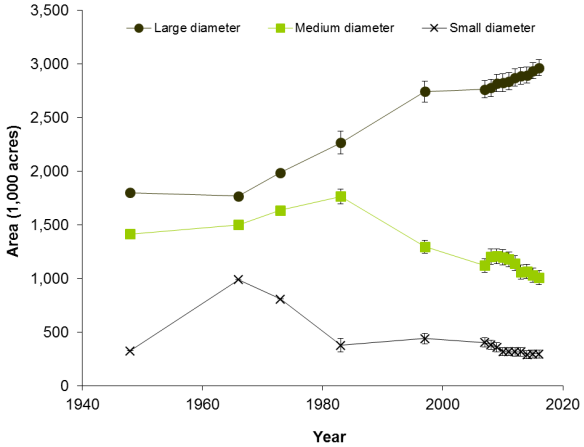

Figure 4.—Timberland by stand-size class and year, Vermont.

Volume, Biomass, and Carbon Trends

Sugar maple (*Acer saccharum*) continues to be the most numerous and voluminous tree in Vermont (Table 2). However, sugar maple has a relatively low net growth-to-harvest removals ratio of 1.9:1 (Fig. 5). A ratio of 1:1 would indicate that the amount of volume added annually is equal to that which was harvested. Red maple (*Acer rubrum*) and eastern white pine (*Pinus strobus*) also have net growth-to-harvest removal ratios below 2:1, and the ratio for paper birch (*Betula papyrifera*) is negative. By contrast, northern white-cedar (*Thuja occidentalis*), red spruce (*Picea rubens*), yellow birch (*Betula alleghaniensis*), eastern hemlock (*Tsuga canadensis*), and northern red oak (*Quercus rubra*) all have net growth-to-harvest removal ratios above 3:1.

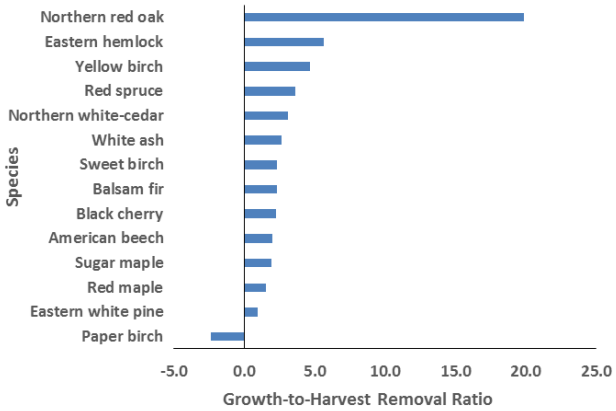

Figure 5.—Growth-to-harvest removal ratio by species, Vermont, 2016.

Forest ecosystems sequester more carbon annually than any other terrestrial land cover. This accumulation of carbon helps offset the emissions of carbon dioxide from sources such as burning of fossil fuels. Estimates of forest carbon storage and annual uptake of carbon are updated annually as a part of the national forest carbon inventory (Woodall et al. 2015).

The 2016 data for Vermont show that forests store approximately 482 million metric tons of carbon (Fig. 6), which amounts to over 264 metric tons per hectare of forest land (Fig. 7). The trends are similar in Figures 6 and 7, but both are provided so that total and per unit area carbon estimates can be cited. The largest pool is stored in soils followed by aboveground (tree) biomass.

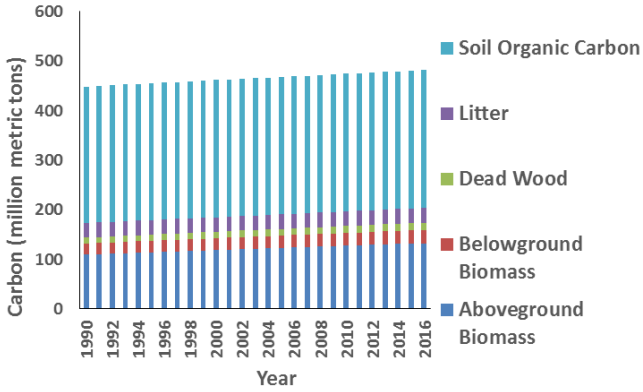

Figure 6.—Trend in carbon stored in Vermont forests, 1990-2016.

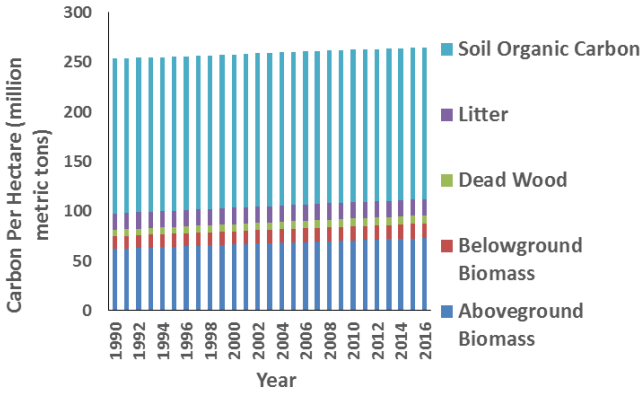

Figure 7.—Trend in per hectare estimates of carbon stored in Vermont forests, 1990-2016.

Table 2.—Number, net volume, oven-dry biomass, net growth, mortality, and harvest removals of live trees on forest land, Vermont, 2016 (selected prominent species)

Species	Trees[a] (millions)	Net volume[a] (million ft^3)	Aboveground biomass[b] (thousand tons)	Net growth[ac] (thousand ft^3/yr)	Mortality[a] (thousand ft^3/yr)	Harvest removals[a] (thousand ft^3/yr)
Sugar maple	156	2,423	77,102	34,284	18,388	17,854
Red maple	108	1,285	35,187	22,285	13,134	14,216
Eastern hemlock	81	1,171	22,318	24,544	3,927	4,333
American beech	67	588	20,419	6,642	13,115	3,344
Balsam fir	65	406	7,812	8,110	11,709	3,487
Yellow birch	60	795	24,778	14,564	8,468	3,132
Red spruce	49	530	9,559	9,249	3,876	2,523
Paper birch	36	378	10,653	-7,005	13,622	2,985
Eastern white pine	35	940	16,370	19,171	8,893	19,687
White ash	34	570	17,469	13,592	5,393	5,078
Northern white-cedar	16	107	1,786	2,148	1,057	690
Black cherry	15	167	4,583	4,307	1,043	1,888
Sweet birch	15	159	5,169	4,438	475	1,883
Northern red oak	12	360	11,614	8,079	2,320	407

[a]At least 5-inch diameter trees; [b]At least 1-inch diameter trees; [c]Net growth = gross growth – mortality

Forest Carbon Assessment

Forest carbon storage has increased steadily between 1990 and 2015 (Fig. 6, Table 3). However, the annual rate of carbon uptake has decreased from -4.7 MMTCO2e per year to -4.39 MMTCO2e. Note that the negative numbers are used to indicate negative emissions (i.e., uptake or sequestration).

Forest carbon stocks should continue to increase as stands mature and accumulate carbon in aboveground and belowground components. Management that encourages carbon sequestration and accumulation will require careful planning and creative silviculture, particularly with other competing land management objectives.

Table 3.—Comparison of Vermont's forest carbon storage and annual uptake (net sequestration) pools in 1990 versus 2015. Units are: MMTC=million metric tons of carbon; MMTCO2e=million metric tons of carbon dioxide equivalents; and MTC/hectare=metric tons of carbon per hectare. Negative values are used with MMTCO2e to mean negative emissions, or rather, uptake of CO2.

Forest Carbon Pool	Carbon Storage (MMTC)		Net Sequestration (MMTCO2e)		Carbon Per Hectare (MTC/hectare)	
	1990	2015	1990	2015	1990	2015
Aboveground biomass	110.1	131.8	-3.29	-3.05	62.2	72.5
Belowground biomass	22.1	26.4	-0.64	-0.60	12.5	14.5
Dead wood	11.7	14.8	-0.44	-0.37	6.6	8.2
Litter	29.2	29.5	-0.05	-0.05	16.5	16.3
Soil Organic Carbon	275.7	277.9	-0.28	-0.31	155.9	152.9
Total	448.9	480.5	-4.70	-4.39	253.7	264.4

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Mature sugar maple. Photo by Vermont Department of Forests, Parks, and Recreation, used with permission.

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