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RESOURCE UPDATE FS-54

Forests of Vermont, 2014

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 cycle length was equal to 5 years. Beginning in 2014, the cycle length was changed to 7 years. For the 2014 inventory, estimates for current variables such as area, volume, and biomass are based on 1074 plot samples collected from 2009-2014. Change variables such as net growth, removals, and mortality are based on 964 samples collected in 2004-2009 and resampled in 2009-2014. Estimates from earlier annual and periodic inventories are shown for comparison. See Bechtold and Patterson (2005) and O'Connell et al. (2013) for definitions and technical details.

Overview

Currently, Vermont is home to over 4.5 million acres of forest land (Table 1). Since the 1983 inventory, the estimate of forest land has been relatively stable (Fig. 1). However, the volume and biomass of trees has risen (Table 1; Morin et al. 2011). Average annual net growth, mortality, and removals have higher sampling errors, indicating higher uncertainty in trend estimates; however, the latest inventory shows notable decreases in average annual net growth and harvest removals of trees on timberland at 14 percent and 12 percent, respectively (Table 1).

Note that 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, 2014 and 2009. Volumes are for 5-inch and larger diameter trees. Number of trees and biomass are for 1-inch and larger diameter trees. Sampling errors and error bars shown in tables and figures in this report represent 68 percent confidence intervals.

	2014 Estimate	Sampling error (percent)	2009 Estimate	Sampling error (percent)	Change since 2009 (percent)
Forest Land					
Area (thousand acres)	4,508	1.0	4,611	1.0	-2.2
Number of live trees (million trees)	3,403	2.7	3,523	2.6	-3.4
Aboveground biomass of live trees (thousand oven-dry tons)	280,582	1.6	278,417	1.6	1.6
Net volume of live trees (million ft^3)	10,379	1.8	10,324	1.8	0.5
Annual net growth of live trees (thousand ft^3/yr)	175,550	5.7	193,866	9.4	-9.4
Annual mortality of trees (thousand ft^3/yr)	115,832	6.0	110,220	8.7	5.1
Annual harvest removals of live trees (thousand ft^3/yr)	85,533	14.4	90,258	22.6	-5.2
Timberland					
Area (thousand acres)	4,279	1.2	4,388	1.2	-2.5
Number of live trees (million trees)	3,230	2.8	3,358	2.8	-3.8
Aboveground biomass of live trees (thousand oven-dry tons)	264,669	1.8	264,425	1.8	0.1
Net volume of live trees (million ft^3)	9,812	2.0	9,821	1.9	-0.1
Net volume of growing stock trees (million ft^3)	8,593	2.1	8,829	2.1	-2.7
Annual net growth of growing stock trees (thousand ft^3/yr)	166,594	4.1	194,107	7.0	-14.2
Annual mortality of growing stock trees (thousand ft^3/yr)	72,847	6.1	65,601	9.9	11
Annual harvest removals of growing stock trees (thousand ft^3/yr)	70,221	14.7	79,441	22.4	-11.6

Forest Area

Although Vermont's current area of forest land has been relatively stable since the early 1980s , there has been a gradual decline in forest area since 2009 that has resulted in a 2 percent decrease (Table 1). Timberland accounts for 4.3 million acres, or 95 percent, of this forest land. Nearly 5 percent of forest land is reserved from timber production and less than 1 percent is other forest land identified as not being able to meet minimum productivity standards. Vermont's total area is 5.9 million acres (excludes census water, e.g., Lake Champlain).

Even though the State is still heavily forested, urbanization is putting increasing pressure on the forest resources of Vermont. The wildland–urban interface (WUI) refers to the zone of transition between unoccupied land and human development. Here we use a housing density greater than 15.5 houses per square mile as the threshold for the WUI (Radeloff et al. 2005).

The amount of forest land that was affected by housing densities greater than 15.5 houses per square mile are highlighted in yellow and red in Figures 2 and 3. The proportion of forest area in the WUI ranges from 8 percent in Essex County to 90 percent in Grand Isle County (Fig. 1). Most importantly, the area in the 15.5 houses per square mile and higher categories increased substantially across much of the State between 2000 and 2010 (Figs. 2, 3).The proportion of forest land area in the WUI increased by 11 percent within the State and in all counties between 2000 and 2010 (Fig. 3). The largest increase was in Chittenden County (19 percent). By contrast, increase in forest land area in the WUI was less than 5 percent in Essex and Grand Isle Counties.

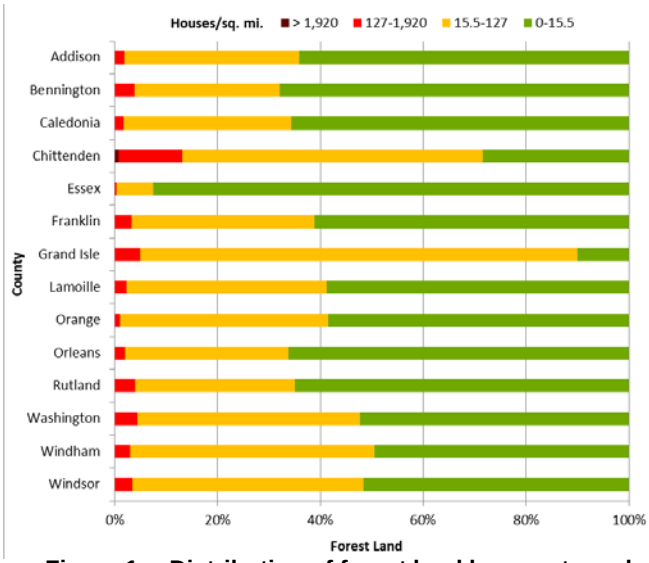

Figure 1.—Distribution of forest land by county and housing density class, Vermont 2010.

Forest that is intermixed with houses is increasingly likely to experience pressures from recreation, invasive plant species, and other local human effects. Additionally, forest health, sustainability, management opportunities, and many other characteristics are affected by changes in the fragmentation of forests and urbanization. Note that the forest land estimates in this section were calculated from the WUI maps not the FIA plots.

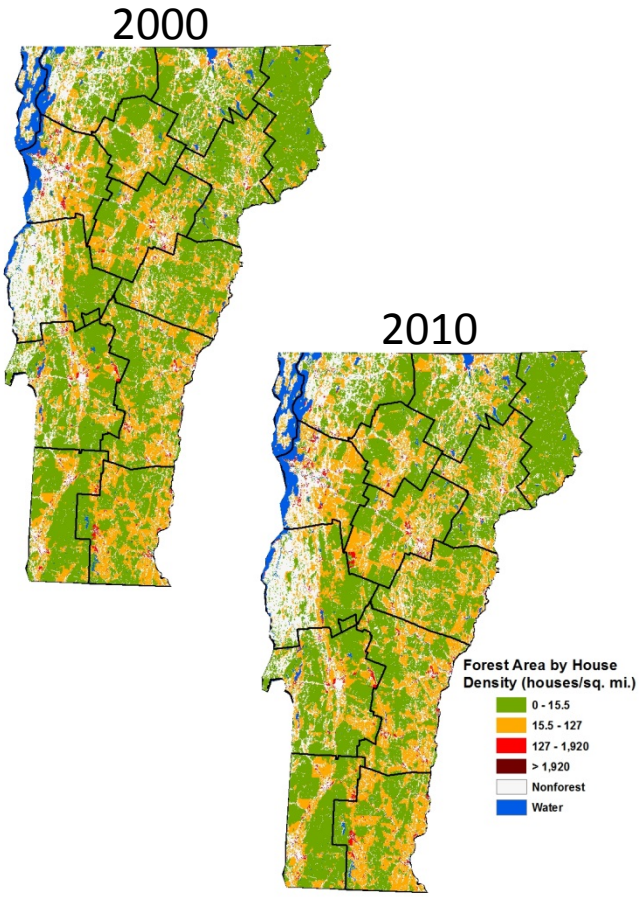

Figure 2.—Distribution of forest land by housing density classes, Vermont 2000 and 2010.

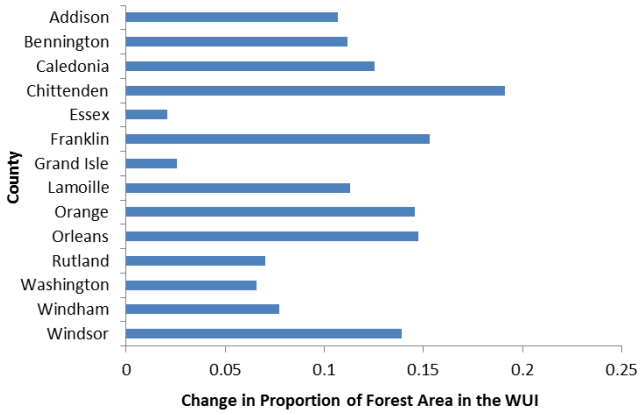

Figure 3.—Change in the proportion of forest land in the WUI, Vermont 2000 to 2010.

Volume, Biomass, and Trends

Despite the small decrease in forest area, increases in volume, biomass, and number of large-diameter trees have accompanied the increase in area of large-diameter stands in Vermont. There are about 823 million live trees (at least 5-inch diameter) on forest land accounting for nearly 10.4 billion ft^3 of volume and 259.8 million oven-dry tons of aboveground biomass. Volume increased 0.5 percent and biomass increased by 1.6 percent since the 2009 inventory (Table 2).

Contributing to this increase, notable gains in volume were observed for white ash (*Fraxinus americana*), eastern hemlock (*Tsuga canadensis*), and yellow birch (*Betula alleghaniensis*) at 8, 5, and 3 percent, respectively. By contrast, paper birch (*Betula papyrifera*), eastern white pine (*Pinus strobus*), and red maple (*Acer rubrum*) decreased in volume by at least 3 percent with paper birch showing the largest decrease at 9 percent (Fig. 4). Paper birch is a short-lived species so elevated mortality is not unusual in mature stands.

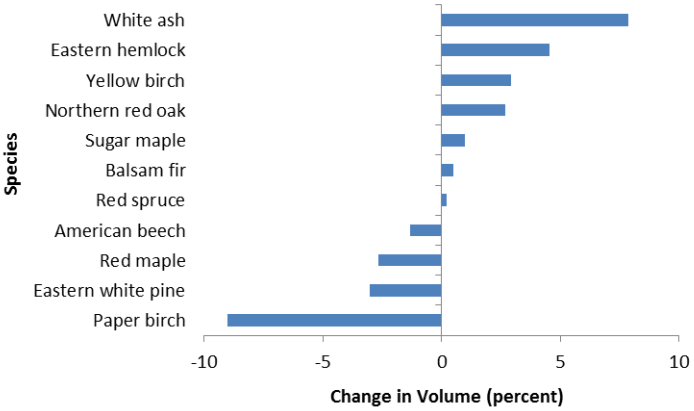

Figure 4.—Percent change in inventory volume by species, Vermont, 2009 to 2014.

The growth-to-harvest removal ratio (G:R) for all species across the State is 2.1:1, but this ratio varies substantially by species. Northern red oak (*Quercus rubr*a), eastern hemlock, and white ash have G:R ratios above 5:1. By contrast, red maple, balsam fir, eastern white pine, and paper birch have G:R ratios below 2:1. In fact, the G:R ratio for eastern white pine is just over 1, and the ratio for paper birch is negative (Fig. 5).

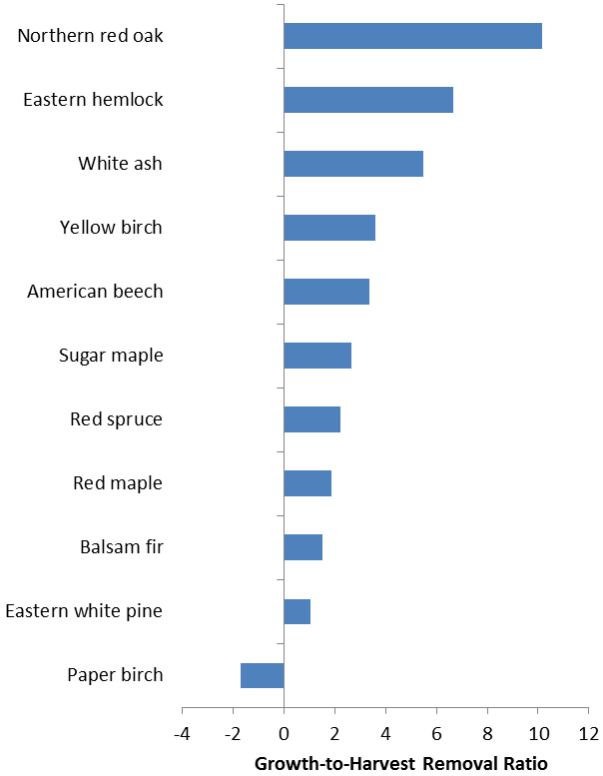

Figure 5.—Growth-to-harvest removal proportion by species, Vermont, 2014.

Table 2.—Number, net volume, oven-dry biomass, net growth, mortality, and harvest removals of live trees on forest land, Vermont 2014 (selected prominent species).

Species	Trees[a] (million trees)	Net volume[a] (million ft^3)	Aboveground biomass[b] (thousand tons)	Net growth[a] (thousand ft^3/yr)	Mortality[a] (thousand ft^3/yr)	Harvest removals[a] (thousand ft^3/yr)
Sugar maple	156	2,412	73,398	34,210	16,769	12,989
Red maple	107	1,253	32,149	22,724	10,418	12,284
Eastern hemlock	81	1,148	21,365	23,765	2,830	3,561
Eastern white pine	35	933	16,152	21,370	6,887	20,267
Yellow birch	58	772	22,501	14,006	7,427	3,893
American beech	67	590	17,318	5,025	12,919	1,495
White ash	33	549	16,006	15,885	3,077	2,905
Red spruce	48	509	8,247	10,084	2,324	4,504
Balsam fir	63	395	5,913	10,901	7,964	7,258
Paper birch	38	393	10,176	-5,650	12,356	3,288
Northern red oak	12	342	10,827	10,448	101	1,028

[a]At least 5-inch diameter trees. [b]At least 1-inch diameter trees.

Urbanization and Fragmentation of Forest Land

We adapted a spatial integrity index (SII) developed by Kapos et al. (2000) that integrates three important facets of fragmentation that affect some aspect of forest ecosystem functioning—patch size, local forest density, and patch connectivity to core forest areas—to create a single resulting metric for comparison. In the SII calculation, core forest is defined by patch size and local forest density within a defined local neighborhood area. An unconnected forest fragment is defined by its patch size, local forest density, and distance to a core forest area. The spatial integrity of all other forest lands are then scaled into the low, medium, and high categories between the core forest and unconnected fragment categories. Note that the forest land estimates in this section were calculated from the SII maps not the FIA plots.

More than 90 percent of Vermont's forest land meets the criteria for high integrity and much of it meets the criteria for core forest (Fig. 6). High forest integrity dominates across nearly all of the State. In fact, Grand Isle is the only county where more than 10 percent of forest area is not in the core forest or high integrity category.

The health and sustainability of forest land are affected in many areas by high levels of fragmentation and the close proximity of urban development and roads. These impacts can affect the ability of forest land to provide the products and ecosystem services that people need. Core and high integrity forest areas may be looked upon as areas to focus conservation activities in order to protect them from fragmentation and urbanization.

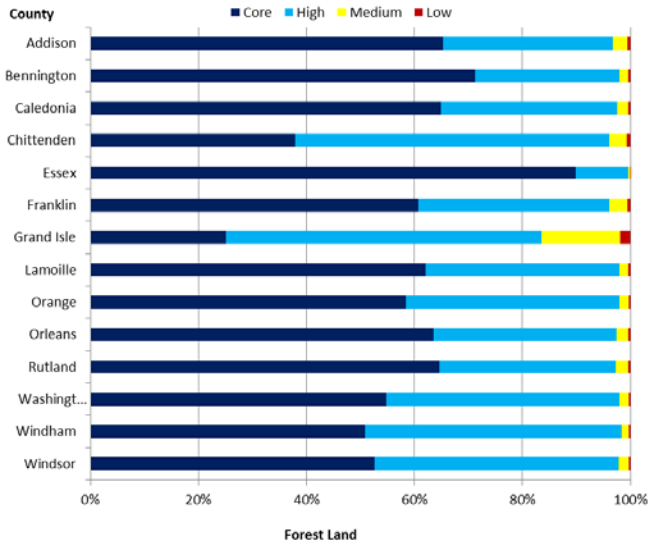

Figure 6.—Proportion of forest land by county and Spatial Integrity Index (SII) class.

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Contact Information
Randall S. Morin, Research Forester
USDA Forest Service, Northern Research Station
11 Campus Blvd., Ste. 200
Newtown Square, PA 19073
Ph: 610-557-4054 / Fax: 610-557-4250
rsmorin@fs.fed.us
Northern FIA: http://nrs.fs.fed.us/fia/
National FIA: http://fia.fs.fed.us