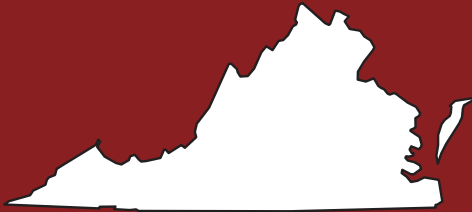




FOREST SERVICE
U.S. DEPARTMENT OF AGRICULTURE

Southern Research Station | Resource Bulletin SRS-240 | July 2024

Virginia's Forests, 2021



Thomas J. Brandeis
Andrew J. Hartsell
KaDonna C. Randolph
William P. Durham
Christopher M. Oswalt



ABOUT THE AUTHORS

Thomas J. Brandeis, Research Forester, USDA Forest Service, Southern Research Station, Forest Inventory and Analysis Research Work Unit, Knoxville, TN 37919

Andrew J. Hartsell, Research Forester, USDA Forest Service, Southern Research Station, Forest Inventory and Analysis Research Work Unit, Knoxville, TN 37919

KaDonna C. Randolph, Research Mathematical Statistician, USDA Forest Service, Southern Research Station, Forest Inventory and Analysis Research Work Unit, Knoxville, TN 37919

William P. Durham, Forester, USDA Forest Service, Southern Research Station, Forest Inventory and Analysis Research Work Unit, Inman, SC 29349

Christopher M. Oswalt, Research Forester, USDA Forest Service, Southern Research Station, Forest Inventory and Analysis Research Work Unit, Knoxville, TN 37919

Cover photo: Maury River. (Virginia Department of Forestry photo by John Pemberton)

July 2024

<https://doi.org/10.2737/SRS-RB-240>



Forest Service
Research & Development
Southern Research Station
Resource Bulletin SRS-240



Southern Research Station
200 W.T. Weaver Blvd.
Asheville, NC 28804
<https://research.fs.usda.gov/srs>

Virginia's Forests, 2021

Thomas J. Brandeis, Andrew J. Hartsell, KaDonna C. Randolph, William P. Durham, and Christopher M. Oswalt



Hungry Mother State Park. (Virginia Department of Forestry photo by John Pemberton)

FOREWORD

The U.S. Department of Agriculture, Forest Service, Southern Research Station's (SRS) Forest Inventory and Analysis (FIA) research work unit and cooperating State forestry agencies conduct annual forest inventories of resources in the 13 Southern States (Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, and Virginia), the Commonwealth of Puerto Rico, and the U.S. Virgin Islands. In order to provide more frequent and nationally consistent information on America's forest resources, all research stations and their respective FIA work units conduct annual surveys with a common sample design. These surveys are mandated by law through the Agricultural Research Extension and Education Reform Act of 1998 (Farm Bill) and updated in Title VIII of the 2014 Farm Bill.

The primary objective in conducting these inventories is to gather the multiresource information needed to formulate sound forest policies, provide information for economic development, develop forest programs, and provide a scientific basis to monitor forest ecosystems. These data are used to provide an overview of forest resources that may include, but is not limited to, forest area, forest ownership, forest type, stand structure, timber volume, growth, removals, mortality, management activity, down woody material, carbon storage and sequestration, and invasive species. The information presented is applicable at the State and survey unit level; although it provides the background for more intensive studies of critical situations, it is not designed to reflect resource conditions at small scales.

More information about Forest Service resource inventories is available in *Forest Resource Inventories: An Overview* (USDA Forest Service 1992). More detailed information about sampling methodologies used in the annual FIA inventories can be found in *The Enhanced Forest Inventory and Analysis Program—National Sampling Design and Estimation Procedures* (Bechtold and Patterson 2005) and *Sampling and Estimation Documentation for the Enhanced Forest Inventory and Analysis Program: 2022* (Westfall and others 2022).

Data tables included in FIA reports are designed to provide an array of forest resource estimates, but additional tables can be obtained at <https://research.fs.usda.gov/programs/fia#data-and-tools>. Additional information about the FIA Program can be obtained at <https://research.fs.usda.gov/programs/fia#overview>.

Additional information about any aspect of Southern Research Station FIA surveys may be obtained from:

Forest Inventory and Analysis Research Work Unit
U.S. Department of Agriculture
Forest Service
Southern Research Station
4700 Old Kingston Pike
Knoxville, TN 37919

Telephone: 865-862-2000

Ausley "Burl" Carraway III
Program Manager

ACKNOWLEDGMENTS

The SRS gratefully acknowledges the continued productive partnership with the Virginia Department of Forestry. This partnership extends from field data collection, data review, through to review of the final published results in documents such as this one. We also thank SRS FIA Data Acquisition for editing the data, Andres Baeza-Castro of SRS FIA Information Management for data review and processing, and the SRS Technical Publications Team for technical edit, layout, and overall production of this report.

The following people made field measurements or checked the quality of the data collected for this most recent survey. SRS FIA appreciates their hard work and consistent efforts to obtain high-quality data.

Virginia Department of Forestry

Scott Adams
Jefferson Armistead
Brad Branner
Rich Brown
Thomas Callahan
Erica Chin
Joey Collard
Dean Cumbia
Catherine Dufault

Michael Farber
Bethany Gregory
Daniel Herbert
Ryan Hewitt
Angela Holmes
Elena Hurley
Hillary Hutchison
Mason Jeffries
Chad Lykins
Andrew Matteson
Logan McGlothlin
John Pemberton
Eli Podyma
Riley Ripa
Justin Rodemeyer
Lynwood Rogers
Cynthia Scheuermann
Mike Sonnek
Jessy Spencer
Ruby Stathers
Travis Tindell
Benjamin Wassum
Vance Yates
Kaci Yost

SRS FIA

Jason Hewitt
Kirk Ramsey
Marcus Wood

CONTENTS

FOREWORD	ii
ACKNOWLEDGMENTS	iii
HIGHLIGHTS	1
INTRODUCTION	3
AREA	4
Forest Land Area and Nonforest Land Uses	4
Forest Ownership, Forest Types, and Stand Size	6
Forest Ownership	6
Forest Types	6
Stand Size	8
Forests and Land-Use Change	10
NUMBER OF TREES, VOLUME, AND BIOMASS	11
GROWTH, REMOVALS, AND MORTALITY.	15
Treated Acres	20
TIMBER PRODUCT OUTPUT AND UTILIZATION.	21
Timber Products	21
Mill Residue	27
Logging Residue.	29
Land-Use Removals	32
DISTURBANCE AND FOREST HEALTH INDICATORS.	32
Disturbance	32
Standing Dead Trees, Down Woody Materials, Forest Duff and Litter	34
Carbon	40

Insects, Diseases, and Species of Concern	.41
Emerald Ash Borer	.41
Hemlock Woolly Adelgid	.44
New Concerns.	.45
Spotted Lanternfly	.49
Nonnative Invasive Plants	.51
LITERATURE CITED	.55
GLOSSARY.	.58
APPENDIX 1—INVENTORY METHODS	.70
What Is Forest Inventory and Analysis?.	.70
What Is a Tree?.	.70
What Is a Forest?	.70
How Do We Estimate a Tree's Volume?	.70
Annual Inventory	.70
What Is in This Bulletin?	.72
Where To Find Additional Information?.	.72
Methods Summary	.72
APPENDIX 2—DATA RELIABILITY	.73
Measurement Error	.73
Sampling Error.	.73
APPENDIX 3—SUPPLEMENTAL TABLES	.76

LIST OF FIGURES

Figure 1 —Counties and forest survey units, Virginia, 2021	5
Figure 2 —Percentage of county in forest land by county, Virginia, 2021	5
Figure 3 —Forest and nonforest land area by survey unit, Virginia, 2021	6
Figure 4 —Forest land area by ownership group, Virginia, 2001–2021	6
Figure 5 —Percentage of forest land area by forest-type group, Virginia, 2021	7
Figure 6 —Forest land in shortleaf pine and shortleaf pine-oak forest types, Virginia, 2001–2021	8
Figure 7 —Distribution and density of shortleaf pine trees and forest land, Virginia, 2021	8
Figure 8 —Southern pine forest (stands where the forest types are predominately pine species) land acreage by stand size class, Virginia, 2001–2021	9
Figure 9 —Hardwood forest (stands where the forest types are predominately hardwood species) forest land acreage by stand size class, Virginia, 2001–2021	9
Figure 10 —Annualized land-use change, Virginia, 2005–2021	10
Figure 11 —Annualized pine forest stand origin change, Virginia, 2005–2021	11
Figure 12 —All-live net volume on timberland by major species group, Virginia, 1977–2021	14
Figure 13 —All-live net volume of live trees on forest land by ownership class, Virginia, 2021	14
Figure 14 —All-live net softwood volume on timberland by diameter class, Virginia, 1977–2021	14
Figure 15 —All-live net hardwood volume on timberland by diameter class, Virginia, 1977–2021	15
Figure 16 —All-live average annual cubic-foot volume growth, removals, and mortality on forest land by survey year, Virginia, 2007–2021	17
Figure 17 —All-live net growth by major species group and stand-size class, Virginia, 2007–2021	17
Figure 18 —Volume of removals by major species group and stand-size class, Virginia, 2007–2021	19
Figure 19 —Volume of mortality by major species group and stand size-class, Virginia, 2007–2021	19
Figure 20 —Hardwood net growth to removals volume for poletimber and sawtimber stand-size classes, Virginia, 2007–2021	20
Figure 21 —Softwood net growth to removals volume for poletimber and sawtimber stand-size classes, Virginia, 2007–2021	20
Figure 22 —Area of forest land treated annually by forest-type group and cutting treatment class, Virginia, 2007–2021	21
Figure 23 —Total removals in million cubic feet by merchantability, species, and product, Virginia, 2021...	22
Figure 24 —Output of Industrial roundwood products by product and year from 2011 to 2021	24
Figure 25 —Maps of Virginia showing (a) total roundwood production, (b) softwood roundwood production, and (c) hardwood roundwood production by county in 2021	25

Figure 26 —Primary mill residue volume by roundwood type, residue type, and year, Virginia 2017–2021 . . .	27
Figure 27 —Disposal of residue at primary wood using plants by product, type of residue, and year, Virginia 2017–2021	29
Figure 28 —Percentage of forest carbon by carbon pool, Virginia, 2021	40
Figure 29 —Approximate location of plots where ash was observed during the latest inventory cycle, and location of counties where the emerald ash borer has been confirmed, by detection year. Data source: Virginia Department of Forestry (2023a)	42
Figure 31 —Net merchantable bole volume of live ash (<i>Fraxinus</i> spp.) trees (d.b.h. ≥5.0 inches) on forest land, by survey unit, Virginia, 2001–2021	43
Figure 30 —Number of standing dead ash (<i>Fraxinus</i> spp.), softwood, and other hardwood trees in Virginia, 2001–2021	43
Figure 32 —Approximate location of plots where eastern hemlock (<i>Tsuga canadensis</i>) was observed during the latest inventory cycle, and location of counties where the hemlock woolly adelgid (<i>Adelges tsugae</i>) has been confirmed, by detection year. The last new detection was in 2007. Data source: Virginia Polytechnic Institute and State University (2023b)	44
Figure 33 —(a) Net merchantable volume and (b) stem count of live eastern hemlock (<i>Tsuga canadensis</i>) trees (d.b.h. ≥5.0 inches) on forest land, by survey unit, Virginia, 2001–2021. Piedmont represents the Northern Piedmont and Southern Piedmont units combined	45
Figure 34 —Approximate location of plots where American beech (<i>Fagus grandifolia</i>) was observed during the latest inventory cycle, and location of counties where beech leaf disease and components of the beech bark disease complex have been confirmed. Data sources: USDA Forest Service (2022b), USDA Forest Service and Cleveland Metroparks (2023), Virginia Cooperative Extension (2023), Virginia Department of Forestry (2023b)	46
Figure 35 —Approximate location of plots where eastern white pine (<i>Pinus strobus</i>) was observed during the latest inventory cycle	47
Figure 36 —Proportion of eastern white pine (<i>Pinus strobus</i> , EWP) and other softwoods (OSW) total stem count (d.b.h. ≥1.0 inch) in the sapling and poletimber size classes that was standing dead in the Northern Mountain and Southern Mountain units, 2021	47
Figure 37 —Approximate location of plots where elm (<i>Ulmus</i> spp.) was observed during the latest inventory cycle, and location of counties where the elm zigzag sawfly (<i>Aproceros leucopoda</i>) has been confirmed, by detection year. Data source: Oten (2023)	48
Figure 38 —Approximate location of plots where sassafras (<i>Sassafras albidum</i>) and redbay (<i>Persea borbonia</i>) were observed during the latest inventory cycle, and location of counties where laurel wilt has been confirmed, by detection year. Data source: USDA Forest Service (2023b)	49
Figure 39 —Approximate location of plots where tree of heaven (<i>Ailanthus altissima</i>) was tallied in the tree, seedling, or invasive plants protocol during the latest inventory cycle, and location of counties where reproducing populations of spotted lanternfly (<i>Lycorma delicatula</i>) have been confirmed. Data source: Virginia Polytechnic Institute and State University (2023a)	50
Figure 40 —Area of forest land for the top five monitored invasive plant species found in Virginia by stand age, 2021	53

LIST OF TABLES

Table 1 —Area by survey unit and land status, Virginia, 2021	4
Table 2 —Area of softwood stands by ownership group and stand origin in Virginia's forests, 2021	10
Table 3 —Number of live trees (d.b.h. ≥ 1 inch), net volume (in trees with d.b.h. ≥ 5 inches) and aboveground green weight (in trees with d.b.h. ≥ 1 inch) on forest land by species group, Virginia, 2021	12
Table 4 —Net volume of live trees on forest land by species group and stand origin, Virginia, 2021	13
Table 5 —Net volume in the sawlog portion of sawtimber trees on timberland, Virginia, 1977–2021	15
Table 6 —Net average annual growth of live trees on forest land by species group and stand origin, Virginia, 2017–2021	16
Table 7 —Average annual removals of live trees on forest land by species group and stand origin, Virginia, 2017–2021	18
Table 8 —Output of industrial roundwood products by product, species group, and year, Virginia, 2017–2021	23
Table 9 —Primary mill residue volume by roundwood type, species group, and residue type, Virginia, 2017–2021	28
Table 10 —Disposal of residue at primary wood using plants by product, species group, and type of residue, Virginia, 2017–2021	30
Table 11 —Volume of timber removals by species group, removals class, and source, Virginia, 2017–2021	32
Table 12 —Volume of timber removals by species group, removals class, and source, Virginia, 2017–2021	33
Table 13 —Area of forest land disturbed annually by forest-type group and disturbance class, Virginia, 2017–2021	34
Table 14 —Number of standing dead trees on forest land by species group and diameter class, Virginia, 2021	35
Table 15 —Total fuel loading on forest land by forest-type group and fuel class, Virginia, 2021	37
Table 16 —Mean fuel loading per acre on forest land by forest-type group and fuel class, Virginia, 2021	37
Table 17 —Carbon stocks of dead, down woody materials by forest-type group on forest land, Virginia, 2021	39
Table 18 —Biomass and carbon mass of down wood by forest-type group on forest land, Virginia, 2021	39
Table 19 —Carbon pool on forest land by forest-type group and carbon pool groups, Virginia, 2021	41
Table 20 —Invasive species on Virginia forest land, 2021	50
Table 21 —Area of forest land/timberland for each monitored invasive plant species found in Virginia, 2021	52
Table 22 —Area of forest land for the monitored invasive plant species found in Virginia by ownership group, 2021	54

Table A1.1 —Volume of all-live species by measurement year in Virginia, 2021	71
Table A1.2 —Average annual removals of all-live species by initial and terminal inventory year, Virginia, 2021	71
Table A1.3 —Average annual removals of all-live species expressed as a percentage of total removals by initial and terminal inventory year, Virginia, 2021	71
Table A2.1 —Statistical reliability of forest land area estimates for Virginia, 2021	73
Table A2.3 —Statistical reliability of growth, removals, and mortality estimates for Virginia, 2021	74
Table A2.2 —Statistical reliability of all-live volume estimates for Virginia, 2021	74
Table A3.1 —Area by survey unit and land status, Virginia, 2021	76
Table A3.2 —Area of forest land by ownership class and land status, Virginia, 2021	77
Table A3.3 —Area of forest land by forest-type group and ownership group, Virginia, 2021	78
Table A3.4 —Area of forest land by forest-type group and stand-size class, Virginia, 2021	79
Table A3.5 —Area of forest land by forest-type group and stand origin, Virginia, 2021	80
Table A3.6 —Area of forest land disturbed annually by forest-type group and disturbance class, Virginia, 2017–2021	81
Table A3.7 —Area of forest land treated annually by forest-type group and treatment class (cutting), Virginia, 2017–2021	82
Table A3.8 —Number of live trees on forest land by species group and diameter class, Virginia, 2021	83
Table A3.9 —Net volume of live trees on forest land by ownership class and land status, Virginia, 2021 ...	84
Table A3.10 —Net volume of live trees on forest land by forest-type group and stand-size class, Virginia, 2021	85
Table A3.11 —Net volume of live trees on forest land by species group and ownership group, Virginia, 2021	86
Table A3.12 —Net volume of live trees on forest land by species group and diameter class, Virginia, 2021 .	87
Table A3.13 —Net volume of live trees on forest land by forest-type group and stand origin, Virginia, 2021 .	88
Table A3.14 —Aboveground dry weight of live trees on forest land by ownership class and land status, Virginia, 2021	89
Table A3.15 —Total carbon of live trees on forest land by ownership class and land status, Virginia, 2021 ..	90
Table A3.16 —Average annual net growth of live trees by ownership class and land status, Virginia, 2021 (2011–2016 to 2017–2021)	91
Table A3.17 —Average annual net growth of live trees on forest land by forest-type group and stand-size class, Virginia, 2021 (2011–2016 to 2017–2021)	92
Table A3.18 —Average annual net growth of live trees on forest land by species group and ownership group, Virginia, 2021 (2011–2016 to 2017–2021)	93

Table A3.19 —Average annual mortality of live trees by ownership class and land status, Virginia, 2021 (2011–2016 to 2017–2021)	94
Table A3.20 —Average annual mortality of live trees on forest land by forest-type group and stand-size class, Virginia, 2021 (2011–2016 to 2017–2021)	95
Table A3.21 —Average annual mortality of live trees on forest land by species group and ownership group, Virginia, 2021 (2011–2016 to 2017–2021)	96
Table A3.22 —Average annual net removals of live trees by ownership class and land status, Virginia, 2021 (2011–2016 to 2017–2021)	97
Table A3.23 —Average annual removals of live trees on forest land by forest-type group and stand-size class, Virginia, 2021 (2011–2016 to 2017–2021)	98
Table A3.24 —Average annual removals of live trees on forest land by species group and ownership group, Virginia, 2021 (2011–2016 to 2017–2021)	99
Table A3.25 —List of tree species ≥ 1.0 inch d.b.h. occurring in the FIA sample and number measured, Virginia, 2017–2021	100
Table A3.26a —Area of sampled land and water by county and major land use, Virginia, 2021	105
Table A3.26b —Sampling error for area of sampled land and water by county and major land use, Virginia, 2021	109
Table A3.27a —Area of timberland by county and major ownership group, Virginia, 2021	113
Table A3.27b —Sampling error for area of timberland by county and major ownership group, Virginia, 2021	117
Table A3.28a —Volume of live trees on timberland by county and major species group, Virginia, 2021	121
Table A3.28b —Sampling error for volume of live trees on timberland by county and major species group, Virginia, 2021	125
Table A3.29a —Area of forest land by county and forest-type group, Virginia, 2021	129
Table A3.29b —Sampling error for area of forest land by county and forest-type group, Virginia, 2021 ...	133

HIGHLIGHTS

- In 2021 Virginia had an estimated 15.9 million acres of forest which covered 58.7 percent of its total land area. The Coastal Plain had the lowest percentage of forest cover at 45.4 percent, and the Southern and Northern Piedmont units were 67.6 and 56.1 percent forested, respectively. The Southern and Northern Mountain units were 65.2 and 65.7 percent forested.
- In 2001, only 39 percent of pine forests were classified as large-diameter (stands where the trees are predominately softwoods ≥ 9.0 inches d.b.h., which are also known as sawtimber trees). By 2021, over half (55 percent) of Virginia's pine forests fall in the sawtimber category, an increase since 2016. Hardwood forests exhibit the same pattern as softwood forests (although to a lesser extent) as large-diameter hardwood stands (forests where the average d.b.h. is ≥ 11.0 inches) have increased since 2001 while small- (1.0 to 4.9 inches d.b.h.) and medium-diameter (5.0 to 10.9 inches d.b.h.) stands have declined.
- This most recent inventory period (2017–2021) featured the continuation of fewer agricultural and developed land acres going to forest land annually. There was a slight increase in acreage being converted from forest to nonforest each year. As with the total acreage estimates, these land-use changes indicate a relatively stable forest land base.
- There were somewhat fewer live trees in 2021 than in 2016 (10.7 billion with a d.b.h. ≥ 1 inch, down from 11.4 billion), but the predominate species remained largely the same as before [red maple (*Acer rubrum*) and loblolly pine (*Pinus taeda*)]. Net volume in trees with d.b.h. ≥ 5 inches increased from 39.4 billion cubic feet (bcf) in 2016 to 43.4 bcf in 2021, and aboveground live biomass in trees with a d.b.h. ≥ 1 inch increased from 2.1 to 2.3 billion tons.
- Net volume has increased steadily for both hardwood and softwood species to reach its current level of 31.9 bcf in hardwoods and 11.5 bcf in softwoods. The softwood volume is almost evenly split between stands that were naturally regenerated (5.6 bcf) and those that were planted (5.9 bcf). Hardwood volume is predominately in naturally regenerated stands.
- In 2021, 53.6 percent of the total net annualized growth of 1.4 bcf per year was on hardwood trees and 46.4 percent of it was on softwoods. Hardwood average annualized growth had been increasing during the previous three periods of annualized forest inventory but now shows little change since 2016. Softwood growth, however, continues to increase.
- Removals in both softwood and hardwood species groups have begun to increase after a period of decline, with annualized removals of softwoods now exceeding that observed in 2007. Since the 2007 inventory, natural mortality has remained consistently low and relatively unchanged in softwoods but hardwood mortality shows a gradual increase.
- For hardwoods, growth continued to exceed removals with a growth to removals ratio of 4.2 in 2021 for medium-diameter stands. In large-diameter hardwood stands, the growth to removals ratio was 1.94 in 2021. Softwoods growth to removals ratio trends continue the trajectory seen in 2016. Softwood growth continued to increase and removals further decreased over time in medium-diameter stands, producing a growth to removals ratio of 2.63. In large-diameter softwood stands, the growth to removals ratio was 1.58 in 2021.
- In contrast to the previous trends, acres clearcut increased from the levels observed in 2011 and 2016, perhaps due to economic recovery and increased demand for wood products. Partially harvested acres, in contrast, continued to decrease over time and acres thinned dropped from previous levels during the 2021 inventory period.
- In 2017, timber volume harvested and delivered for products (including residential fuelwood) totaled 632.3 million cubic feet (mmcf). By

the end of 2021 the State's total output had dropped 6 percent to 593.5 mmcf. The overall decline in output was driven by decreasing hardwood roundwood production, while output of softwood products increased over the 2017 to 2021 period.

- In 2017 softwoods accounted for 49 percent of sawlog output volume (102.1 mmcf) and hardwoods accounted for 51 percent of sawlog output volume (105.9 mmcf). By 2021 softwood sawlog output volume was 150.2 mmcf, 64 percent of total sawlog output volume with hardwood sawlog volume accounting for 36 percent, 85.3 mmcf.
- Over the 2017 to 2021 report period, <2 percent of mill residues (i.e., bark, coarse residue, and fine residue) were unused. Of the 173.2 mmcf of mill residues produced in 2021, 44 percent were used for industrial fuel either at pulpmills for boiler fuel or sawmills for dry kiln operations, pellets, or residential fuelwood, and another 31 percent were used in the production of fiber products.
- The number of standing dead trees ≥ 5.0 inches d.b.h. in forests of Virginia was 205.6 million in 2021. Decreasing numbers of standing dead trees as diameters increase reflect the distribution of live trees across the landscape.
- The forests of Virginia sequester approximately 1.2 billion tons of carbon, of which 34.0 percent was in the forest soil and 44.2 percent was in the aboveground portions of living trees.
- From 2017 to 2021, insect damage predominated the disturbances that impacted Virginia's forests, affecting an average of 242,700 forest land acres per year, mostly in oak-hickory dominated forests.
- Evidence of emerald ash borer (*Agrilus planipennis*) grew stronger during the latest inventory cycle. In 2007, there were 17.7 live ash trees for every one standing dead ash tree (≥ 5.0 inches d.b.h.) in the State. This ratio declined to 10.9 during the 2012–2016 inventory cycle and even further to 1.9 during the latest inventory cycle (2017–2021). The greatest loss of live ash volume from 2016 to 2021 occurred in the Southern Piedmont.
- The effect of hemlock woolly adelgid (*Adelges tsugae*) remained evident to varying degrees across the State. In the Northern Mountains, the precipitous decline in hemlock total volume and stem count for live trees ≥ 5.0 inches d.b.h. that was evident from 2001 to 2016 lessened during the latest inventory period. In the Southern Mountains and Piedmont units, total live volume and stem count were mostly unchanged from 2016.
- Newly discovered insects and diseases in the State pose a threat to multiple tree species, namely American beech (*Fagus grandifolia*), eastern white pine (*Pinus strobus*), elm (*Ulmus* spp.), sassafras (*Sassafras albidum*), and redbay (*Persea borbonia*). Damage from these agents was not evident in the latest inventory cycle, likely because they have not progressed into areas where their hosts are most abundant. Using 2021 estimates as a baseline, the next inventory cycle will play a critical role in monitoring their spread.
- Invasive plants are impacting a total of 1.6 million acres—approximately 10 percent of all forest land in the State. Japanese honeysuckle (*Lonicera japonica*) was the most frequently detected nonnative species, followed by Japanese stiltgrass (*Microstegium vimineum*), nonnative roses (*Rosa* spp.), and Chinese and European privets (*Ligustrum sinense*/L. *vulgare*).

INTRODUCTION

This resource bulletin is the fifth report produced by the collaboration of the Virginia Department of Forestry and the U.S. Department of Agriculture, Forest Service, Forest Inventory and Analysis (FIA) program at the Southern Research Station. This and the previous four bulletins (Brandeis and others 2018; Rose 2007, 2009, 2013) summarize information gathered from data collected on the FIA program's forest inventory and monitoring plot network. The data used to make the estimates presented in this report come from 4,881 FIA sampling points across the State of Virginia that were surveyed from 2017 through 2021. Of those sampling points, 3,330 were forested and had an FIA forest inventory and monitoring plot. The remaining 1,509 points were not forested and the only data collected there were land use. The data used in this publication were accessed from the FIA database (<https://research.fs.usda.gov/products/dataandtools/tools/fia-datamart>) from January to June of 2023 unless otherwise indicated.

As in the previous reports on the status of Virginia's forests, forest land and timberland acreage remains stable. There continues to be a

gradual increase in the proportion of stands comprised of larger trees, and with that, more wood volume than previously, and a greater percentage of that volume is in sawtimber-sized trees. Hardwood average annualized growth had been increasing during the previous three periods of annualized forest inventory but now shows little change since 2016. Softwood growth, however, continues to increase. Removals in both softwood and hardwood species groups have begun to increase after a period of decline, with annualized removals of softwoods now exceeding that observed in 2007. Although the number of wood processing mills has fluctuated (particularly for hardwood sawmills), Virginia's forests support a forest products industry that includes a diverse mix of mills, ranging from small- to large-sized softwood and hardwood sawmills, pole, veneer, composite, bioenergy, and other miscellaneous mills to very large pulpmills. Since the 2007 inventory, natural mortality has remained consistently low and relatively unchanging in softwoods but hardwood mortality shows a gradual increase. The increase in hardwood mortality is important to note. Insect damage was the predominate disturbance impacting Virginia's forests from 2017 to 2021, with insects particularly affecting ash and oak trees.



A riparian area along the Virginia Creeper Trail outside of Damascus, VA. (USDA Forest Service photo by Tom Brandeis)

AREA

Forest Land Area and Nonforest Land Uses

Virginia's total land area is 27.4 million acres, 16.0 million (58.4 percent) of which are forested according to the results of the latest forest inventory completed in 2021 (table 1). Though repetitive it is worth stating again that Virginia's forest land area has remained relatively stable for over two decades. The previous four, 5-year cycles of FIA data collection under the annualized forest inventory have estimates of forest land acreage in

the State at 15.9 million in 2001, 15.8 million in 2006, 15.9 million in 2011, and 16.1 million in 2016.

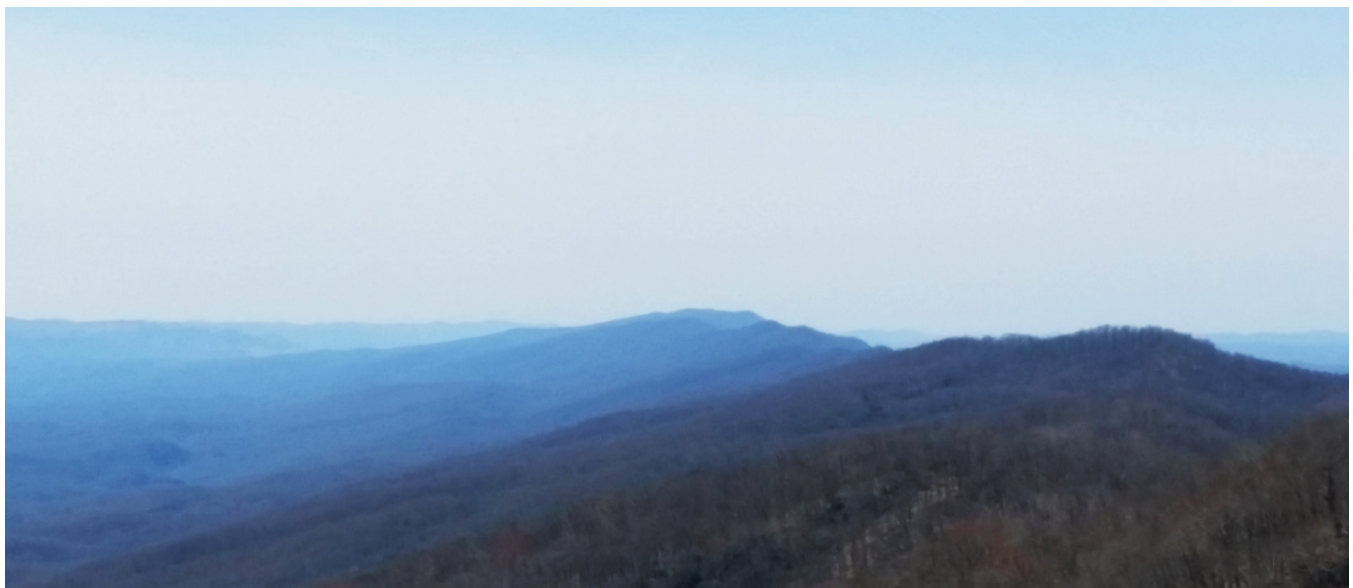
In 2021, there were minimal changes in the percentage of forest land acreage by survey unit. Of the five survey units (figs. 1 and 2) the Coastal Plain continued to have the lowest percentage of forest cover at 45.4 percent. The Southern and Northern Piedmont units were 67.6 and 56.1 percent forested, respectively. The Southern and Northern Mountain units were 65.2 and 65.7 percent forested, respectively (fig. 3).

Table 1—Area by survey unit and land status, Virginia, 2021

Unit	Total area	All forest	Unreserved			Reserved			Nonforest land	Census water
			Total	Timberland	Unproductive	Total	Productive	Unproductive		
thousand acres										
Coastal Plain	8,159.6	3,706.2	3,572.9	3,572.9	—	133.3	133.3	—	2,641.3	1,812.0
Southern Piedmont	5,673.5	3,835.8	3,809.3	3,804.9	4.4	26.4	20.5	5.9	1,757.4	80.3
Northern Piedmont	4,432.5	2,488.0	2,307.7	2,307.7	—	180.3	180.3	—	1,882.3	62.2
Northern Mountains	4,342.0	2,854.1	2,708.4	2,634.8	73.6	145.7	145.7	—	1,468.6	19.3
Southern Mountains	4,768.4	3,111.3	3,017.6	3,010.9	6.7	93.7	90.4	3.4	1,637.3	19.8
All survey units	27,376.0	15,995.4	15,415.9	15,331.2	84.7	579.6	570.3	9.3	9,386.9	1,993.6

Numbers in rows and columns may not sum to totals due to rounding.

— = no sample for the cell or a value of >0.0 but <0.05.



The view from Pine Mountain in the Blue Ridge Mountains, VA. (Virginia Department of Forestry photo by John Pemberton)



Figure 1—Counties and forest survey units, Virginia, 2021.

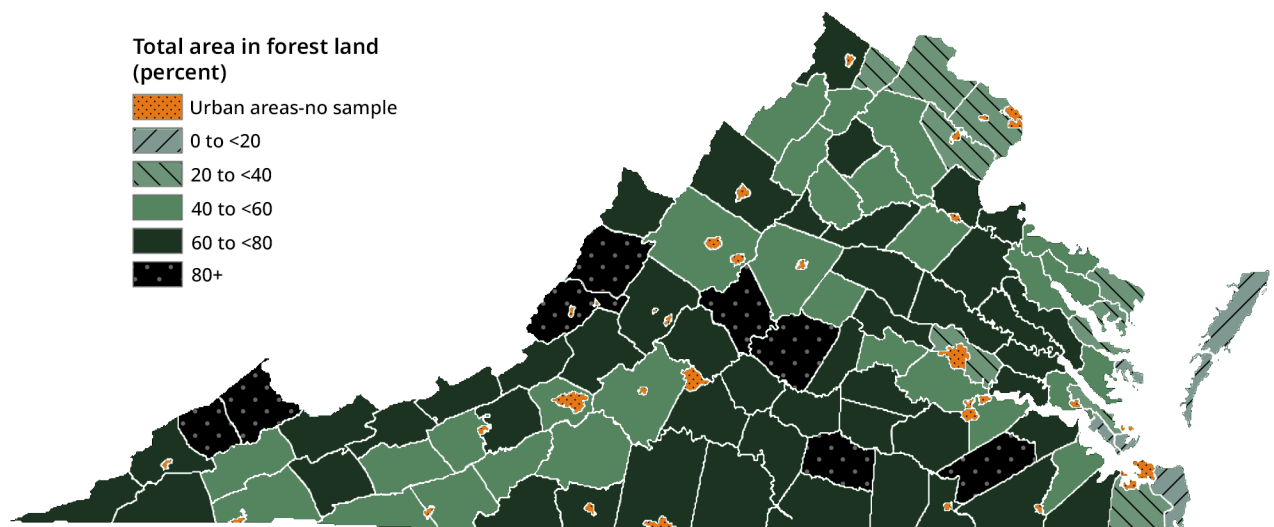


Figure 2—Percentage of county in forest land by county, Virginia, 2021.

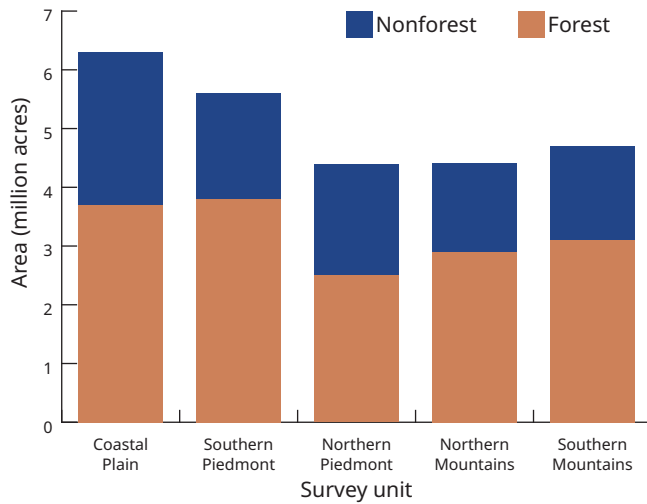


Figure 3—Forest and nonforest land area by survey unit, Virginia, 2021.

Forest Ownership, Forest Types, and Stand Size

Forest Ownership

Forest ownership in Virginia continues to be dominated by nonindustrial private forest ownership (fig. 4). Divestiture by forest products industry of its timberland and its acquisition by nonindustrial corporate entities, primarily Timber Investment Management Organizations (TIMOs) and Real Estate Investment Trusts (REITs), a trend that occurred across the Southern United States, has been largely completed and the distribution of land ownership stable in recent years. In 2001,

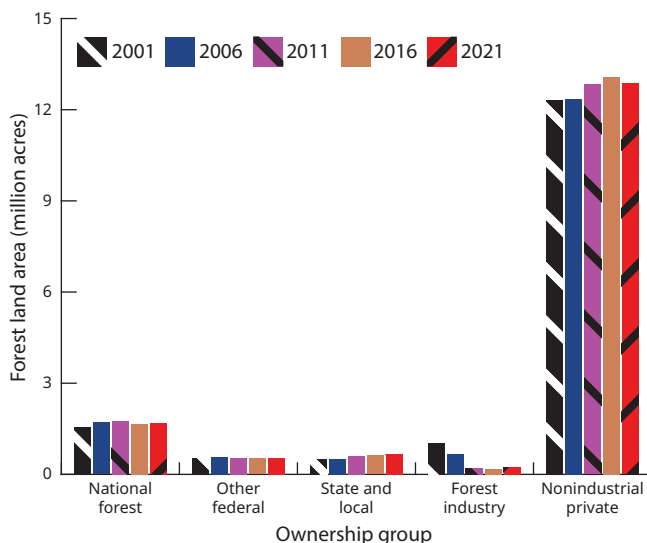


Figure 4—Forest land area by ownership group, Virginia, 2001–2021.

forest industry owned just over 1 million acres of forest land (Rose 2007). By 2021, that number dropped by 76 percent to 244.1 thousand acres.

Forest Types

The diversity of Virginia's forest-type groups are represented in figure 5. Forest type groups in which oaks predominate are the most common across the State, with the oak-hickory (60.6 percent) and oak-pine (10.4 percent) comprising over 70 percent of the forest. As previously stated in Brandeis and others (2018), the forests of Virginia lie within the transition zone of forest-type groups typical of the Southern United States to those found in the more northern States. Loblolly-shortleaf pine, a forest-type group very common across the South, is still the most extensive conifer group (almost 20 percent). But there are also small areas of conifer forest-type groups more typical of the North such as spruce-fir and white-red-jack pine (which primarily consists of eastern white pine in Virginia).



The oak-hickory forest type is the most prevalent across the State of Virginia. (Virginia Department of Forestry photo by John Pemberton)

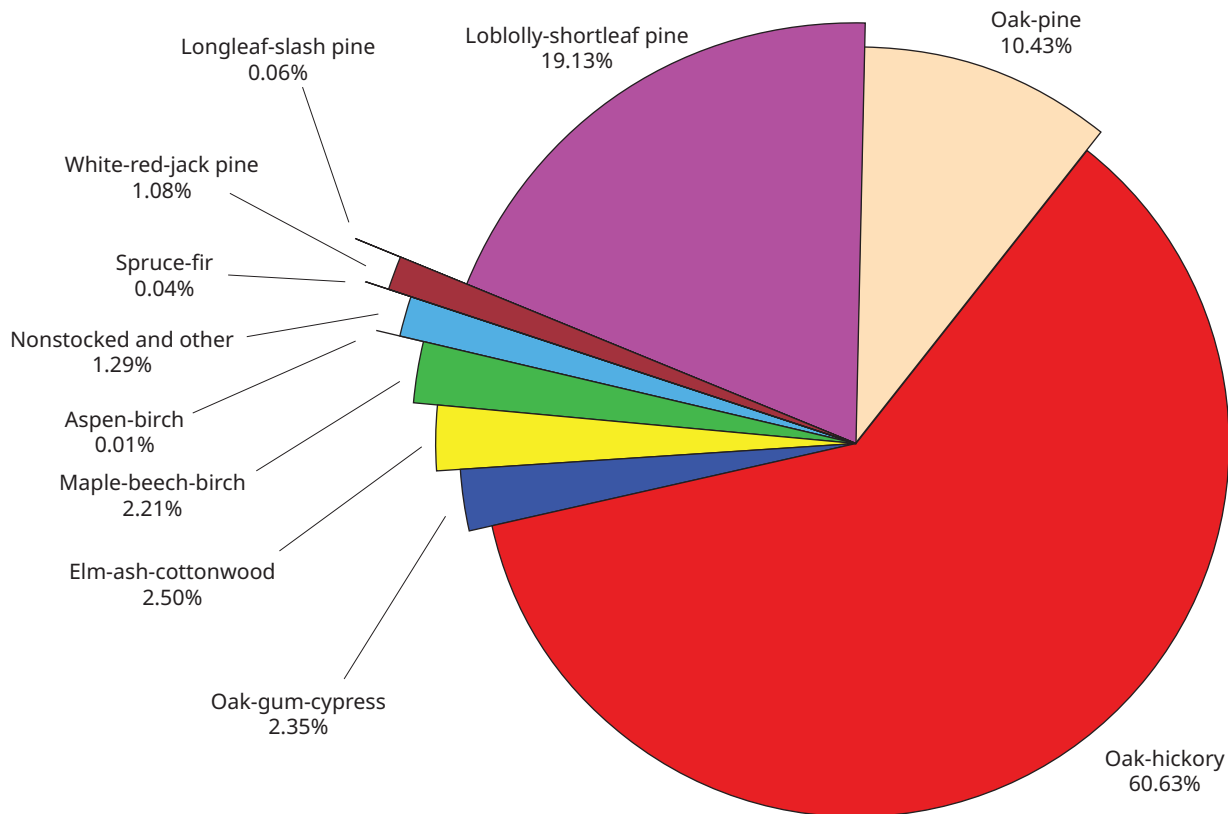


Figure 5—Percentage of forest land area by forest-type group, Virginia, 2021.

Shortleaf pine in Virginia—An update

In Brandeis and others (2018), we explored the status of shortleaf pine (*Pinus echinata*). Shortleaf pine is of special interest in the State because of its reduced population there and existence at the northern edge of the species' natural distribution, factors which make it valuable from the genetic diversity of the species perspective and vulnerable to loss from land-use or climate change. Here we update this examination of the species' status in the State of Virginia.

Shortleaf pine-dominated forests are defined as the combination of two FIA forest types, shortleaf pine (a forest type within the loblolly-shortleaf pine forest-type group) and shortleaf pine-oak (a forest type within the oak-pine forest-type group). In 2021, a total of 156 plots across the State contained at least one shortleaf pine ≥ 1 inch d.b.h.

(diameter at breast height). Nine plots contained enough stocking of shortleaf pine to be classified as the shortleaf pine forest type and 13 plots were stocked with enough shortleaf pine and oak species to be classified as the shortleaf pine-oak forest type. Shortleaf pine was observed within 16 other forest types, but most commonly found in association with loblolly and Virginia pine.

In 2021, the decline of shortleaf pine-dominated forests continued (fig. 6). During the period between 2001 and 2021 shortleaf pine-dominated timberland declined approximately 42 percent, over 63 thousand acres. The shortleaf pine resource is still concentrated in the southcentral part of the State (fig. 7), with the highest proportion of shortleaf pine stems and highest estimated shortleaf pine populations located in counties within the Southern Piedmont (fig. 7).

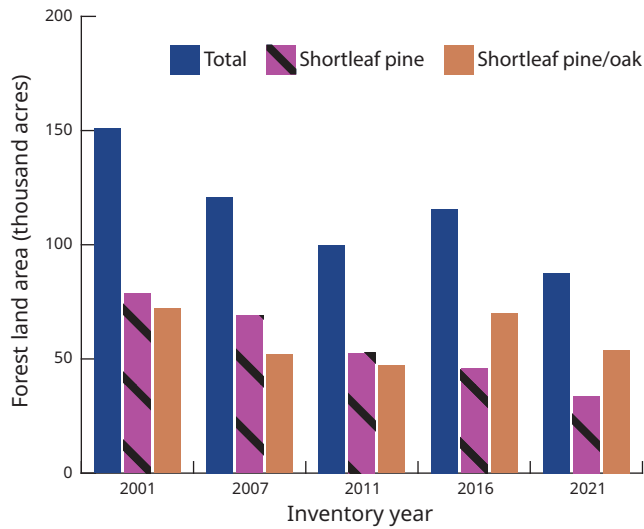


Figure 6—Forest land in shortleaf pine and shortleaf pine-oak forest types, Virginia, 2001–2021.

Stand Size

The average size of forests in Virginia has continued to evolve, although slowly. Our observations in 2016 (Brandeis and others 2018) continue to hold true in the 2021 forest stand structure, from the effects of State Reforestation of Timberlands, Farm Service Agency Forest Incentive, Environmental Quality Incentive, and Conservation Reserve Enhancement programs, and to a lesser extent, Federal incentive programs such as the Agriculture Conservation Program of the 1930s, the Soil Bank Program of the 1950s, and Conservation Reserve Program of the late 1980s (Conner and others 2004).

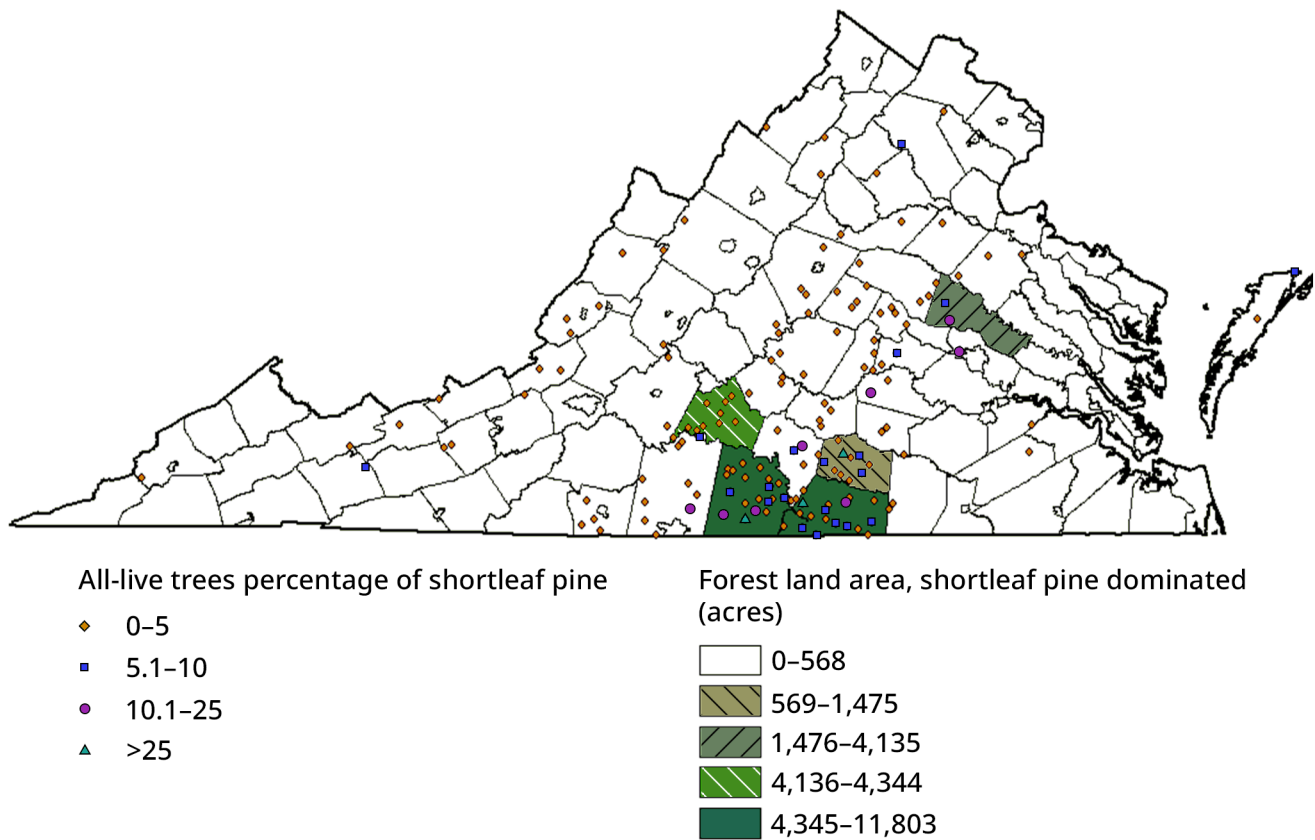


Figure 7—Distribution and density of shortleaf pine trees and forest land, Virginia, 2021.

In figure 8, the area of large-diameter, southern-pine forests (stands where the trees are predominately softwoods ≥ 9.0 inches d.b.h., which are also known as sawtimber trees) has been increasing since 2001, versus the area of small (1.0 to 4.9 inches in d.b.h.) or medium stand-size classes (5.0 to 8.9 inches d.b.h.), which has decreased over the same time frame. In 2001, only 39 percent of the pine forests were classified as large diameter. By 2021, over half (55 percent) of Virginia's pine forests fell in the sawtimber category, an increase since 2016. Hardwood forests exhibit the same pattern as softwood forests (although to a lesser extent); large-diameter hardwood stands (forests where there average d.b.h. is ≥ 11.0 inches) have increased since 2001 and small- (1.0 to 4.9 inches in d.b.h.) and medium-diameter (5.0 to 10.9 inches d.b.h) stands have declined (fig. 9), indicating that clearcutting of forests has declined and fewer new stands are being established. As observed previously, the predominance of large-diameter stands in hardwood-dominated forests is particularly compelling as hardwood forests require a larger average d.b.h. to be classified as large diameter.

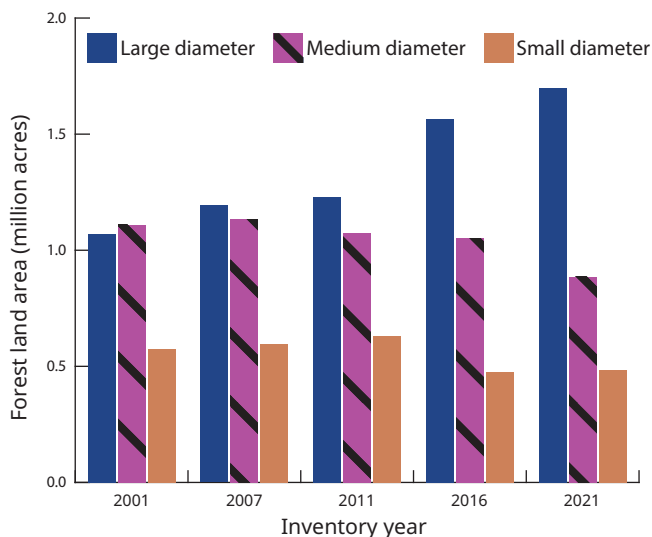


Figure 8—Southern pine forest (stands where the forest types are predominately pine species) land acreage by stand size class, Virginia, 2001–2021.

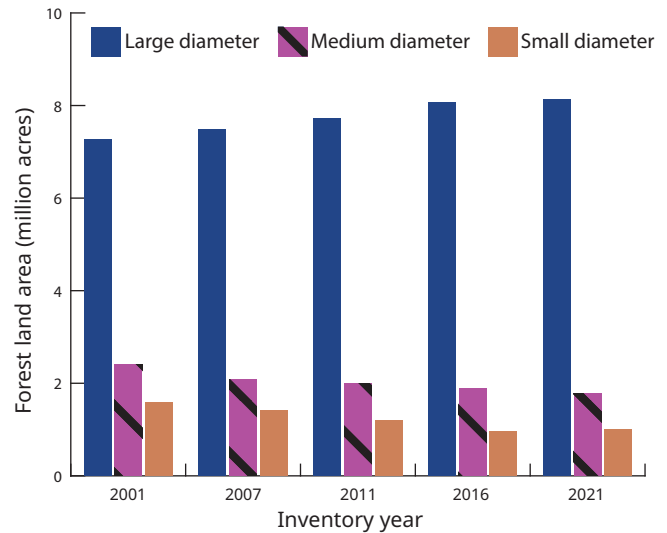


Figure 9—Hardwood forest (stands where the forest types are predominately hardwood species) forest land acreage by stand size class, Virginia, 2001–2021.



A pine plantation in Highland County, VA (Virginia Department of Forestry photo by Ryan Hewitt)

Forests and Land-Use Change

As in the previous report on the forests of Virginia (Brandeis and others 2018), we created a matrix of land-use change by using the remeasured plots that are also used to calculate tree-level growth, removals, and mortality (see Scott and others [2005] for the methods used to calculate these components of change, USDA Forest Service [2014] for the FIA field guide on field plot data collection and the FIA plot layout, and Brandeis and others [2018] for the limitations of this approach).

Annualized area change was estimated in Virginia from 2005 to 2021. Looking at land-use change over time shows not only how many acres changed land use on average each year but also trends in the rate of those changes. Figure 10 shows that this most recent period (2017–2021) featured the continuation of the slow decline in reforestation of agricultural and developed land, partially offset by increases in the acreage being converted from forest to nonforest. As with the total acreage estimates, these land-use changes indicate a relatively stable forest land base.

Focusing on softwood forests only (those predominantly consisting of pines and other conifers), about two-thirds were planted (67.5 percent) and one-third naturally regenerated (32.5 percent) (table 2). This is primarily due to the



After many years of reforestation of agricultural land, land uses across the State of Virginia have become relatively stable (Virginia Department of Forestry photo by John Pemberton)

Table 2—Area of softwood stands by ownership group and stand origin in Virginia's forests, 2021

Ownership group	Total	Natural	Planted
<i>thousand acres</i>			
National forest	91.1	84.9	6.2
Other Federal	81.9	56.3	25.6
State and local	103.7	37.4	66.3
Private	3,057.7	905.6	2,152.1
Total	3,334.5	1,084.2	2,250.3

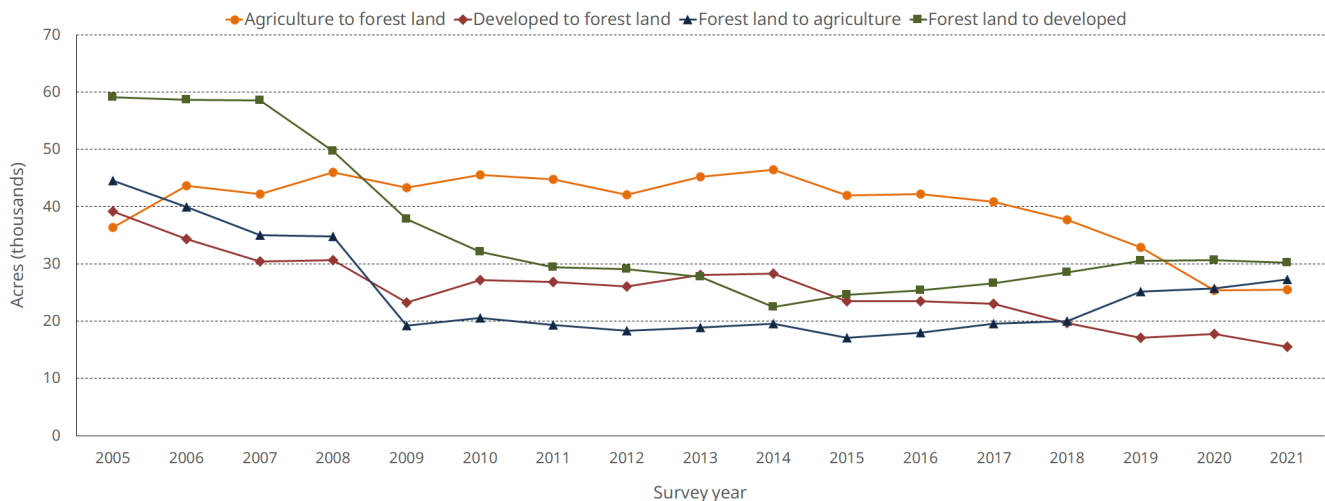


Figure 10—Annualized land-use change, Virginia, 2005–2021.

similar distribution found on private lands where most of the softwood acreage is found, and to a lesser extent on State and locally owned public lands. The situation is markedly different on Federal public lands where most softwood stands are naturally regenerated (93.2 percent in national forests and 68.7 percent on other Federal lands). Figure 11 shows that the rate at which natural pine stands were harvested and artificially regenerated has largely stabilized over the past 5 years, almost equaling the rate at which planted pine stands were not replanted or were not sufficiently successfully regenerated to be considered a plantation by field crew or the FIA forest typing algorithm.



Virginia's rural landscape is a patchwork of agricultural and forest lands as seen here in Burke's Garden (USDA Forest Service photo by Tom Brandeis)

NUMBER OF TREES, VOLUME, AND BIOMASS

There were somewhat fewer live trees in 2021 (10.7 billion with a d.b.h. ≥ 1 inch, down from 11.4 billion) than in 2016, but the predominate species remained largely the same as before (red maple [*Acer rubrum*] and loblolly pine [*Pinus taeda*]) (tables 3 and A3.25). Net volume in trees with d.b.h. ≥ 5 inches increased from 39.4 billion cubic feet (bcf) in 2016 to 43.4 bcf in 2021, and aboveground live biomass in trees with d.b.h. ≥ 1 inch increased from 2.1 to 2.3 billion tons (table 3).

The species group with the largest amounts of live tree wood volume in Virginia's forests was loblolly and shortleaf pines (18.7 percent of total volume) (table 4). The next most voluminous species was yellow-poplar (17.0 percent of total volume). The combined groups of all oak trees have 29.4 percent of total volume.

As done in the previous reports, we examined trends in wood volume further back in time by including those forest inventories in Virginia that were previously limited to timberland (a subset of all forest land which excludes lands reserved from timber harvesting by statute). Net volume has increased steadily for both hardwood and softwood species (fig. 12), to reach its current level of 30.2 bcf in hardwoods and 11.3 bcf in softwoods (table 4).

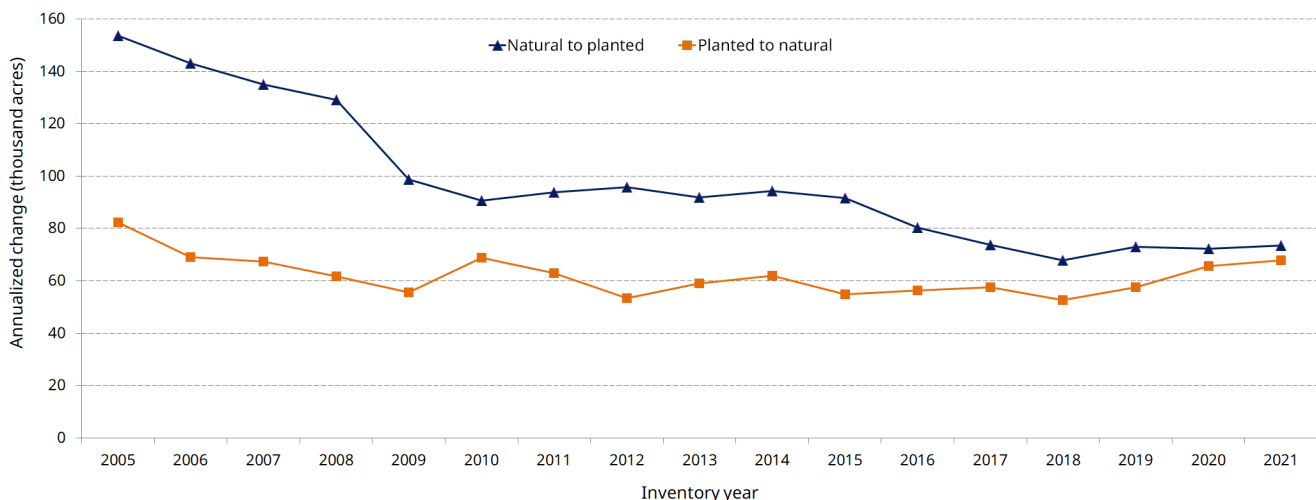


Figure 11—Annualized pine forest stand origin change, Virginia, 2005–2021.

VIRGINIA'S FORESTS, 2021

Table 3—Number of live trees (d.b.h. ≥ 1 inch), net volume (in trees with d.b.h. ≥ 5 inches) and aboveground green weight (in trees with d.b.h. ≥ 1 inch) on forest land by species group, Virginia, 2021

Species group		Number of live trees	Net volume	Aboveground green weight
		<i>million trees</i>	<i>million cubic feet</i>	<i>thousand tons</i>
Softwood	Longleaf and slash pines	4.1	0.1	84.2
	Loblolly and shortleaf pines	1,138.0	8,113.8	370,019.2
	Other yellow pines	391.4	1,631.0	78,698.5
	Eastern white and red pines	162.2	1,213.3	46,015.8
	Spruce and balsam fir	3.3	30.2	1,324.5
	Eastern hemlock	35.5	173.0	9,695.2
	Cypress	5.1	83.0	4,226.0
	Other eastern softwoods	227.0	282.6	16,055.1
	Total softwoods	1,966.5	11,526.9	526,118.5
Hardwoods	Select white oaks	377.9	3,611.2	208,102.5
	Select red oaks	143.6	2,123.0	120,365.4
	Other white oaks	321.4	3,837.8	207,922.0
	Other red oaks	413.2	3,182.2	191,170.6
	Hickory	400.8	1,791.1	103,610.4
	Yellow birch	7.1	27.9	1,589.4
	Hard maple	159.7	524.8	32,568.6
	Soft maple	1,317.0	2,693.8	157,163.3
	Beech	311.8	829.4	53,974.3
	Sweetgum	763.7	1,441.1	75,824.3
	Tupelo and blackgum	619.1	717.1	41,174.3
	Ash	148.2	443.5	18,414.4
	Cottonwood and aspen	7.2	27.2	1,352.7
	Basswood	25.8	267.4	12,008.7
	Yellow-poplar	936.0	7,361.7	325,558.4
	Black walnut	30.9	232.1	15,789.4
	Other eastern soft hardwoods	631.9	1,494.8	76,970.4
	Other eastern hard hardwoods	980.1	694.5	52,552.5
	Eastern noncommercial hardwoods	1,182.4	552.1	43,616.4
	Urban-specific hardwoods	4.1	2.4	180.1
	Total hardwoods	8,781.8	31,855.0	1,739,908.2
All species		10,748.3	43,381.9	2,266,026.7

Numbers in rows and columns may not sum to totals due to rounding.

Table 4—Net volume of live trees on forest land by species group and stand origin, Virginia, 2021

Species Group		Total	Stand Origin	
			Planted	Natural
		million cubic feet		
Softwood	Longleaf-slash pine	0.10	—	0.10
	Loblolly and shortleaf pine	8,113.77	2,463.06	5,650.71
	Other yellow pines	1,630.99	1,518.00	112.99
	Eastern white and red pine	1,213.29	1,079.13	134.16
	Spruce and balsam fir	30.19	30.19	—
	Eastern hemlock	173.00	172.28	0.71
	Cypress	83.02	83.02	—
	Other eastern softwoods	282.57	273.29	—
	Total softwoods	11,526.94	5,618.98	5,898.68
Hardwood	Select white oaks	3,611.16	57.98	3,553.19
	Select red oaks	2,122.97	17.36	2,105.61
	Other white oaks	3,837.80	21.73	3,816.08
	Other red oaks	3,182.22	89.64	3,094.93
	Hickory	1,791.13	12.70	1,778.43
	Yellow birch	27.86	—	27.86
	Hard maple	524.83	0.08	524.76
	Soft maple	2,693.80	80.90	2,612.90
	Beech	829.38	7.00	822.38
	Sweetgum	1,441.13	107.80	1,333.33
	Tupelo and blackgum	717.12	8.52	708.60
	Ash	443.49	3.68	439.81
	Cottonwood and aspen	27.16	4.28	22.88
	Basswood	267.37	0.09	267.28
	Yellow-poplar	7,361.67	229.50	7,132.17
	Black walnut	232.13	3.18	228.95
	Other eastern soft hardwoods	1,494.77	47.24	1,447.53
	Other eastern hard hardwoods	694.51	21.09	673.42
	Eastern noncommercial hardwoods	552.09	13.54	538.55
	Total hardwoods	31,852.61	726.33	31,128.64
All Species		43,381.90	6,631.93	36,749.97

— = no sample for the cell.

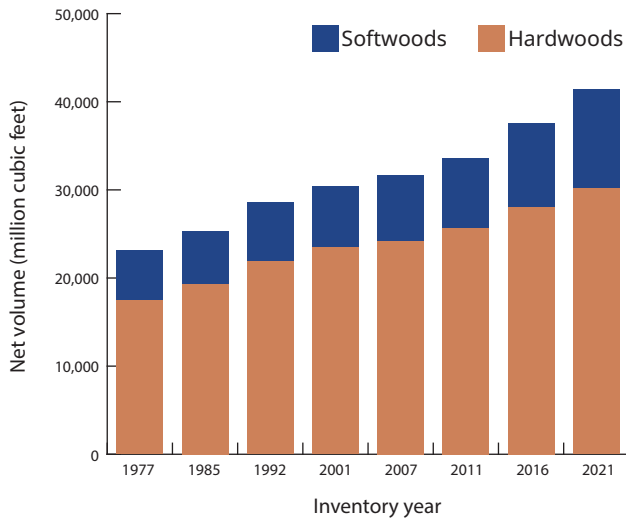


Figure 12—All-live net volume on timberland by major species group, Virginia, 1977–2021.

The softwood volume is almost evenly split between stands that were naturally regenerated (5.6 bcf) and those that were planted (5.9 bcf). Hardwood volume is predominately in naturally regenerated stands and perhaps even the relatively small percentage of hardwood volume in planted stands could be hardwood trees that regenerated naturally within softwood plantations rather than planted hardwood trees.

As mentioned previously, the broad patterns of forest land ownership in Virginia have remained

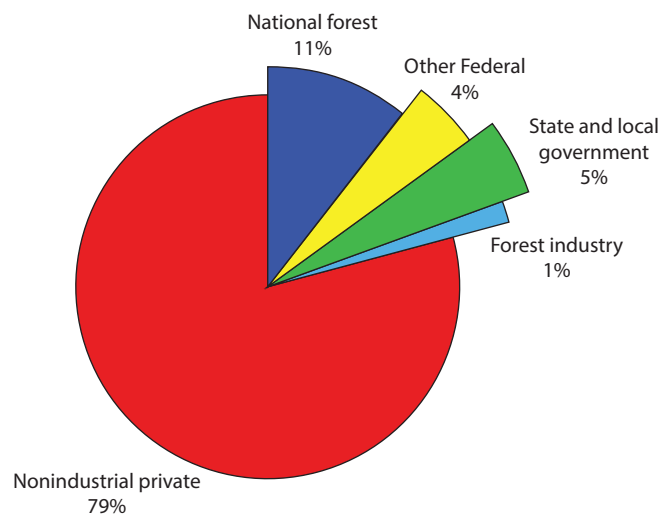


Figure 13—All-live net volume of live trees on forest land by ownership class, Virginia, 2021.

largely unchanged. This is also reflected in the ownership of wood volume on those lands. The bulk of the wood volume (79 percent) is owned by nonindustrial private landowners (fig. 13). One percent of the volume is on lands owned by forest industries, and 20 percent of the volume is on public lands.

The distribution of wood volume by tree diameter class is in keeping with the trend of decreasing numbers of trees across the State but increasing overall wood volume. Wood volume in the larger diameter classes continued to increase while that in the smaller diameter classes remained relatively unchanged (figs. 14 and 15). For softwood volume, volume in the smallest diameter class (5.0–6.9 inches) fluctuated but remained fairly stable, and trees with diameters of ≥ 9.0 inches continued to hold an increasing proportion of the total volume (fig. 14). Hardwood trees show similar volume distribution patterns but less strongly than softwoods (fig. 15). The increased hardwood volume was slightly more concentrated in the larger, sawtimber-sized trees (d.b.h. ≥ 17 inches). Overall, the State's sawtimber resource continued to grow for both hardwoods and softwoods in table 5.

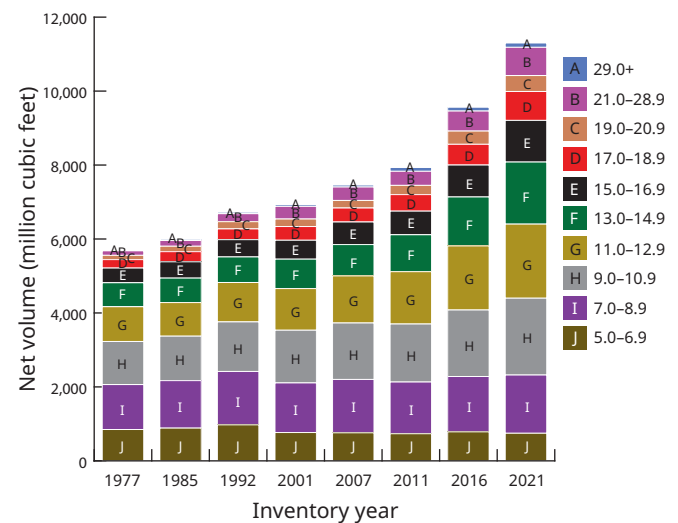


Figure 14—All-live net softwood volume on timberland by diameter class, Virginia, 1977–2021.

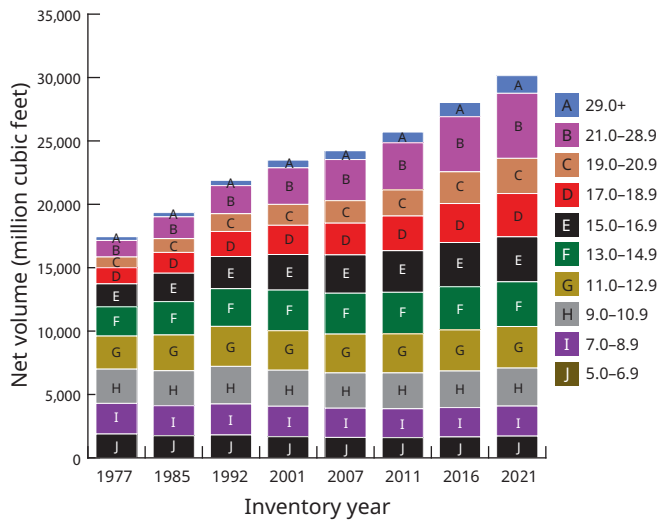


Figure 15—All-live net hardwood volume on timberland by diameter class, Virginia, 1977–2021.

Table 5—Net volume in the sawlog portion of sawtimber trees on timberland, Virginia, 1977–2021

Inventory year	Total	Softwoods	Hardwoods
<i>million cubic feet</i>			
1977	10,558	3,169	7,389
1985	11,407	3,187	8,220
1992	15,307	3,801	11,507
2001	16,699	4,158	12,541
2007	17,371	4,498	12,873
2011	19,571	5,077	14,494
2016	22,971	6,448	16,523
2021	26,020	7,953	18,067

GROWTH, REMOVALS, AND MORTALITY

In 2021, 53.6 percent of the total net annualized growth of 1.4 bcf per year was on hardwood trees and 46.4 percent on softwoods (table 6). As in 2016, yellow-poplar trees accumulated the most volume annually over the 2017 to 2021 inventory period (35.2 percent of the total hardwood growth) but many other hardwood species like oaks (31.0 percent cumulatively) and maples also contributed significantly to total hardwood

growth. Notable was the negative growth (a loss of 33.6 million cubic feet [mmcf] of volume per year over the 2017 to 2021 measurement period) of ash trees (*Fraxinus* spp.). (See the section on emerald ash borer and its impact on ash trees in the [Insects, Diseases, and Species of Concern](#) section of this bulletin for more information on this issue.) Softwood net growth was again heavily concentrated on planted loblolly pines. Hardwood average annualized growth had been increasing during the previous three periods of annualized forest inventory but now shows little change since 2016 (fig. 16). Softwood growth, however, continues to increase. Removals in both softwood and hardwood species groups have begun to increase after a period of decline, with annualized removals of softwoods now exceeding that observed in 2007. Since the 2007 inventory, natural mortality has remained consistently low and relatively unchanging in softwoods but hardwood mortality shows a gradual increase.

A greater proportion of wood volume comes from trees growing in stands mostly made up of larger diameter trees. For hardwoods, average annualized growth on trees growing in large-diameter stands increased though it remained relatively stable or decreased slightly in medium- and small-diameter stands (fig. 17). Net annual softwood growth from trees in all stand-size classes had been increasing over time but this situation changed from 2017 to 2021. The amount of volume grown annually on trees in small-diameter stands decreased since the 2016 inventory period. Volume grown on trees in medium-diameter stands remained stable but was overtaken by the growth on trees in large-diameter stands, which had increased considerably.

The distribution of average annual removals from Virginia's forests from 2017 to 2021 is similar to that of net annual growth (table 7). Softwood removals were again concentrated in planted loblolly pine as was net growth though hardwood removals were spread across many species as was their net growth. Average annual volume removed had been declining for both hardwoods and

Table 6—Net average annual growth of live trees on forest land by species group and stand origin, Virginia, 2017–2021

Species group		Total	Stand origin	
			Natural	Planted
million cubic feet				
Softwood	Longleaf and slash pine	0.02	—	0.02
	Loblolly and shortleaf pine	594.54	121.35	473.19
	Other yellow pines	14.40	9.81	4.58
	Eastern white and red pine	43.36	35.05	8.32
	Spruce and balsam fir	0.84	0.84	—
	Eastern hemlock	0.53	0.49	0.04
	Cypress	2.76	2.51	0.25
	Other eastern softwoods	7.44	6.78	0.66
	Total softwoods	663.88	176.83	487.06
Hardwood	Select white oaks	73.96	71.34	2.61
	Select red oaks	39.06	38.48	0.58
	Other white oaks	57.15	56.58	0.57
	Other red oaks	68.18	63.51	4.66
	Hickory	34.36	33.87	0.49
	Yellow birch	0.80	0.80	—
	Hard maple	16.75	16.74	0.01
	Soft maple	56.34	52.70	3.64
	Beech	29.72	28.77	0.95
	Sweetgum	50.12	43.86	6.26
	Tupelo and blackgum	13.22	12.84	0.38
	Ash	-33.64	-33.88	0.23
	Cottonwood and aspen	1.01	0.41	0.59
	Basswood	4.07	4.05	0.02
	Yellow-poplar	270.12	251.21	18.91
	Black walnut	9.24	8.92	0.33
	Other eastern soft hardwoods	47.93	44.68	3.25
	Other eastern hard hardwoods	11.50	10.43	1.07
	Eastern noncommercial hardwoods	17.92	16.70	1.22
	Total hardwoods	767.81	722.01	45.79
All species	1,431.69	898.84	532.85	

— = no sample for the cell.

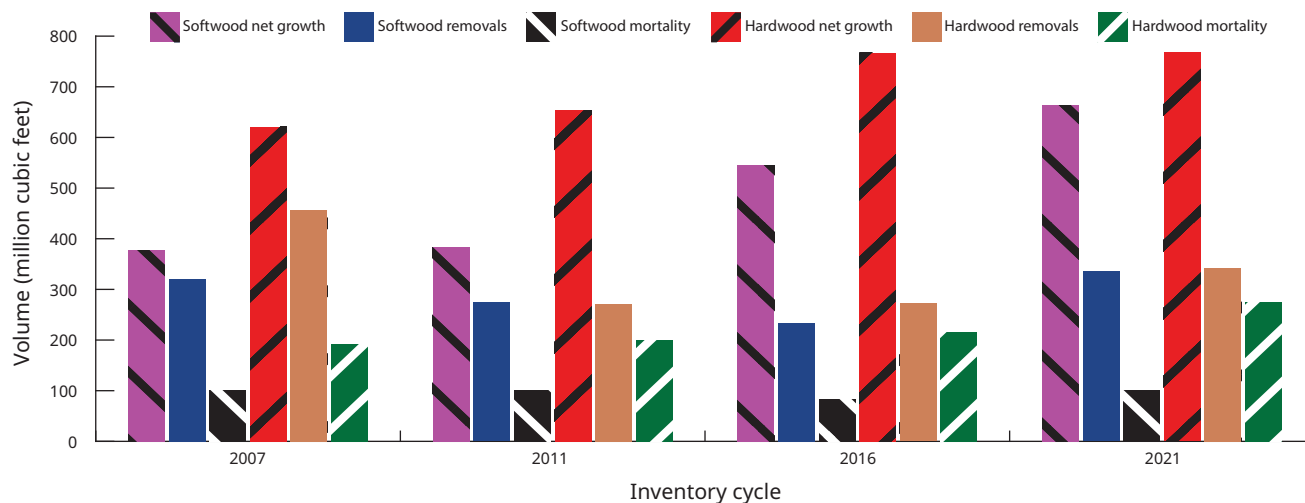


Figure 16—All-live average annual cubic-foot volume growth, removals, and mortality on forest land by survey year, Virginia, 2007–2021.

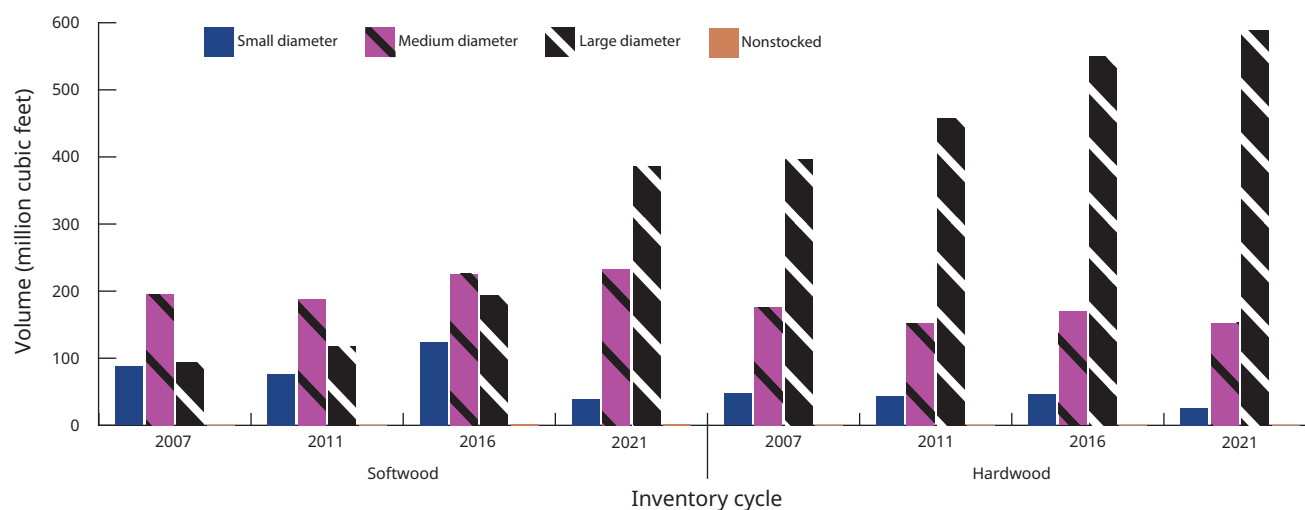


Figure 17—All-live net growth by major species group and stand-size class, Virginia, 2007–2021.

softwoods until the 2017 to 2021 period when both increased (fig. 18). In the case of softwoods, the increase brought average annualized removals to a level even higher than that observed in the 2007 inventory period.

Hardwood removals in Virginia have been concentrated in the large-diameter stands due to the use of these tree species for sawn lumber rather than pulp products. In an interesting shift, average annualized removals from medium-diameter softwood stands decreased though those from large-diameter stands increased, potentially, but not necessarily, indicating greater pine use for sawn lumber rather than pulp and

paper products. In Brandeis and others (2018) we speculated that the decreasing removal volumes observed from 2007 to 2016 reflected the economic downturn experienced from 2007 to 2009 and overall weakened demand for wood products. The increase in removals may thus reflect economic recovery and strengthened wood products markets.

Hardwood tree volume lost as average annual mortality has continued to increase over time, particularly in large-diameter stands (fig. 19). But average annual mortality volume losses still remained well below average annual growth volume gains, and net growth continued to exceed

Table 7—Average annual removals of live trees on forest land by species group and stand origin, Virginia, 2017–2021

Species group		Total	Stand origin	
			Natural	Planted
million cubic feet				
Softwood	Loblolly and shortleaf pine	306.71	63.64	243.07
	Other yellow pines	18.98	15.67	3.31
	Eastern white and red pine	6.37	4.44	1.93
	Eastern hemlock	0.03	0.03	—
	Cypress	0.63	0.63	—
	Other eastern softwoods	2.40	2.15	0.25
	Total softwoods	335.12	86.56	248.56
Hardwood	Select white oaks	52.27	51.18	1.08
	Select red oaks	14.31	14.21	0.10
	Other white oaks	21.21	21.21	—
	Other red oaks	45.66	43.55	2.11
	Hickory	20.65	20.14	0.51
	Yellow birch	0.12	0.12	—
	Hard maple	2.67	2.67	—
	Soft maple	24.66	23.43	1.24
	Beech	4.77	4.19	0.58
	Sweetgum	25.74	22.61	3.13
	Tupelo and blackgum	5.05	4.99	0.06
	Ash	6.09	6.02	0.07
	Cottonwood and aspen	0.61	0.08	0.53
	Basswood	0.53	0.53	—
	Yellow-poplar	92.42	85.75	6.68
	Black walnut	2.67	2.67	—
	Other eastern soft hardwoods	12.94	12.26	0.68
	Other eastern hard hardwoods	5.14	4.62	0.52
	Eastern noncommercial hardwoods	4.49	4.40	0.09
	Total hardwoods	341.99	324.61	17.38
All species		677.11	411.18	265.94

— = no sample for the cell.

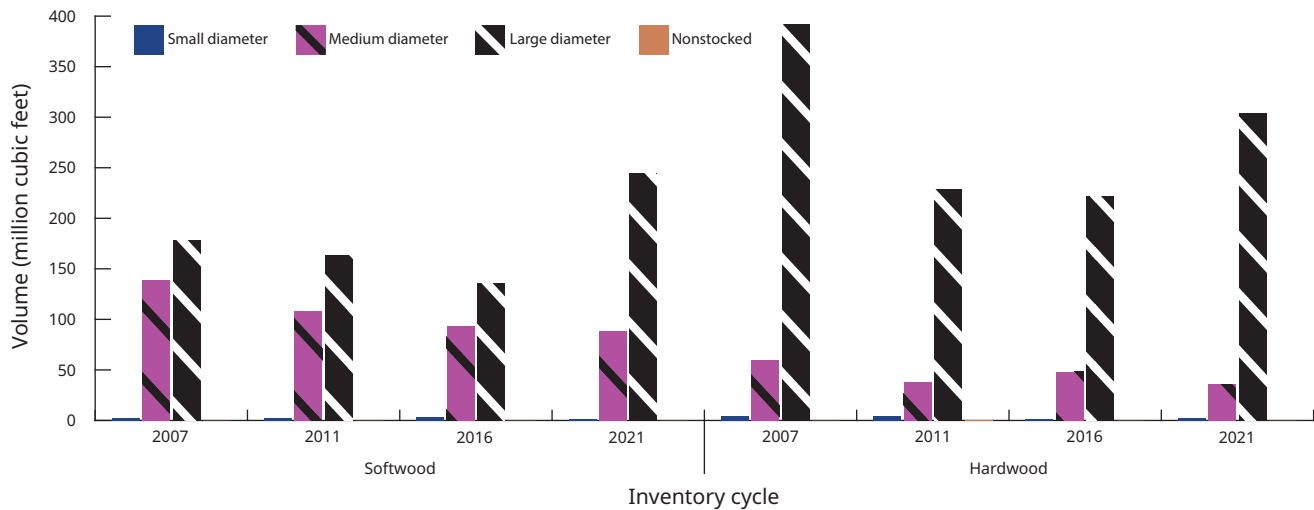


Figure 18—Volume of removals by major species group and stand-size class, Virginia, 2007–2021.

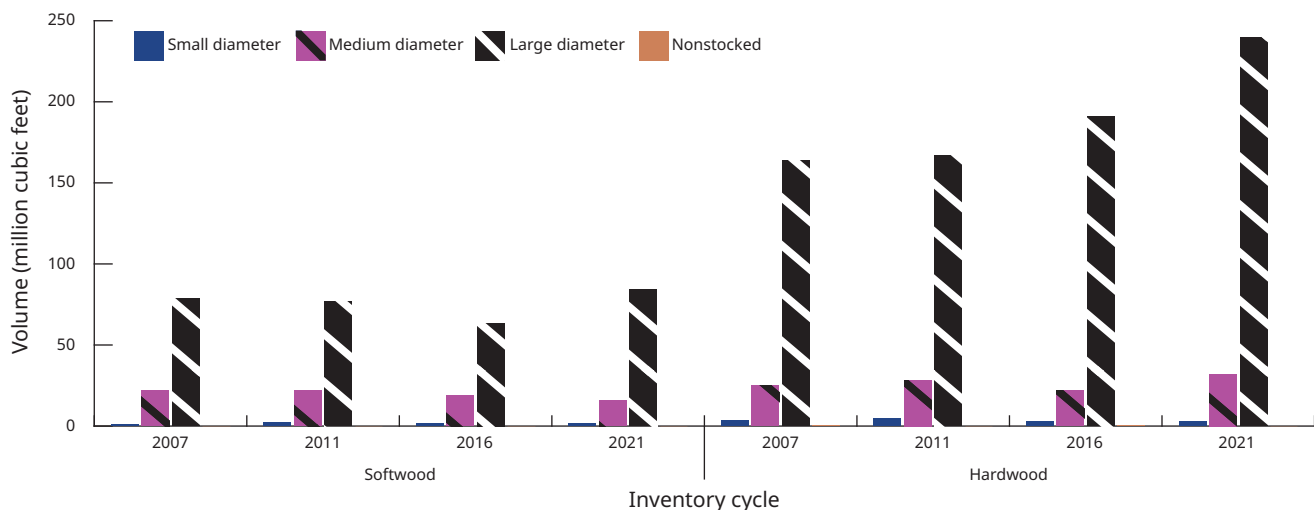


Figure 19—Volume of mortality by major species group and stand size-class, Virginia, 2007–2021.

removals for both softwoods and hardwoods, an indication of timber harvest sustainability. When the ratio of growth to removals is greater than 1.0, that means annual growth exceeds annual removals. A growth to removals ratio of 2.0 means twice as much wood volume is grown as is removed annually. Growth of hardwoods in medium-diameter stands continued to exceed removals with growth to removals ratios of 2.9 in 2007, 4.0 in 2011, 3.5 in 2016, and 4.2 in 2021 for medium-diameter stands (fig. 20). In large-diameter stands, however, hardwood net growth was only slightly greater than removals during the inventory period of 2002 to 2007 with a growth

to removals ratio of only 1.0. Growth to removals ratios were 2.0 in 2011, 2.5 in 2016, and 1.9 in 2021.

Softwoods growth to removals ratio trends continue the trajectory from 2016. Growth continued to increase and removals further decreased over time in medium-diameter stands, with growth to removals ratio increasing from 1.4 in 2007 to 2.6 in 2021 (fig. 21). As previously noted in Brandeis and others (2018), removals exceeded growth in large-diameter softwood stands in 2007 (growth to removals ratio of 0.5) and 2011 (growth to removals ratio of 0.7). However, removals exceeded growth in 2016 (growth to removals ratio of 1.4) and 2021 (growth to removals ratio of 1.6).

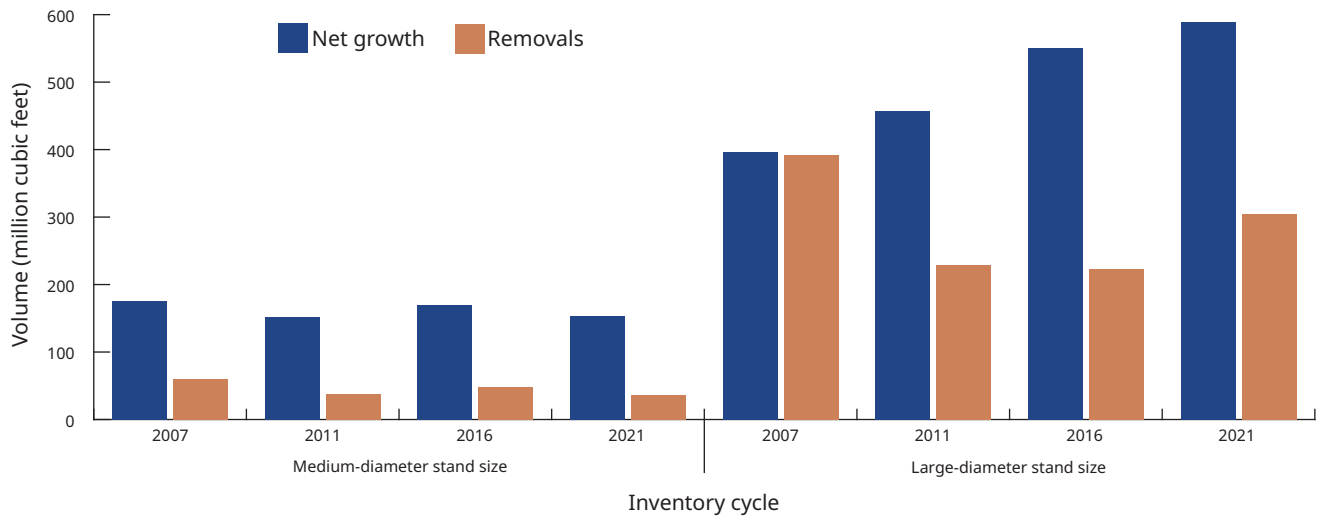


Figure 20—Hardwood net growth to removals volume for poletimber and sawtimber stand-size classes, Virginia, 2007–2021.

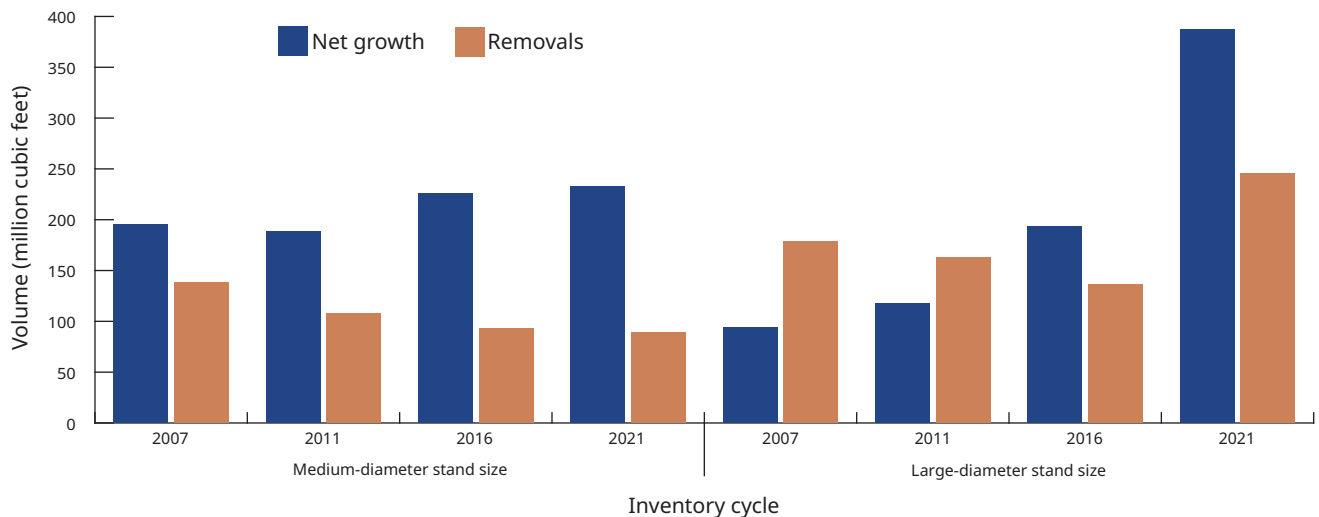


Figure 21—Softwood net growth to removals volume for poletimber and sawtimber stand-size classes, Virginia, 2007–2021.

Treated Acres

The types of silvicultural activity noted by the SRS FIA program are clearcut harvesting, partial harvesting, commercial thinning, timber stand improvement, and salvage cutting. Clearcut harvesting is where the majority of the merchantable trees in a stand are removed and utilized, with residual stand stocking lowered to <50 percent. Partial harvest is when primarily the highest quality trees are removed and the residual stand consists of lower quality trees in

the case of high grading or selection harvest. This cutting type can also include silvicultural systems that involve partial harvesting but not necessarily the retention of lower quality trees, e.g., uneven-aged management. Seed-tree/shelterwood harvesting, where crop trees are harvested leaving seed source trees either in a shelterwood or seed tree, are also noted but not often recorded in the Southern States. Commercial thinning involves the removal of trees (usually of medium diameter) from medium-diameter stands

leaving sufficient stocking of growing-stock trees to feature in future stand development. Also of note are timber stand improvements and salvage cutting (see the [Glossary](#) for more details on SRS FIA harvesting categories).

In contrast to the previous trends, acres clearcut increased from the levels observed in 2011 and 2016, again perhaps due to the economic recovery and increased demand for wood products (fig. 22). Partially harvested acres, in contrast, continued to decrease over time, and acres thinned dropped from previous levels during the 2021 inventory period. In Brandeis and others (2018), we speculated that the decrease in final clearcut harvesting but stable or slightly increased thinning activity might have indicated that stand tending activities were not as impacted by the economic downturn as were final harvests. The reversing of these treatment trends may be indicative of the improved forest product market conditions.

TIMBER PRODUCT OUTPUT AND UTILIZATION

Timber Products

This section presents estimates from FIA's National Resource Use Monitoring (NRUM) program, which includes data from Virginia's Timber Products Output (TPO) surveys and Harvest Utilization (HU) studies, covering the 2017–2021 period. Timber Products Output surveys are used to determine the types and amount of roundwood products (i.e., sawlogs, plywood and veneer logs, poles, etc.) received by primary wood using mills, the county of origin, species used, and how the mills disposed of wood residues produced. Harvest Utilization studies help determine the utilization of merchantable and nonmerchantable tree sections removed during harvest operations. Figure 23 shows the allocation of merchantable and nonmerchantable volume by species group and product type, with

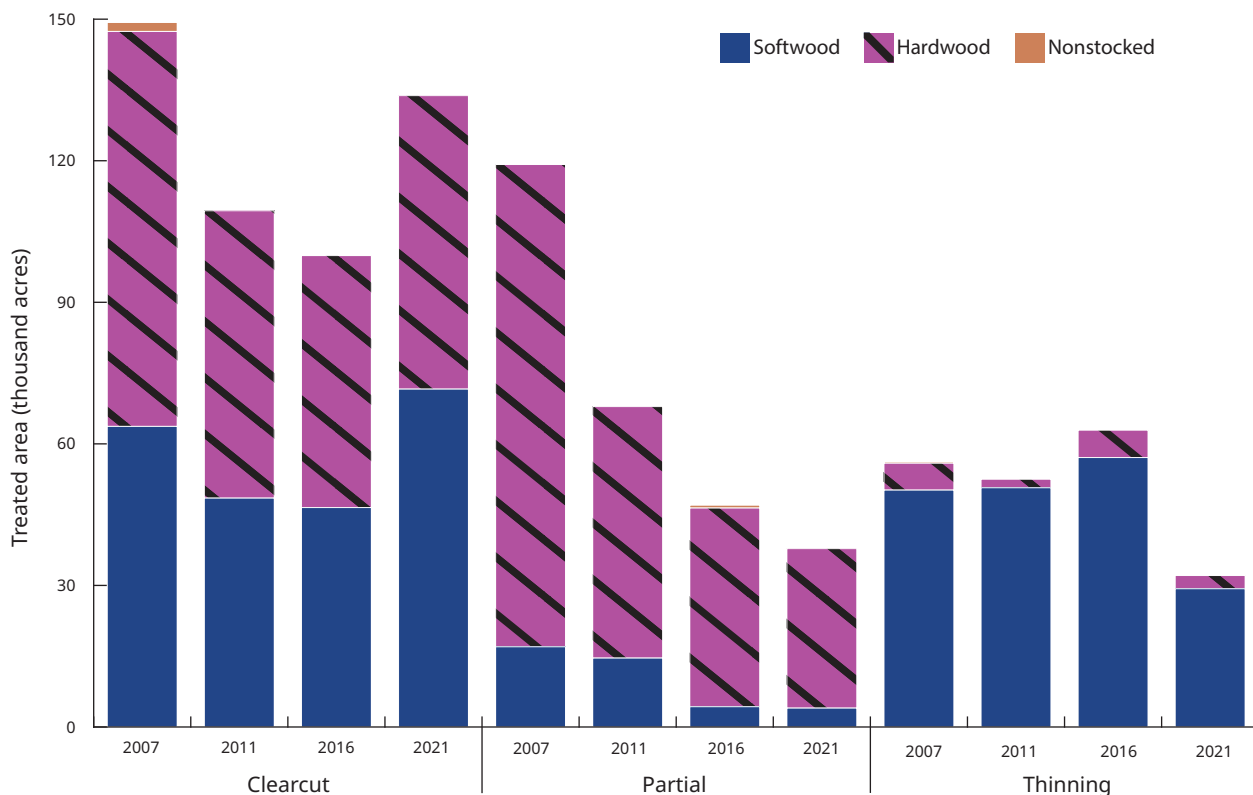


Figure 22—Area of forest land treated annually by forest-type group and cutting treatment class, Virginia, 2007–2021.

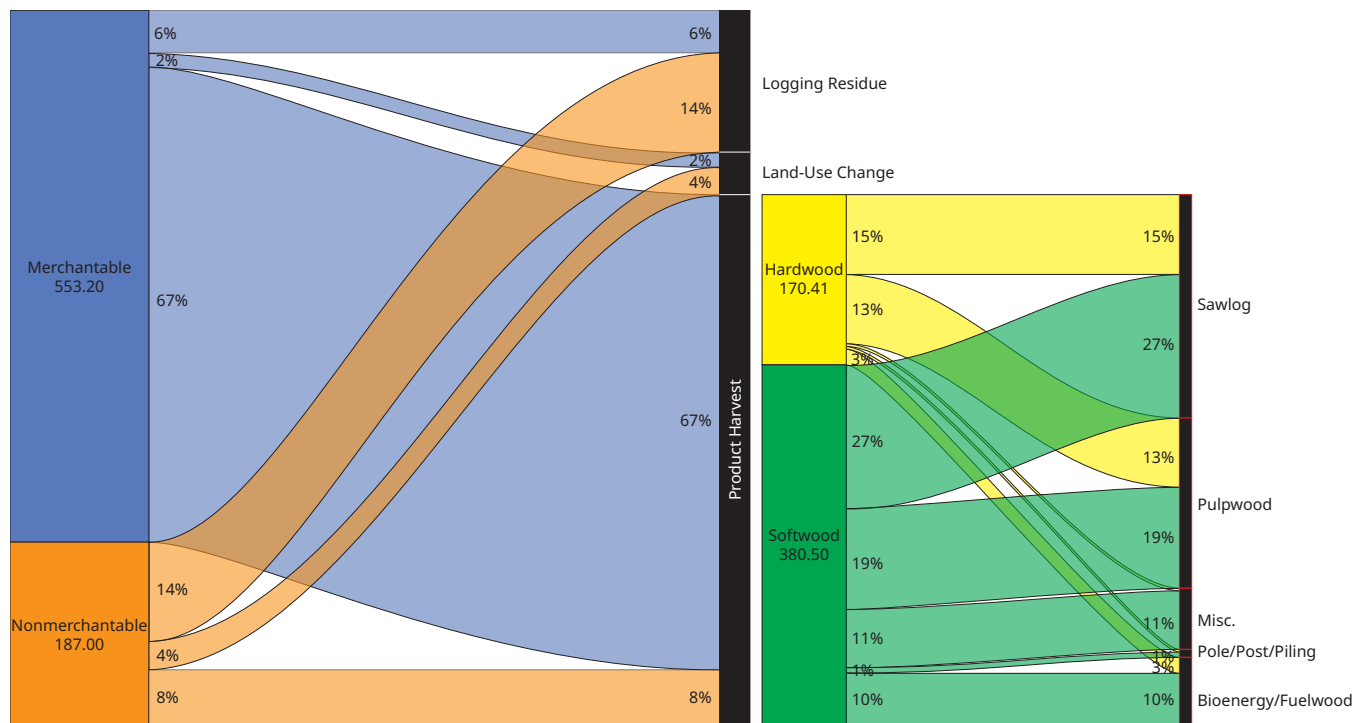


Figure 23—Total removals in million cubic feet by merchantability, species, and product, Virginia, 2021.

the largest amount of merchantable volume coming from softwoods and going into sawlogs and pulpwood. Prior to 2018, FIA collected TPO information through a biennial survey of all active primary mills. From 2018 forward, data collection has been based on an annual mill sample where roughly 40 percent of active mills are sampled using a stratified sample design (Coulston 2022).

Mill surveys are conducted by personnel from SRS and the Virginia Department of Forestry. Additionally, Virginia Department of Forestry personnel collect HU study data. HU data is collected at several active logging operations across the State. TPO and HU data are used to derive the proportions of FIA's all-live annual average harvest removals that are used for timber products and that are left behind as logging residue. Data used for this section were compiled from the NRUM Toolkit-TPO Interactive Reporting Tool and NRUM Data Download (USDA Forest Service 2021a, 2021b).



A log landing at a pine plantation harvest (USDA Forest Service photo by Jason Cooper)

Virginia's forest products industry includes a diverse mix of mills, ranging from small- to large-sized softwood and hardwood sawmills pole, veneer, composite, bioenergy, and other miscellaneous mills, to very large pulpmills. Though TPO studies in 2017 and 2021 reported a similar number of operating mills (164 and 163, respectively) those numbers fluctuated through the interval years. We observed a 9-percent

VIRGINIA'S FORESTS, 2021

increase from 2017 to 2018 (164 to 179 mills), and a gradual decrease over the following years (175 mills in 2019 and 166 mills in 2020). The total number of sawmills remained relatively stable from 2017 through 2019, ranging from 131 to 135. However, there was a notable decrease to 119 sawmills in 2020 and 116 sawmills in 2021.

The number of sawmills decreased by almost 12 percent over the report period.

In 2017, volume harvested and delivered for products (including residential fuelwood) totaled 632.3 mmcf (23.1 million green tons [mmgt]) (table 8, fig. 24). By the end of 2021, the State's total output had dropped by 6 percent to 593.5 mmcf

Table 8—Output of industrial roundwood products by product, species group, and year, Virginia, 2017–2021

Product	Species group	2017	2018	2019	2020	2021	2017	2018	2019	2020	2021
<i>thousand cubic feet</i>						<i>green tons</i>					
Sawlogs	Softwood	102,121	144,275	143,665	154,430	150,188	3,489,178	4,917,934	4,908,555	5,276,362	5,131,471
	Hardwood	105,930	113,213	80,191	112,592	85,234	4,032,017	4,184,571	3,069,278	4,309,458	3,261,433
	Total	208,051	257,488	223,856	267,023	235,422	7,521,195	9,102,505	7,977,833	9,585,820	8,392,903
Pulpwood	Softwood	163,544	119,762	111,167	109,804	105,102	6,067,388	4,509,264	3,932,481	3,883,711	3,717,345
	Hardwood	88,625	82,111	72,255	64,737	69,751	3,362,219	3,130,035	2,650,784	2,375,003	2,560,233
	Total	252,170	201,873	183,421	174,541	174,853	9,429,607	7,639,299	6,583,265	6,258,714	6,277,578
Bioenergy/ fuelwood	Softwood	20,311	70,889	46,285	65,072	56,902	712,188	2,485,701	1,622,985	2,281,760	1,995,276
	Hardwood	39,062	18,227	31,319	37,641	14,527	1,448,639	675,807	1,161,490	1,395,954	538,761
	Total	59,372	89,116	77,604	102,713	71,430	2,160,827	3,161,508	2,784,475	3,677,714	2,534,037
Poles, posts, pilings	Softwood	5,143	3,498	2,213	4,073	6,190	121,870	102,909	66,372	122,194	185,679
	Hardwood	6	15	36	15	15	238	437	1,094	437	437
	Total	5,148	3,513	2,249	4,088	6,204	122,108	103,347	67,465	122,631	186,116
Miscellaneous ¹	Softwood	59,228	60,899	63,524	58,377	62,076	2,079,898	2,130,218	2,214,998	2,036,232	2,164,785
	Hardwood	5,787	6,021	3,440	801	985	240,171	239,646	127,798	29,489	36,155
	Total	65,014	66,921	66,964	59,178	63,061	2,320,069	2,369,864	2,342,796	2,065,721	2,200,940
Total (industrial)	Softwood	350,347	399,324	366,853	391,757	380,458	12,470,522	14,146,027	12,745,390	13,600,259	13,194,555
	Hardwood	239,409	219,586	187,242	215,786	170,512	9,083,285	8,230,497	7,010,444	8,110,341	6,397,019
	Total	589,756	618,910	554,095	607,543	550,970	21,553,807	22,376,524	19,755,834	21,710,600	19,591,574
Residential fuelwood ²	Undifferentiated	42,560	42,560	42,560	42,560	42,560	1,596,000	1,596,000	1,596,000	1,596,000	1,596,000
	Total	42,560	42,560	42,560	42,560	42,560	1,596,000	1,596,000	1,596,000	1,596,000	1,596,000
Total	Softwood	350,347	399,324	366,853	391,757	380,458	12,470,522	14,146,027	12,745,390	13,600,259	13,194,555
	Hardwood	239,409	219,586	187,242	215,786	170,512	9,083,285	8,230,497	7,010,444	8,110,341	6,397,019
	Undifferentiated	42,560	42,560	42,560	42,560	42,560	1,596,000	1,596,000	1,596,000	1,596,000	1,596,000
	Total	632,316	661,470	596,655	650,103	593,530	23,149,807	23,972,524	21,351,834	23,306,600	21,187,574

Numbers in rows and columns may not add to totals due to rounding.

¹ Includes veneer, composite, mulch, shavings and other miscellaneous products.

² Residential fuelwood volume from the latest Department of Energy estimates.

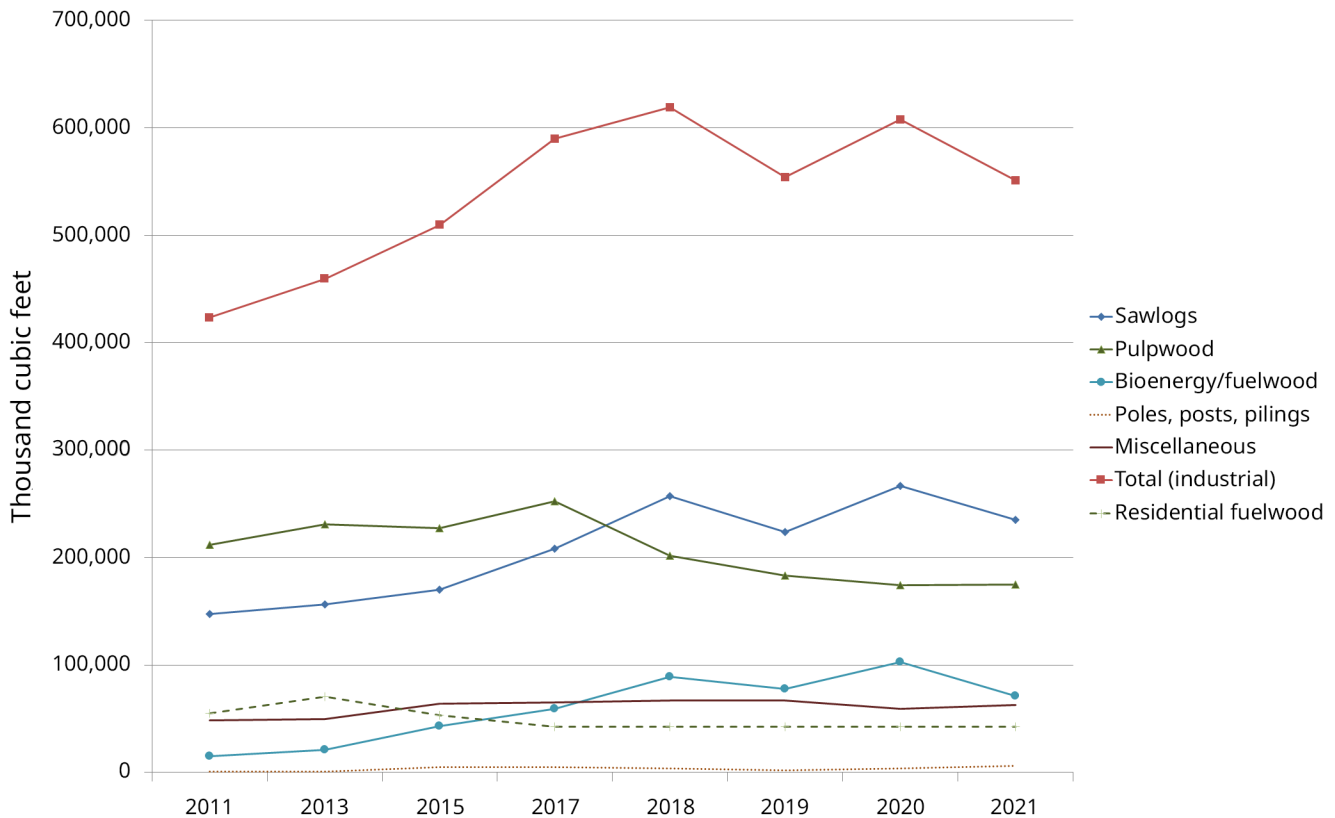


Figure 24—Output of Industrial roundwood products by product and year from 2011 to 2021.

(21.2 mmgt). Year to year changes varied, however, with a 5-percent volume increase in 2018 to 661.5 mmcf (24.0 mmgt), followed by a 10-percent decline in output to 596.7 mmcf (21.4 mmgt), before a 9-percent year over year drop in 2021 to the level previously mentioned. The overall decline in output was driven by decreasing hardwood roundwood production, though output of softwood roundwood products displayed an overall increase over the 2017–2021 period. Namely, for the 2017–2021 period, volume harvested for softwood products rose by 9 percent, from 350.3 mmcf (12.5 mmgt) in 2017 to 380.5 mmcf (13.2 mmgt) in 2021. Figure 25 illustrates the State's 2021 softwood and hardwood roundwood production. Like total roundwood production output, softwood roundwood production fluctuated year over year, increasing by 14 percent to 399.3 mmcf (14.1 mmgt) from 2017 to 2018, decreasing by 8 percent to 366.9 mmcf (12.7 mmgt) from 2018 to 2019, rising by 7 percent

in 2020 to 391.8 mmcf (13.6 mmgt) and decreasing by 3 percent to 380.5 mmcf (13.2 mmgt) in 2021. Softwood roundwood products' share of industrial production (not including undifferentiated fuelwood) also increased between 2017 and 2021, from 59 percent to 69 percent. In contrast, hardwood output volume showed more volatility for the report period, and trended downward overall, from 239.4 mmcf (9.1 mmgt) in 2017 to 170.5 mmcf (6.4 mmgt) in 2021.

Although the number of sawmills decreased over the 2017 to 2021 period, sawlog output increased by 14 percent over the same period, from 208.1 mmcf in 2017 to 235.4 mmcf in 2021. Over the past decade, the State has experienced 60-percent growth in sawlog production with softwood accounting for a larger share of total sawlog production over time. In 2017 softwoods accounted for 49 percent of sawlog output volume (102.1 mmcf, 3.5 mmgt) and hardwoods accounted

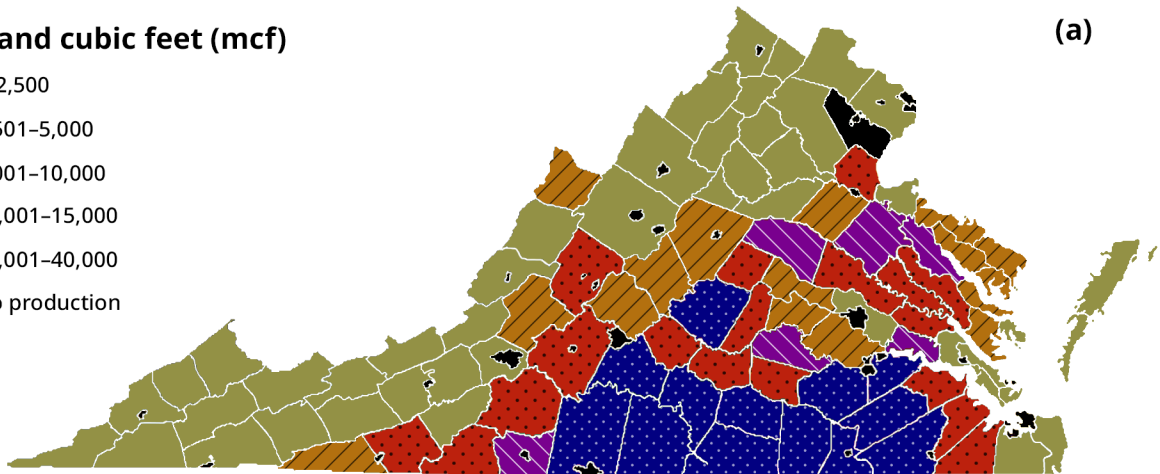
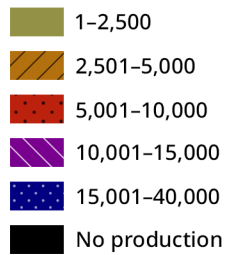
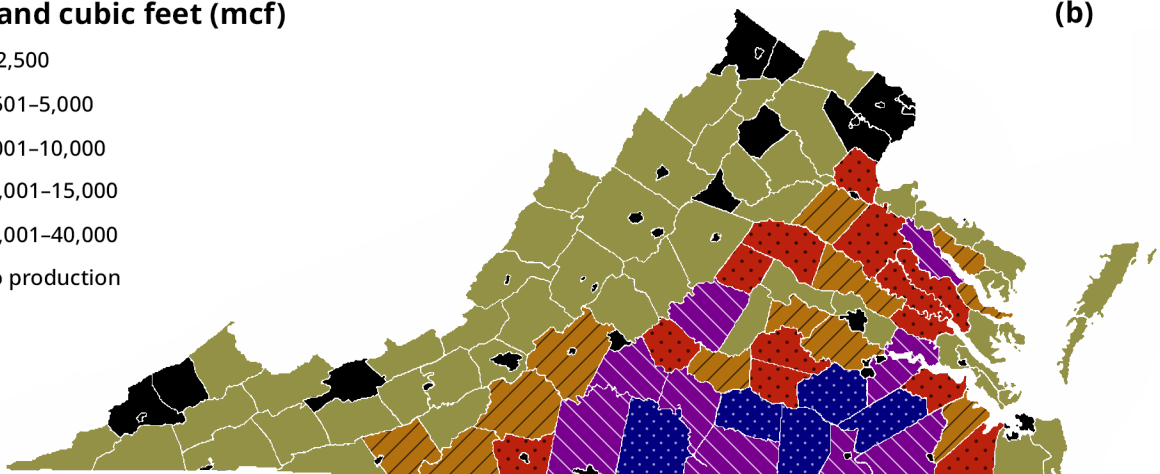
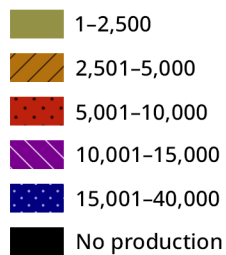
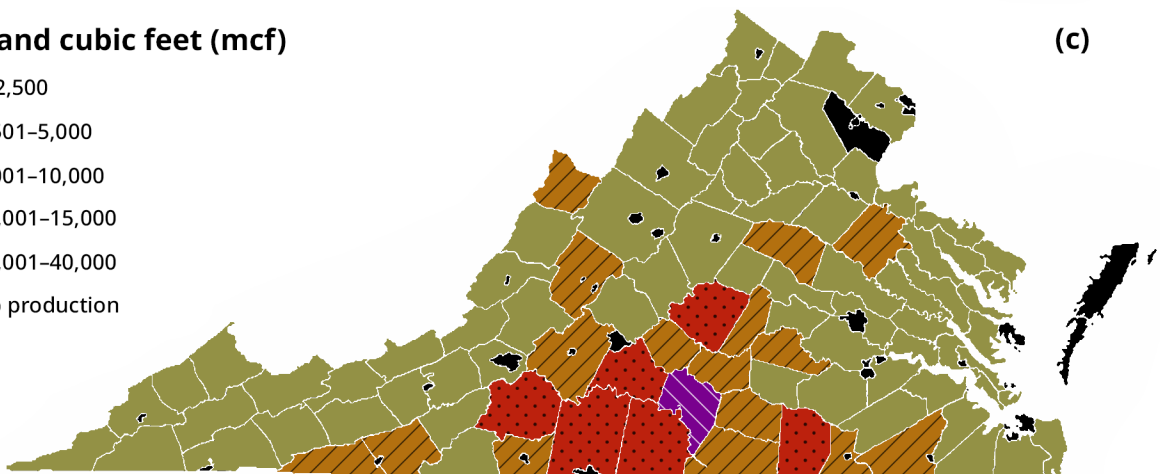
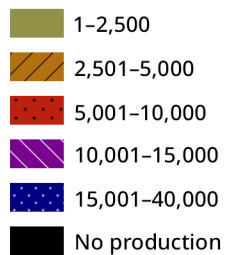
Thousand cubic feet (mcf)**Thousand cubic feet (mcf)****Thousand cubic feet (mcf)**

Figure 25—Maps of Virginia showing (a) total roundwood production, (b) softwood roundwood production, and (c) hardwood roundwood production by county in 2021.

for 51 percent of sawlog output volume (105.9 mmcf, 4.0 mmgt). By 2021 softwood sawlog output volume was 150.2 mmcf (5.1 mmgt) or 64 percent of total sawlog output volume with hardwood sawlog volume accounting for 36 percent, 85.3 mmcf (3.3 mmgt).



Hardwood lumber such as these rough-sawn boards are an important resource for the State of Virginia. (USDA Forest Service photo by Jason Cooper)

Over the 2017 to 2021 report period, the amount of roundwood used for pulp decreased, ranging from a high of 252.2 mmcf (9.4 mmgt) in 2017 to a low of 174.5 mmcf (6.3 mmgt) in 2020 and ending at 174.9 mmcf (6.3 mmgt) in 2021. Pulpwood's share of total roundwood production has declined in Virginia over time. From 2011 to 2017, pulpwood was the State's leading product, producing an average of 47 percent of total industrial roundwood production. Over the 2018 to 2021 period, pulpwood's share of total industrial roundwood production declined to 32 percent with sawlogs taking the larger share (42 percent). Yet the six pulpmills over the 2017 to 2021 reporting period still accounted for almost a third of the 551.0 mmcf total industrial product output. Over the report period, softwood pulpwood production peaked at 163.5 mmcf (6.1 mmgt) in 2017, decreasing annually from 2018 to 2021. The percentage of softwood roundwood used for

pulpwood production for the 2017 to 2021 report period ranged from 59 to 65 percent. Hardwood pulpwood production decreased by 21 percent from 2017 to 2021, from 88.6 mmcf (3.4 mmgt) in 2017 to 69.8 mmcf (2.6 mmgt) by 2021.

Volume harvested for poles, posts, and pilings in 2017 totaled 5.1 mmcf (122.1 mmgt), or <1 percent of the State's total product output. From 2017 to 2019, posts, poles, and pilings product volume decreased to a low of 2.2 mmcf (67.5 mmgt) in 2019 but increased in 2020 and 2021 to a peak of 6.2 mmcf (186.1 mmgt) in 2021 and accounted for just over 1 percent of total products for the State. The volume harvested for poles, posts, and pilings increased by 21 percent over the 2017 to 2021 period, and increased nearly 9-fold from 2011 to 2021.

Volume used for commercial fuelwood, bioenergy, and related products totaled 59.4 mmcf (2.2 mmgt) and accounted for 9 percent of total product output in 2017. Bioenergy and commercial fuelwood production generally increased over the 2017 to 2021 report period. There was a decrease in production from 2020 to 2021. In 2020 biofuel and commercial fuelwood production increased by 73 percent from 2017 to peak at 102.7 mmcf (3.7 mmgt) and 16 percent of total product output. Use of roundwood for bioenergy and commercial fuelwood production decreased in 2021 to 71.4 mmcf (2.5 mmgt).

Volume harvested for other roundwood products including veneer, composite panel, mulch, and shavings totaled 65.0 mmcf (2.3 mmgt) and accounted for 10 percent of total product output in 2017. In 2019, other industrial production peaked at 67.0 mmcf (2.3 mmgt) and 11 percent of total product output. Other industrial production decreased to 63.0 mmcf (2.2 mmgt) in 2021, but still accounted for the same portion of total product output.

Mill Residue

Mill or plant residues are defined as wood material generated in the production of timber products from roundwood at primary manufacturing plants. This material falls into three main categories:

1. Coarse residues, or material, such as slabs, edgings, trim, veneer cores and ends, which is suitable for chipping
2. Fine residues, or material such as sawdust, shavings, and veneer residue, which is not suitable for chipping
3. Bark, which is used mainly for industrial fuel

For many years, most mill residue produced in Virginia has been utilized either for primary products such as pulp and bioenergy, by-products

such as mulch and animal bedding, or as fuel at wood product mills.

Table 9 and figure 26 depict the volume of mill residue by roundwood and residue type. Data on mill residue production and use indicated 167.1 mmcf of wood and bark residues were generated by primary processors in 2017. This total generally increased from 2017 to 2021, with peak residue production of 198.9 mmcf in 2020 and a decrease in 2021 to 173.2 mmcf. Residue totals show the largest increase, 14 percent, for all residue types from 2019 to 2020. Overall roundwood residue increased by 4 percent from the 2017 total of 167.1 mmcf to 173.2 mmcf in 2021. In 2021 bark accounted for 46.3 mmcf (27 percent), coarse residues accounted for 72.3 mmcf (42 percent), and sawdust and shavings accounted for 54.6 mmcf (31 percent) of mill residue produced. Over the report period sawmills generated an average of 79 percent of total mill residues.

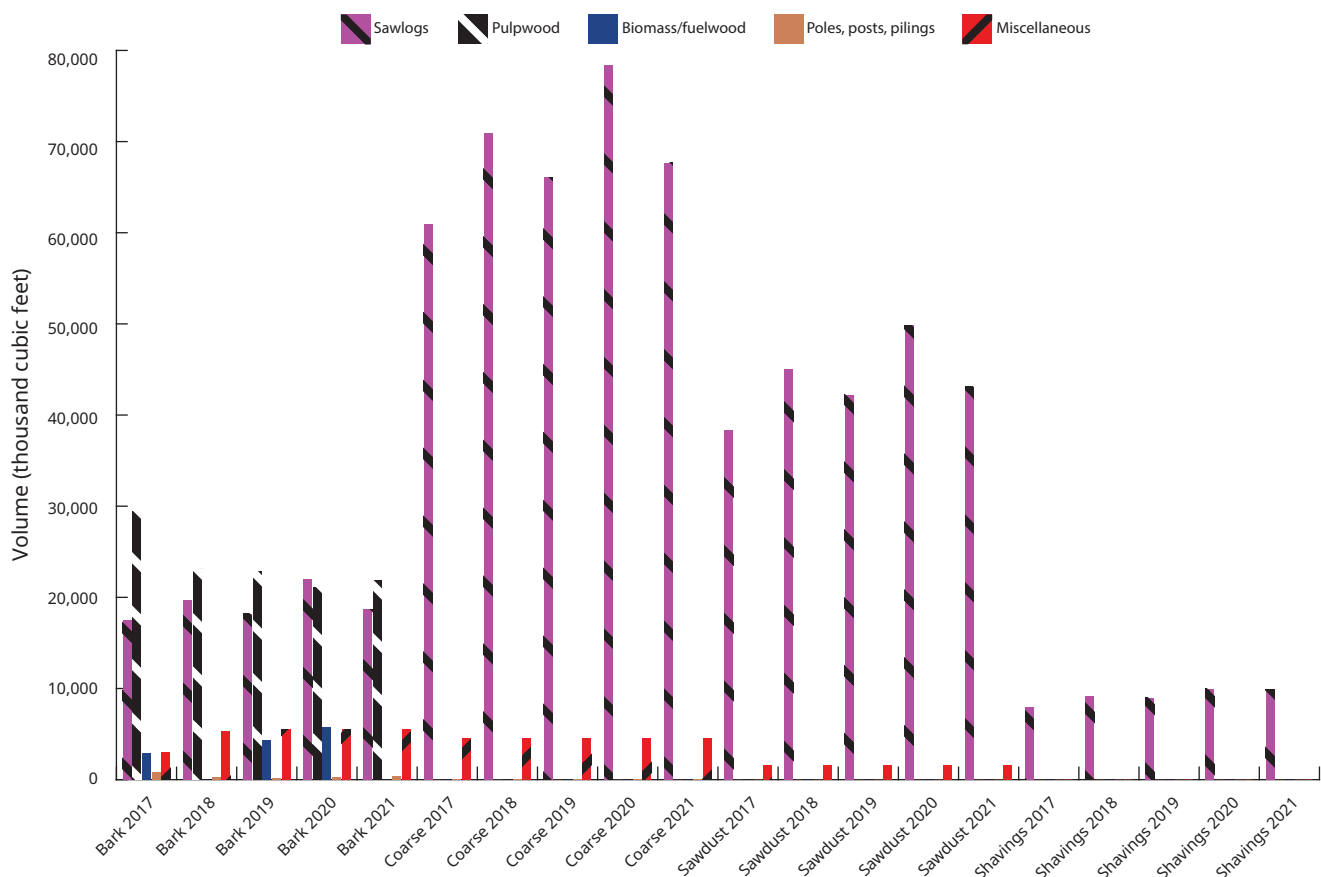


Figure 26—Primary mill residue volume by roundwood type, residue type, and year, Virginia 2017–2021.

Table 9—Primary mill residue volume by roundwood type, species group, and residue type, Virginia, 2017–2021

Roundwood type and species group	All types					Residue type																				
						Bark			Coarse			Sawdust			Shavings											
	2017	2018	2019	2020	2021	2017	2018	2019	2020	2021	2017	2018	2019	2020	2021	2017	2018	2019	2020	2021						
thousand cubic feet																										
Sawlogs	Softwood	59,490	83,130	84,775	89,322	85,184	6,720	9,674	9,938	10,365	9,817	27,257	39,230	40,299	42,034	39,809	17,758	25,558	26,255	27,385	25,936	7,755	8,668	8,284	9,538	9,622
	Hardwood	65,237	61,752	50,720	70,808	54,183	10,741	10,046	8,246	11,589	8,838	33,688	31,680	25,809	36,321	27,870	20,559	19,505	15,964	22,456	17,159	249	521	702	442	317
	Total	124,727	144,881	135,496	160,129	139,367	17,462	19,720	18,183	21,955	18,654	60,944	70,910	66,107	78,354	67,679	38,317	45,063	42,218	49,841	43,095	8,004	9,188	8,987	9,979	9,938
	Softwood	15,608	11,227	10,963	10,267	9,336	15,608	11,227	10,963	10,267	9,336	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pulpwood	Hardwood	13,901	11,925	11,911	10,893	12,498	13,901	11,925	11,911	10,893	12,498	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Total	29,508	23,152	22,874	21,160	21,834	29,508	23,152	22,874	21,160	21,834	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Softwood	493	0	740	987	0	493	0	740	987	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bioenergy/ fuelwood	Hardwood	2,395	0	3,592	4,789	0	2,395	0	3,592	4,789	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Total	2,888	0	4,332	5,776	0	2,888	0	4,332	5,776	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Softwood	905	335	127	319	444	828	259	127	243	343	77	76	0	76	101	0	0	0	0	0	0	0	0	0	0
Poles, posts, pilings	Hardwood	0	2	4	2	2	0	1	2	1	1	0	1	2	1	1	0	0	0	0	0	0	0	0	0	0
	Total	905	336	131	321	445	828	260	129	244	344	77	77	2	77	102	0	0	0	0	0	0	0	0	0	0
	Softwood	8,988	11,322	11,518	11,489	11,488	2,921	5,255	5,451	5,422	5,421	4,507	4,507	4,507	4,507	4,507	4,507	1,560	1,560	1,560	1,560	0	0	0	0	0
Miscellaneous ¹	Hardwood	65	65	65	65	65	65	65	65	65	65	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Total	9,052	11,387	11,582	11,553	11,553	2,986	5,320	5,515	5,487	5,486	4,507	4,507	4,507	4,507	4,507	1,560	1,560	1,560	1,560	0	0	0	0	0	
	Softwood	85,483	106,014	108,123	112,383	106,451	26,570	26,415	27,219	27,284	24,916	31,841	43,813	44,806	46,617	44,418	19,318	27,118	27,814	28,945	27,496	7,755	8,668	8,284	9,538	9,622
Total	Hardwood	81,597	73,743	66,292	86,556	66,748	27,102	22,036	23,816	27,337	21,402	33,688	31,681	25,811	36,321	27,870	20,559	19,505	15,964	22,456	17,159	249	521	702	442	317
	Total	167,081	179,757	174,416	198,940	173,199	53,672	48,451	51,034	54,621	46,318	65,529	75,493	70,616	82,938	72,288	39,877	46,623	43,778	51,401	44,655	8,004	9,188	8,987	9,979	9,938
	Numbers in rows and columns may not add to totals due to rounding.																									
¹ Includes veneer, composite, mulch, shavings, and other industrial products.																										

Numbers in rows and columns may not add to totals due to rounding.

¹ Includes veneer, composite, mulch, shavings, and other industrial products.

Mill residue produced in Virginia from 2017 to 2021 was predominately used for industrial fuel. In 2017 nearly 83.7 mmcf, or 50 percent, of mill residue produced was used for industrial fuel either at pulpmills for boiler fuel or at sawmills for dry kiln operations, pellets, or residential fuelwood (table 10, fig. 27). From 2017 to 2021 this total decreased by 8 percent to 76.7 mmcf. Bark and fine residues, at 28.1 and 37.3 mmcf, respectively, accounted for 85 percent of mill residue utilized for industrial fuel in 2021, which was just below the average of 88 percent for 2017–2021. In 2021, 61 percent of bark residue produced was utilized for fuel, with a miniscule portion that was not used, and the remainder of the utilized bark going for miscellaneous and fiber products. During 2017, 2018, 2019, 2020, and 2021, 62, 67, 46, 71, and 70 percent of the coarse residue produced was utilized for fiber products, respectively. Bark and wood residues not utilized over the 2017 to 2021 report period averaged <2 percent of all residues produced.

Logging Residue

The merchantable (growing stock) portions of trees cut and left onsite are underutilized removals by FIA merchantability standards, and the nonmerchantable (nongrowing stock) portions of trees (part of the 1-foot stump or volume in tops <4 inches in diameter) used for products are considered overutilized removals. Under and overutilization factors used to determine average annual logging residue in this section were derived from the most recent Virginia HU study estimates available (unpublished data available upon request). Logging residue has been considered a possible source for bioenergy and other timber products during recent years. It is important to keep in mind that logging residue, traditionally, has not had a marketable value. Retrieval of logging residue is a matter of economics and markets. If markets are available and a willingness to pay a reasonable price exists, then more total tree volume (including what has been left as logging residues) is utilized for products.

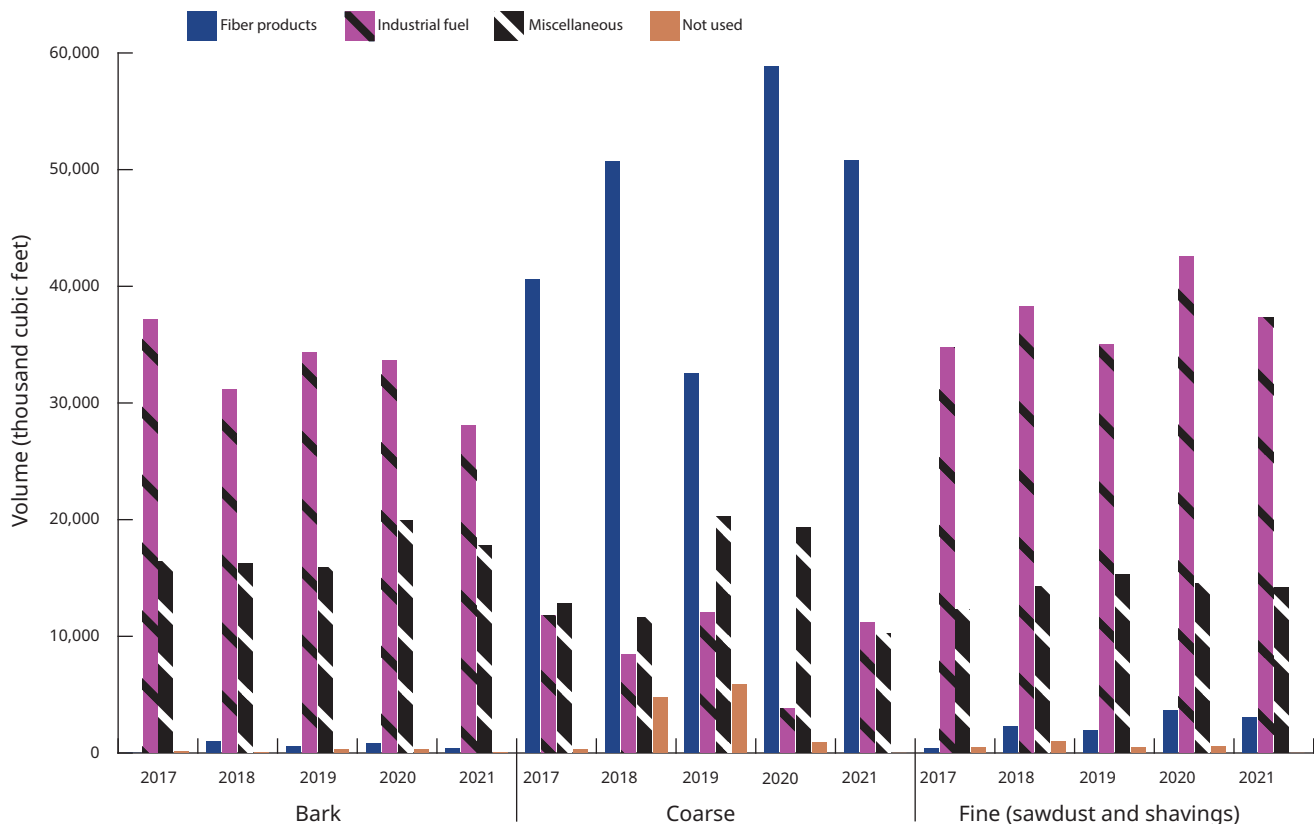


Figure 27—Disposal of residue at primary wood using plants by product, type of residue, and year, Virginia 2017–2021.

Table 10—Disposal of residue at primary wood using plants by product, species group, and type of residue, Virginia, 2017–2021

Product and species group	All types					Bark					Coarse					Fines (sawdust and shavings)					
	2017	2018	2019	2020	2021	2017	2018	2019	2020	2021	2017	2018	2019	2020	2021	2017	2018	2019	2020	2021	
thousand cubic feet																					
Fiber products	Softwood	19,821	28,575	18,593	33,568	34,104	0	278	17	0	0	19,539	27,579	17,911	31,700	33,026	281	718	664	1,868	1,078
	Hardwood	21,081	25,407	16,358	29,793	20,172	0	745	500	808	427	21,006	23,091	14,576	27,171	17,766	75	1,571	1,281	1,814	1,979
	Total	40,901	53,982	34,951	63,361	54,276	0	1,023	518	808	427	40,545	50,670	32,487	58,872	50,792	356	2,289	1,946	3,681	3,057
Industrial fuel	Softwood	40,550	43,471	45,813	44,094	45,326	19,494	18,391	17,684	17,350	15,429	2,158	819	4,704	136	4,217	18,898	24,261	23,425	26,608	25,680
	Hardwood	43,147	34,348	35,627	35,975	31,324	17,691	12,766	16,660	16,288	12,673	9,640	7,610	7,349	3,696	6,999	15,816	13,972	11,617	15,990	11,651
	Total	83,697	77,819	81,440	80,068	76,650	37,185	31,157	34,344	33,638	28,102	11,798	8,429	12,053	3,832	11,217	34,714	38,233	35,043	42,598	37,331
Miscellaneous	Softwood	25,064	28,234	38,616	34,721	27,020	7,071	7,746	9,517	9,934	9,487	10,108	10,684	17,089	14,781	7,174	7,884	9,804	12,009	10,006	10,359
	Hardwood	16,492	13,978	12,816	19,070	15,252	9,314	8,525	6,382	9,959	8,301	2,738	970	3,144	4,565	3,105	4,440	4,483	3,290	4,546	3,846
	Total	41,556	42,212	51,432	53,791	42,273	16,385	16,271	15,899	19,893	17,788	12,847	11,654	20,234	19,345	10,279	12,324	14,287	15,299	14,553	14,206
Not used	Softwood	49	5,734	5,102	1	1	5	1	0	1	1	35	4,731	5,102	0	0	9	1,003	0	0	0
	Hardwood	877	10	1,492	1,719	0	97	0	273	282	0	303	10	741	889	0	477	0	477	547	0
	Total	926	5,744	6,594	1,719	1	101	1	273	283	1	339	4,741	5,843	889	0	486	1,003	477	547	0
All products	Softwood	85,483	106,014	108,123	112,383	106,451	26,570	26,415	27,219	27,284	24,916	31,841	43,813	44,806	46,617	44,418	27,072	35,786	36,099	38,482	37,117
	Hardwood	81,597	73,743	66,292	86,556	66,748	27,102	22,036	23,816	27,337	21,402	33,688	31,681	25,811	36,321	27,870	20,808	20,026	16,666	22,898	17,476
	Total	167,081	179,757	174,416	198,940	173,199	53,672	48,451	51,034	54,621	46,318	65,529	75,493	70,616	82,938	72,288	47,880	55,812	52,765	61,380	54,593

Numbers in rows and columns may not add to totals due to rounding.

Woody material typically left on a logging site includes:

1. Whole trees, ≥ 5 inches d.b.h., or portions of the merchantable boles of severed trees broken and left during the felling operation (merchantable)
2. Small trees, < 5 inches d.b.h., damaged or killed during harvesting operations (nonmerchantable)
3. Residual stump portions, tops, and limbs or forks not utilized because of insufficient size or quality (nonmerchantable)

This wood material left on the site is known as merchantable and nonmerchantable logging residues.

FIA calculates the merchantable portion of logging residue in a two-stage process. First, for those plots that were classified as timberland during the previous inventory and stayed in timberland for the current inventory cycle, the volume of whole trees cut and not utilized are identified by FIA field crews during the remeasurement phase of the inventory. A removal volume is derived for trees that are classified in this category. Second, underutilization factors derived from HU studies are applied to the volume classified as utilized by field crews for the remainder of the merchantable portion of logging residue.

The total removal volume is made up of volume from the merchantable and nonmerchantable portions of removal trees. Overutilization factors from the HU studies were used to determine how much of the nonmerchantable portion of removals was used for timber products. The nonmerchantable volume is calculated for the land-use change removal estimate and added to the merchantable volume for a total land-use change removal volume. With the nonmerchantable portion of timber products and

land-use change values calculated and subtracted from total nonmerchantable removals volume the remainder is the volume of nonmerchantable logging residues.

The logging residue volume in Virginia for 2017 totaled 122.7 mmcf (4.5 mmgt), followed by a continuous upward trend in subsequent years, increasing to 147.7 mmcf (5.4 mmgt) in 2021 (tables 11 and 12). This volume accounted for < 20 percent of total timber removals for the previously stated survey years. During 2017, logging residue from the merchantable portion of all-live removals totaled 38.9 mmcf (1.4 mmgt), 32 percent of total logging residue. Though volume of logging residue from the merchantable portion of all-live tree removals gradually increased through the reported period, it maintained its 32-percent share of total logging residues across all years. Logging residue volume from merchantable material increased from 40.8 mmcf (1.5 mmgt) in 2018 to 44.7 mmcf (1.6 mmgt) in 2019 and 2020, and to 46.9 mmcf (1.7 mmgt) in 2021. The merchantable portion of logging residue for both softwood and hardwood combined accounted for 5 to 6 percent of total live removals over the survey period. For softwoods, the merchantable portion of logging residue accounted for 3 to 4 percent of the total softwood all-live tree removals for the 2017 through 2021 surveys. The merchantable portion of hardwood logging residue remained stable at 32 percent for 2017, 2018, 2019, 2020, and 2021 (25.7, 26.8, 29.8, 29.8, and 30.2 mmcf, and 1.0, 1.0, 1.1, 1.1, and 1.1 mmgt respectively). Nonmerchantable sources (such as the residual stump, forks, tops, and limbs) accounted for 83.7 mmcf (3.1 mmgt), 68 percent of total logging residue in 2017. This percentage remained consistent for each year from 2018 through 2021, though the amount produced increased to 87.7 mmcf (3.2 mmgt) in 2018, 96.0 mmcf (3.5 mmgt) in 2019 and 2020, and 100.9 mmcf (3.7 mmgt) in 2021.

Table 11—Volume of timber removals by species group, removals class, and source, Virginia, 2017–2021

Year	Species group	Roundwood products			Logging residues			Other removals			All removals		
		Growing stock	Nongrowing stock	All sources	Growing stock	Nongrowing stock	All sources	Growing stock	Nongrowing stock	All sources	Growing stock	Nongrowing stock	All sources
thousand cubic feet													
2017	Softwood	319,600	30,746	350,347	13,230	29,708	42,937	1,223	2,746	3,969	334,053	63,200	397,254
	Hardwood	226,946	12,463	239,409	25,701	54,016	79,717	8,710	18,305	27,015	261,356	84,784	346,140
	Total	546,546	43,210	589,756	38,930	83,724	122,654	9,933	21,052	30,984	595,409	147,985	743,394
2018	Softwood	339,972	59,352	399,324	13,999	31,434	45,432	835	1,876	2,711	354,806	92,661	447,467
	Hardwood	209,257	10,329	219,586	26,759	56,240	82,998	7,970	16,751	24,721	243,985	83,319	327,305
	Total	549,229	69,681	618,910	40,757	87,673	128,430	8,805	18,626	27,431	598,791	175,981	774,772
2019	Softwood	323,425	43,428	366,853	14,808	33,252	48,060	910	2,043	2,952	339,143	78,723	417,866
	Hardwood	177,305	9,936	187,242	29,843	62,722	92,564	10,661	22,407	33,067	217,809	95,065	312,874
	Total	500,730	53,365	554,095	44,651	95,974	140,625	11,571	24,449	36,020	556,952	173,787	730,739
2020	Softwood	336,697	55,059	391,757	14,808	33,252	48,060	910	2,043	2,952	352,415	90,354	442,769
	Hardwood	205,067	10,719	215,786	29,843	62,722	92,564	10,661	22,407	33,067	245,570	95,848	341,418
	Total	541,764	65,778	607,543	44,651	95,974	140,625	11,571	24,449	36,020	597,986	186,201	784,187
2021	Softwood	330,744	49,714	380,458	16,620	37,320	53,940	912	2,047	2,958	348,275	89,081	437,356
	Hardwood	162,224	8,288	170,512	30,239	63,554	93,793	12,423	26,110	38,533	204,886	97,952	302,838
	Total	492,968	58,002	550,970	46,859	100,874	147,733	13,335	28,157	41,492	553,161	187,033	740,194

Numbers in rows and columns may not add to totals due to rounding.

Land-Use Removals

Land-use removals (set aside forest land), or removal volume attributed to land-use change, is data acquired from FIA inventory plots. Land-use removals accounted for 4 to 6 percent of total removals for each year surveyed, 2017–2021 (tables 11 and 12). There was an increase in the volume of land-use removals during the report period, increasing from 31 mmcf (1.2 mmgt) in 2017 to 41.5 mmcf (1.5 mmgt) in 2021. The nonmerchantable (nongrowing stock) portion of live trees accounted for 68 percent of land-use change removals for the entire report period of 2017–2021. The hardwood species group accounted for 87 to 93 percent of the land-use change removals from 2017 to 2021.

DISTURBANCE AND FOREST HEALTH INDICATORS

Disturbance

From 2017 to 2021, insect damage predominated the disturbances that impacted Virginia's forests, affecting an average of 242,700 forest land acres per year (table 13). These were mostly oak-hickory dominated forests (191,600 acres disturbed annually). The next most common cause of forest land disturbance was domestic animals (for example, livestock grazing), followed by severe weather, forest fires, and other natural disturbances.

Table 12—Volume of timber removals by species group, removals class, and source, Virginia, 2017–2021

Year	Species group	Roundwood products			Logging residues			Other removals			All removals		
		Growing stock	Nongrowing stock	All sources	Growing stock	Nongrowing stock	All sources	Growing stock	Nongrowing stock	All sources	Growing stock	All sources	
green tons													
2017	Softwood	11,368,161	1,102,361	12,470,522	463,043	1,039,767	1,502,810	42,806	96,121	138,927	11,874,010	2,238,249	14,112,259
	Hardwood	8,613,110	470,175	9,083,285	963,773	2,025,600	2,989,373	326,608	686,445	1,013,053	9,903,491	3,182,220	13,085,711
	Total	19,981,270	1,572,536	21,553,807	1,426,816	3,065,367	4,492,183	369,414	782,566	1,151,980	21,777,500	5,420,469	27,197,970
2018	Softwood	12,042,612	2,103,414	14,146,027	489,948	1,100,184	1,590,132	29,234	65,645	94,879	12,561,794	3,269,243	15,831,038
	Hardwood	7,842,043	388,454	8,230,497	1,003,446	2,108,983	3,112,429	298,871	628,149	927,020	9,144,360	3,125,586	12,269,946
	Total	19,884,655	2,491,868	22,376,524	1,493,394	3,209,167	4,702,561	328,105	693,794	1,021,899	21,706,154	6,394,829	28,100,984
2019	Softwood	11,223,185	1,522,205	12,745,390	518,289	1,163,823	1,682,112	31,838	71,493	103,331	11,773,312	2,757,521	14,530,833
	Hardwood	6,641,569	368,875	7,010,444	1,119,103	2,352,063	3,471,166	399,785	840,245	1,240,030	8,160,457	3,561,183	11,721,640
	Total	17,864,754	1,891,080	19,755,834	1,637,392	3,515,886	5,153,278	431,623	911,738	1,343,361	19,933,769	6,318,704	26,252,473
2020	Softwood	11,670,725	1,929,534	13,600,259	518,289	1,163,823	1,682,112	31,838	71,493	103,331	12,220,852	3,164,850	15,385,702
	Hardwood	7,711,279	399,062	8,110,341	1,119,103	2,352,063	3,471,166	399,785	840,245	1,240,030	9,230,167	3,591,370	12,821,537
	Total	19,382,004	2,328,596	21,710,600	1,637,392	3,515,886	5,153,278	431,623	911,738	1,343,361	21,451,019	6,756,220	28,207,239
2021	Softwood	11,452,859	1,741,696	13,194,555	581,694	1,306,200	1,887,894	31,904	71,641	103,545	12,066,457	3,119,537	15,185,994
	Hardwood	6,089,023	307,995	6,397,019	1,133,954	2,383,276	3,517,230	465,866	979,130	1,444,997	7,688,844	3,670,402	11,359,246
	Total	17,541,883	2,049,691	19,591,574	1,715,648	3,689,476	5,405,124	497,771	1,050,771	1,548,542	19,755,301	6,789,939	26,545,240

Numbers in rows and columns may not add to totals due to rounding.

Table 13—Area of forest land disturbed annually by forest-type group and disturbance class, Virginia, 2017–2021

Forest-type group ²		Disturbance class ¹							
		Insects	Disease	Weather	Fire	Domestic animals	Wild animals	Human	Other natural
		<i>thousand acres</i>							
Softwood types	White-red-jack pine	0.6	—	—	0.2	—	—	—	—
	Spruce-fir	—	—	—	—	—	—	—	—
	Longleaf-slash pine	—	—	—	—	—	—	—	—
	Loblolly-shortleaf pine	4.5	3.0	3.2	2.4	1.8	0.8	1.5	4.4
	Other eastern softwoods	2.0	—	—	—	1.1	1.1	—	—
	Exotic softwoods	—	—	—	—	—	—	—	—
	Total softwoods	7.2	3.0	3.2	2.6	2.9	1.9	1.5	4.4
Hardwood types	Oak-pine	10.9	—	3.9	3.5	5.8	0.8	—	2.9
	Oak-hickory	191.6	1.6	12.6	14.9	36.9	3.4	4.1	8.8
	Oak-gum-cypress	1.4	—	—	—	—	2.7	0.7	0.9
	Elm-ash-cottonwood	16.8	0.8	1.1	—	1.7	1.3	—	0.4
	Maple-beech-birch	13.3	—	1.1	—	—	—	—	1.1
	Aspen-birch	—	—	—	—	—	—	—	—
	Other hardwoods	1.2	—	—	—	1.2	—	—	—
	Exotic hardwoods	0.3	—	—	—	1.5	—	—	—
	Total hardwoods	235.6	2.4	18.7	18.4	48.2	8.2	4.8	14.1
Nonstocked		—	—	—	—	—	—	—	—
All groups		242.7	5.5	21.9	21.0	51.1	10.1	6.3	18.5

Numbers in rows and columns may not sum to totals due to rounding.

— = no sample for the cell or a value of >0.0 but <0.05.

¹ Based on current conditions.

² Based on past conditions.



Virginia's forests help ensure the supply of clean, fresh water. (Virginia Department of Forestry photo by Kaci Yost)

Standing Dead Trees, Down Woody Materials, Forest Duff and Litter

Though perhaps not immediately evident, dead wood plays an important role in the health of forest ecosystems. We quantified dead wood in the biogeochemical cycle that involves the flow of nutrients and carbon from tree to soil to atmosphere and back again. The number of standing dead trees ≥ 5.0 inches d.b.h. in forests of Virginia was 205.6 million in 2021 (table 14). Decreasing numbers of standing dead trees as diameters increase reflect the size distribution of live trees across the landscape.

VIRGINIA'S FORESTS, 2021

Table 14—Number of standing dead trees on forest land by species group and diameter class, Virginia, 2021

Species group		Diameter class (inches)										
		All classes	5.0–6.9	7.0–8.9	9.0–10.9	11.0–12.9	13.0–14.9	15.0–16.9	17.0–18.9	19.0–20.9	21.0–28.9	29.0+
<i>million trees</i>												
Softwood	Loblolly and shortleaf pines	16.2	7.3	4.5	2.3	1.1	0.4	0.3	0.2	—	0.1	—
	Other yellow pines	29.6	10.8	8.3	5.8	2.9	1.2	0.5	0.1	—	—	—
	Eastern white and red pines	7.4	3.2	1.7	0.8	0.6	0.3	0.2	0.1	0.1	0.2	0.1
	Spruce and balsam fir	0.2	—	0.1	—	—	—	—	—	—	—	—
	Eastern hemlock	4.1	1.6	1.1	0.6	0.3	0.1	0.1	0.1	—	0.1	—
	Cypress	0.1	0.1	—	—	—	—	—	—	—	—	—
	Other eastern softwoods	8.9	4.9	2.1	1.1	0.3	0.2	0.1	0.1	0.1	—	—
	Total softwoods	66.5	27.9	17.8	10.6	5.3	2.2	1.2	0.7	0.2	0.3	0.1
Hardwood	Select white oaks	10.4	4.0	2.3	1.3	0.9	0.5	0.4	0.4	0.2	0.3	—
	Select red oaks	5.8	1.6	1.0	0.7	0.8	0.6	0.3	0.2	0.2	0.4	0.1
	Other white oaks	17.1	5.7	3.6	2.4	2.0	1.0	1.0	0.5	0.3	0.5	0.1
	Other red oaks	18.6	6.5	3.5	2.9	1.9	1.4	0.8	0.7	0.4	0.5	—
	Hickory	3.2	0.8	0.9	0.5	0.3	0.4	0.2	0.1	0.1	—	—
	Yellow birch	0.2	—	0.1	—	—	—	—	—	—	—	—
	Hard maple	0.7	0.2	0.2	0.1	—	—	—	—	—	0.1	—
	Soft maple	10.6	4.9	2.8	1.2	0.8	0.3	0.1	0.3	0.1	—	—
	Beech	0.6	0.2	0.1	0.1	0.1	0.1	—	—	—	—	—
	Sweetgum	3.2	1.7	1.0	0.2	0.1	0.1	—	0.1	—	—	—
	Tupelo and blackgum	2.0	0.8	0.6	0.2	0.2	0.2	—	—	—	—	—
	Ash	15.7	4.7	3.3	2.5	1.9	1.3	0.7	0.7	0.5	0.2	—
	Cottonwood and aspen	0.0	—	0.0	—	—	—	—	—	—	—	—
	Basswood	0.6	0.2	0.2	0.1	—	—	—	—	—	0.1	—
	Yellow-poplar	6.0	2.7	1.3	0.8	0.5	0.4	0.2	0.1	—	0.1	—
	Black walnut	0.9	0.2	0.1	0.2	0.2	—	—	—	0.1	—	—
	Other eastern soft hardwoods	13.2	6.2	3.3	1.5	1.1	0.4	0.4	0.1	0.1	0.1	—
	Other eastern hard hardwoods	24.8	9.6	6.4	4.0	2.2	1.3	0.5	0.3	0.3	0.2	—
	Eastern noncommercial hardwoods	5.2	3.5	1.0	0.4	0.2	0.1	0.1	—	—	—	—
	Total hardwoods	139.1	53.5	31.6	19.0	13.1	8.3	4.6	3.5	2.2	2.4	0.0
All species		205.6	81.4	49.4	29.7	18.5	10.6	6.0	4.3	2.6	2.8	0.5

Numbers in rows and columns may not sum to totals due to rounding.

— = no sample for the cell or a value of >0.0 but <0.05.



Down woody materials are an important part of Virginia's forests. (Virginia Department of Forestry photo by John Pemberton)

Down woody materials (DWM) consist of standing dead trees that have fallen to the ground along with small twigs and branches falling from live trees. When sufficiently dry, DWM are also part of a forest's fire fuel load. Quantities of DWM are expressed by FIA in terms of total tons and tons per acre in various size classes. Time-lag fuel hour size classes, which are 1, 10, 100 and 1,000 hours, represent the time it would take for two-thirds of the piece of DWM to dry to the same moisture that is in the surrounding air. One-hour fuels are 0.01 to 0.24 inch in diameter, 10-hour fuels are 0.25 to 0.9 inch in diameter, 100-hour fuels are 1.0 to 2.9 inches in diameter, and 1,000-hour fuels are 3.0 to 8.0 inches in diameter. Where DWM have been piled after harvesting or other human activity and cannot be practically separated into

individual pieces, the total volume and mass of the pile is estimated and presented as slash. Details on how these data are collected and what type of material are included in each size class can be found in the FIA national core field guide (USDA Forest Service 2014).

Table 15 presents the total fuel loading on forest land by forest-type group and fuel class for Virginia in 2021. Table 16 shows mean fuel loading on a per acre basis. Note that the forest land acres used to make the calculations in table 16 differ from those that appear in other places in this bulletin. For example, Tables 1 and A3.3 will show there was an estimated 15,995,400 acres of forest in Virginia in 2021 but the forest land area used to estimate DWM tons per acre was 15,490,080 acres

VIRGINIA'S FORESTS, 2021

Table 15—Total fuel loading on forest land by forest-type group and fuel class, Virginia, 2021

Forest-type group	Down and dead wood by time-lag fuel hour classes					Forest floor fuels	
	1 hr	10 hr	100 hr	1000+ hr	Piles/slash	Duff	Litter
<i>tons</i>							
Maple-beech-birch	25,530.5	186,257.7	590,132.2	965,131.8	—	1,940,150.6	2,475,035.0
Elm-ash-cottonwood	5,296.1	119,874.0	182,859.2	—	—	67,946.0	317,596.9
White-red-jack pine	6,826.4	62,600.1	244,354.1	215,053.0	—	1,824,828.4	1,102,205.7
Loblolly-shortleaf pine	99,829.8	884,215.0	3,040,729.4	2,979,036.7	7,141,108.5	41,795,977.7	30,333,900.8
Other hardwoods	9,185.5	83,668.5	420,562.4	278,614.7	—	1,266,359.6	766,791.8
Oak-pine	76,489.4	701,674.0	3,007,081.0	4,016,244.2	3,164,595.6	24,052,511.4	16,032,126.6
Nonstocked	7,989.6	356,026.9	903,671.3	423,328.4	60,775,490.7	85,617.7	795,751.5
Exotic hardwoods	3,072.7	26,416.5	150,958.7	—	—	89,564.1	267,135.0
Oak-gum-cypress	4,808.6	69,994.8	341,154.3	234,839.2	—	1,796,033.0	649,167.6
Oak-hickory	461,489.4	4,498,845.3	16,171,523.0	31,091,659.3	18,317,641.9	94,135,772.0	74,656,561.3
All groups	700,517.9	6,989,572.8	25,053,025.5	40,203,907.3	89,398,836.7	167,054,760.5	127,396,272.2

— = no sample for the cell or a value of >0.0 but <0.05.

Table 16—Mean fuel loading per acre on forest land by forest-type group and fuel class, Virginia, 2021

Forest-type group	Forest land area	Down and dead wood by time-lag fuel hour classes						Forest floor fuels			Total
		1 hr	10 hr	100 hr	1000+ hr	Piles/slash	Total DWM	Duff	Litter	Total forest floor fuels	DWM and forest floor
	acres	tons per acre									
Maple-beech-birch	369,026.47	0.07	0.50	1.60	2.62	—	4.79	5.26	6.71	11.96	16.75
Elm-ash-cottonwood	107,384.43	0.05	1.12	1.70	—	—	2.87	0.63	2.96	3.59	6.46
White-red-jack pine	125,255.89	0.05	0.50	1.95	1.72	—	4.22	14.57	8.80	23.37	27.59
Loblolly-shortleaf pine	2,872,802.77	0.03	0.31	1.06	1.04	2.49	4.92	14.55	10.56	25.11	30.03
Other hardwoods	124,527.80	0.07	0.67	3.38	2.24	—	6.36	10.17	6.16	16.33	22.69
Oak-pine	1,893,798.99	0.04	0.37	1.59	2.12	1.67	5.79	12.70	8.47	21.17	26.96
Nonstocked	83,269.39	0.10	4.28	10.85	5.08	729.87	750.17	1.03	9.56	10.58	760.76
Exotic hardwoods	77,456.96	0.04	0.34	1.95	—	—	2.33	1.16	3.45	4.61	6.93
Oak-gum-cypress	191,466.41	0.03	0.37	1.78	1.23	—	3.40	9.38	3.39	12.77	16.17
Oak-hickory	9,645,091.21	0.05	0.47	1.68	3.22	1.90	7.31	9.76	7.74	17.50	24.81

— = no sample for the cell or a value of >0.00 but <0.05.

DWM = down woody materials.

(table 16). This is because separate forest land area estimates had to be made using only those plots where DWM were inventoried, approximately one-sixteenth of the FIA plots. These forest land area estimates are less accurate because they are based on fewer plots but must be used to correctly calculate the tons per acre of DWM. If we had used the oak-hickory forest land acreage in table A3.3, the tons per acre of DWM for that forest type would have been overestimated. Details for these DWM estimation procedures can be found in Woodall and Monleon (2008) and Woodall and others (2011a, 2011b). Based on the FIA plots where DWM were sampled, the forests of Virginia hold an average of 10.5 tons of biomass per acre of DWM (the sum of the 1-hr, 10-hr, 100-hr fuels and slash piles [table 16]). These current DWM estimates agree well with those presented in previous forest inventory reports (Brandeis and others 2018; Rose 2007, 2009, 2013).

The forest floor organic material that is too small to be recorded as individual pieces of DWM is also measured and monitored by FIA. Litter is the layer of freshly fallen leaves, needles, twigs, cones, detached bark, dead moss, dead lichens and all other detached tree and plant parts that cover the forest floor (USDA Forest Service 2014). Duff is the layer below the litter, located just above the uppermost layer of mineral soil, consisting of organic material derived from the decomposition of the litter (USDA Forest Service 2014). (As with DWM, more detailed duff and litter definitions can be found in the glossary and data collection details can be found in the *FIA National Core Field Guide* [USDA Forest Service 2014]). Both of these biomass deposits play important roles in forest ecosystem functioning similar to those of the DWM. Virginia's forests have on average 19.0 tons of duff and litter biomass per acre (table

16). This estimate is higher than previous ones due to higher tons per acre of litter observed in this inventory cycle. Previous reports cite duff estimates of 9.9 and 10.4 tons per acre (Rose 2007, 2009) which agree well with the 10.8 tons per acre found in this inventory cycle. Litter estimates, however, of 8.2 tons per acre were considerably higher than the previously reported 3.6 and 3.5 tons per acre (Rose 2007, 2009). Domke and others (2016) cite studies that show the high variability of this forest floor litter across forested landscapes and how it complicates the estimation of this carbon pool. Continued monitoring should clarify the range of litter values to expect in Virginia's forests.

These forest floor biomass deposits are important forest carbon storage pools. The FIA program reports DWM in size categories useful for monitoring carbon cycling in the forest. Fine woody debris (FWD) is counted in 3 size classes according to its diameter. Small FWD ranges from 0.01 to 0.24 inch, medium FWD is 0.25 to 0.9 inch, and large FWD is 1.0 to 2.9 inches, the same as the 1-, 10- and 100-hour fuel classes. Coarse woody debris (CWD) is 3.0 inches and greater in diameter, unlike the 1,000-hour fuel category which ends at 8.0 inches. Once the number of tons of biomass in DWM is estimated, it is converted to tons of carbon stored, taking into account decay reduction factors for CWD. This conversion is described in detail in Woodall and Monleon (2008). In Virginia, these data gave a total of 81.1 million tons of carbon stored in DWM and another 147.2 million tons in duff and litter (table 17). These estimates can be broken down further into forest-type groups and ownership categories, which highlights the importance of the State's oak-hickory forests in terms of carbon storage and sequestration (table 18).

VIRGINIA'S FORESTS, 2021

Table 17—Carbon stocks of dead, down woody materials by forest-type group on forest land, Virginia, 2021

Forest-type group	Forest floor		Fine woody debris			Coarse woody debris	Piles/slash
	Duff	Litter	Small	Medium	Large		
	thousand tons						
White-red-jack pine	912.4	551.1	3.4	31.3	122.2	109.8	—
Loblolly-shortleaf pine	20,898.0	15,167.0	49.9	442.1	1,520.4	1,524.0	3,570.6
Oak-pine	12,026.3	8,016.1	38.2	350.8	1,503.5	2,033.9	1,582.3
Oak-hickory	47,067.9	37,328.3	230.7	2,249.4	8,085.8	15,376.0	9,158.8
Oak-gum-cypress	898.0	324.6	2.4	35.0	170.6	120.3	—
Elm-ash-cottonwood	34.0	158.8	2.6	59.9	91.4	—	—
Maple-beech-birch	970.1	1,237.5	12.8	93.1	295.1	478.2	—
Other hardwoods	633.2	383.4	4.6	41.8	210.3	143.5	—
Exotic hardwoods	44.8	133.6	1.5	13.2	75.5	—	—
Nonstocked	42.8	397.9	4.0	178.0	451.8	220.5	30,387.7
All groups	83,527.4	63,698.1	350.3	3,494.8	12,526.5	20,006.2	44,699.4

— = no sample for the cell or a value of >0.0 but <0.05.

Table 18—Biomass and carbon mass of down wood¹ by forest-type group on forest land, Virginia, 2021

Forest-type group	USDA Forest Service		Other Federal		State and local government		Corporate		Noncorporate	
	Biomass	Carbon	Biomass	Carbon	Biomass	Carbon	Biomass	Carbon	Biomass	Carbon
<i>thousand tons</i>										
White-red-jack pine	204.9	104.5	—	—	—	—	—	—	10.1	5.3
Loblolly-shortleaf pine	305.5	156.2	335.6	174.0	—	—	—	—	2,338.0	1,193.7
Oak-pine	553.0	281.4	—	—	—	—	—	—	3,463.2	1,752.5
Oak-hickory	6,730.9	3,322.5	1,015.6	501.5	600.8	299.3	—	—	22,744.4	11,252.7
Oak-gum-cypress	29.5	14.5	—	—	—	—	—	—	205.4	105.8
Elm-ash-cottonwood	—	—	—	—	—	—	—	—	—	—
Maple-beech-birch	383.3	188.3	—	—	—	—	—	—	581.8	289.9
Other hardwoods	32.5	16.0	222.3	115.8	—	—	—	—	23.8	11.7
Exotic hardwoods	—	—	—	—	—	—	—	—	—	—
Nonstocked	0.7	0.3	—	—	—	—	—	—	422.7	220.2
All groups	8,240.3	4,083.7	1,573.5	791.3	600.8	299.3	0.0	0.0	29,789.3	14,831.8

— = no sample for the cell or a value of >0.0 but <0.05.

¹ Down wood includes all pieces with a diameter >3 inches at the point of intersection. Thus only includes coarse woody debris.

Carbon

The need for information about forest carbon pools has increased in recent years due to concerns about global climate change. The FIA program has responded to these information needs by converting field-measured estimates like tree volume to carbon and using models or ancillary sources of data to estimate carbon stored in other pools like tree roots and nontree understory vegetation. The FIA program used models to estimate DWM, duff and litter carbon quantities prior to having field-based measurements. The models used geographic region, stand age, and species composition as predictive variables and were implemented as part of the larger component ratio method suite of forest carbon pool estimators. See EPA (2012), Smith and Heath (2002), and Woodall and others (2011a, 2011b) for details on the modeling procedures for DWM and forest floor carbon. There are notable differences when the field-based estimates to the model-based estimates for Virginia in 2016 are compared. At a national level, field-based litter estimates were 44-percent lower than model-based estimates (Domke and others

2016), though for CWD the model-based estimates were 9-percent higher than field-based estimates (Domke and others 2013).

For this bulletin (and as in the previous one), we chose to present the total quantities and percentages of forest carbon by carbon pool using the model-based estimates of forest floor litter and DWM (fig. 28). This is because they are more comparable to the previous modeled estimates and the same categories of forest carbon produced by the models cannot be directly replicated. For example, the model-based DWM estimate is part of a larger category that includes coarse tree roots and stumps. Though the exact quantities are not the same, the distribution of carbon across the pools remains similar, again with almost half of forest carbon stored in the soil and about a third in the aboveground portions of live trees. Similar to the results observed in 2016 in Brandeis and others (2018), the forests of Virginia sequester approximately 1.2 billion tons of carbon (table 19), of which 34.0 percent was in the forest soil and 44.2 percent in the aboveground portions of living trees (fig. 28).

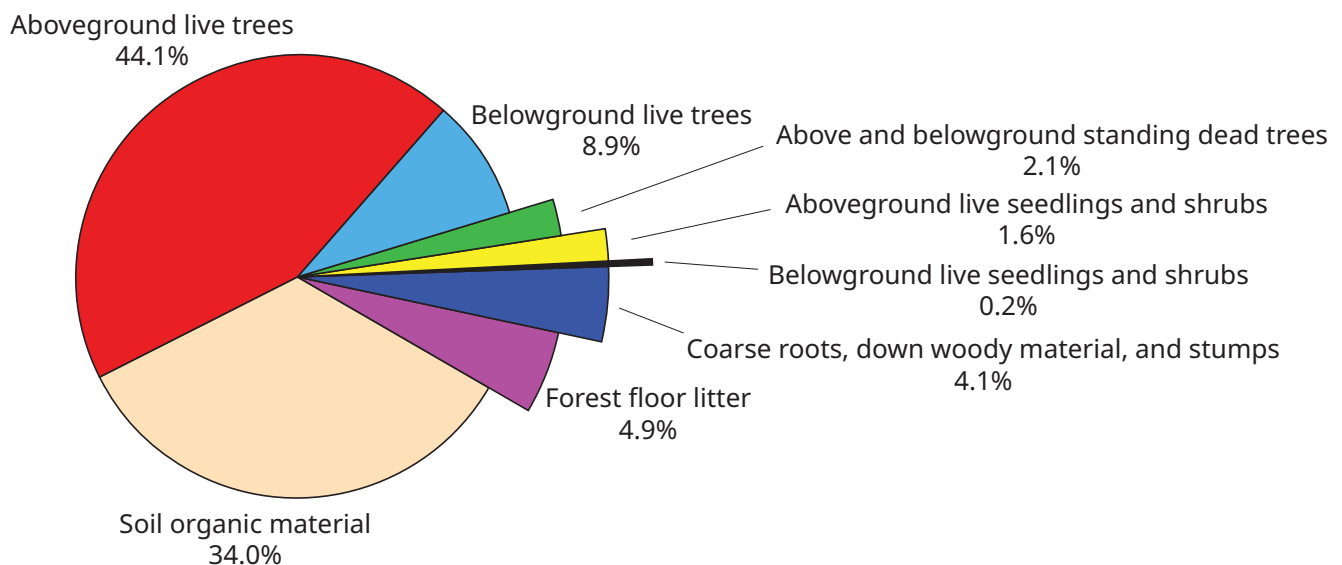


Figure 28—Percentage of forest carbon by carbon pool, Virginia, 2021.

Table 19— Carbon pool on forest land by forest-type group and carbon pool groups, Virginia, 2021

		Carbon pool groups							Total	
		Above ground trees	Below ground trees	Standing dead trees	Above ground understory	Below ground understory	Down dead material	Forest floor litter		Soil organic matter
Forest-type group¹		thousand short tons								
Softwood types	White-red-jack pine	5,374.0	1,177.0	414.0	195.0	22.0	677.0	999.0	4,043.0	12,902.0
	Spruce-fir	191.0	42.0	23.0	7.0	1.0	28.0	46.0	458.0	796.0
	Longleaf-slash pine	27.0	7.0	1.0	17.0	2.0	28.0	32.0	506.0	621.0
	Loblolly-shortleaf pine	97,825.0	21,964.0	2,678.0	4,347.0	483.0	11,356.0	13,809.0	99,531.0	251,993.0
	Other eastern softwoods	1,355.0	301.0	205.0	101.0	11.0	204.0	417.0	1,179.0	3,773.0
	Exotic softwoods	29.0	7.0	8.0	5.0	1.0	9.0	16.0	308.0	383.0
	Total softwoods	104,801.0	23,498.0	3,329.0	4,672.0	520.0	12,302.0	15,319.0	106,025.0	270,468.0
Hardwood types	Oak-pine	47,177.0	9,820.0	1,881.0	2,150.0	239.0	4,342.0	7,516.0	45,703.0	118,828.0
	Oak-hickory	343,627.0	67,030.0	16,889.0	11,118.0	1,235.0	29,508.0	32,822.0	195,774.0	698,003.0
	Oak-gum-cypress	13,076.0	2,581.0	733.0	235.0	26.0	1,220.0	1,259.0	26,444.0	45,573.0
	Elm-ash-cottonwood	9,958.0	1,945.0	1,010.0	253.0	28.0	1,047.0	1,137.0	17,084.0	32,462.0
	Maple-beech-birch	12,127.0	2,353.0	1,070.0	402.0	45.0	1,058.0	1,278.0	9,917.0	28,250.0
	Aspen-birch	68.0	13.0	6.0	1.0	—	5.0	4.0	41.0	138.0
	Other hardwoods	1,510.0	297.0	146.0	71.0	8.0	132.0	176.0	4,486.0	6,825.0
	Exotic hardwoods	350.0	69.0	20.0	12.0	1.0	30.0	47.0	1,755.0	2,286.0
Total hardwoods		427,893.0	84,108.0	21,755.0	14,242.0	1,582.0	37,342.0	44,239.0	301,204.0	932,365.0
Nonstocked		100.0	20.0	13.0	136.0	15.0	14.0	101.0	3,551.0	3,949.0
All groups		532,794.0	107,626.0	25,097.0	19,050.0	2,117.0	49,658.0	59,659.0	410,780.0	1,206,782.0

Numbers in rows and columns may not sum to totals due to rounding.

[†] Based on past conditions.

— = no sample for the cell or a value of >0.0 but <0.05.

Insects, Diseases, and Species of Concern

The forests of Virginia are subject to a number of stresses that impact growth and vitality. As previously mentioned, insects were the most common class of disturbance in Virginia's forest lands (table 13). Pressure from insects and diseases, especially those introduced from other areas of the world, are particularly great. Between 2016 and 2021, insect and disease surveys by the Virginia Department of Forestry and the Forest Service identified ongoing activity of the emerald

ash borer (*Agrilus planipennis*) and hemlock woolly adelgid (*Adelges tsugae*). New activity by insects and diseases affecting American beech, eastern white pine, elm, sassafras, and redbay were also observed.

Emerald Ash Borer

The emerald ash borer is a wood-boring beetle native to Asia that was first identified in the United States in 2002 (Herms and McCullough 2014). Feeding galleries created underneath the bark of ash trees (*Fraxinus* spp.) by the beetle



Emerald ash borer has been causing widespread ash mortality across Virginia. (Virginia Department of Forestry photo by John Pemberton)

larvae disrupt nutrient and water transportation throughout the tree resulting in crown dieback and eventual tree mortality. Since its accidental introduction near Detroit, MI, infestations of the beetle have spread to multiple States (Emerald Ash Borer Network 2023) and killed millions of ash trees. In Virginia, the emerald ash borer was detected and successfully eradicated from Fairfax County in 2003, but in 2008, the beetle reappeared and by the end of 2021 had spread throughout most of the State (fig. 29) (Virginia DOF 2008, 2023a).

Ash trees are found throughout Virginia (fig. 29) and all species of native ash observed in the latest inventory, i.e., white ash (*F. americana*), green ash (*F. pennsylvanica*), and blue ash (*F. quadrangulata*), are susceptible to emerald ash borer (Herms and McCullough 2014). In 2007, prior to the establishment of the insect, there were 44.5 million live and 2.5 million standing dead ash trees ≥ 5.0 inches d.b.h. across Virginia, a ratio of 17.7 live ash for every 1.0 standing dead ash. From 2007 to 2016, the total number of live ash trees ≥ 5.0 inches d.b.h. remained fairly stable (approximately 44.0 million trees); however,

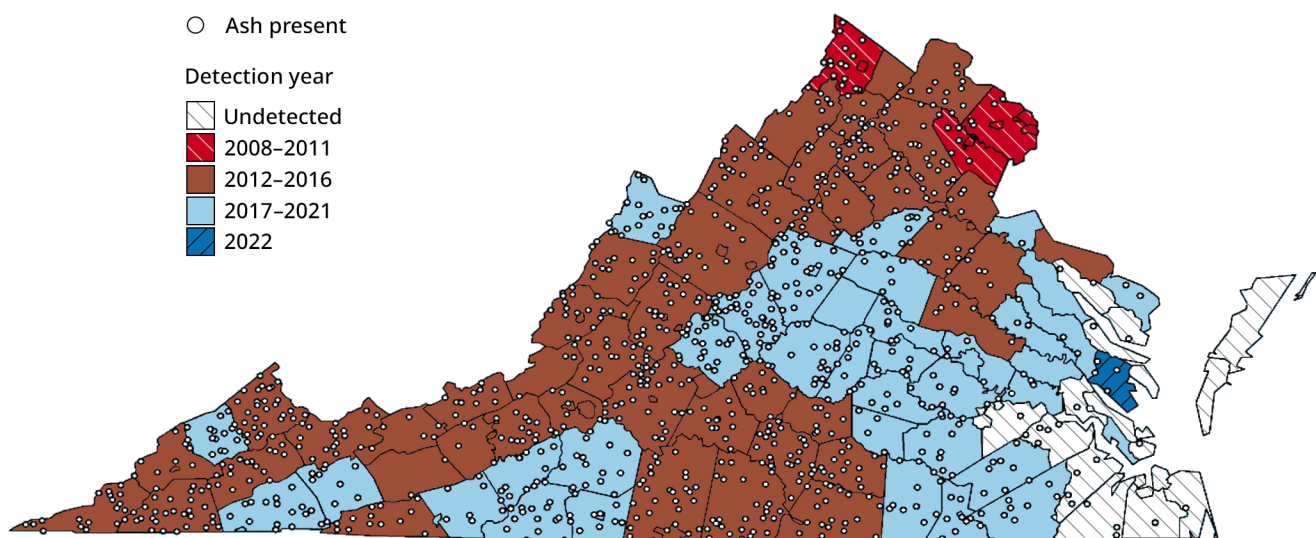


Figure 29—Approximate location of plots where ash was observed during the latest inventory cycle, and location of counties where the emerald ash borer has been confirmed, by detection year. Data source: Virginia Department of Forestry (2023a).

during the latest inventory cycle the number of live ash trees declined significantly to 29.7 million and growth for the species during this latest inventory period was negative (tables 6 and A3.8). Accompanied by an increase in standing dead trees (fig. 30), the statewide ratio of live-to-dead ash in 2021 was 1.9. The greatest loss of live ash volume from 2016 to 2021 occurred in the Southern Piedmont (fig. 31).

Because the emerald ash borer can colonize and kill stems as small as 1.0 inch d.b.h. (Klooster and others 2014), it is unclear how ash will endure in the landscape long term. The number of ash saplings (trees with d.b.h. ≥ 1.0 inch and < 5.0 inches) declined from 145.6 million in 2016 to 118.5 million in 2021. However, the number of ash seedlings (trees with d.b.h. < 1.0 inch) increased from 1.3 billion in 2016 to 1.9 billion in 2021. Whether or not the current cohort of ash

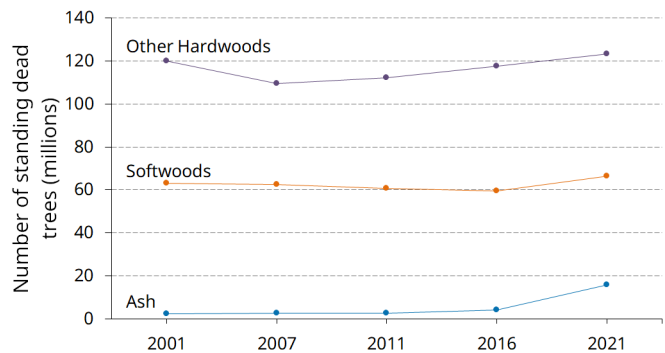


Figure 30—Number of standing dead ash (*Fraxinus* spp.), softwood, and other hardwood trees in Virginia, 2001–2021.

regeneration survives to maturity will depend upon a number of interrelated factors including environmental conditions, management practices, individual tree resistance to the insect, and borer-ash dynamics following infestation (Aubin and others 2015, Klooster and others 2014).

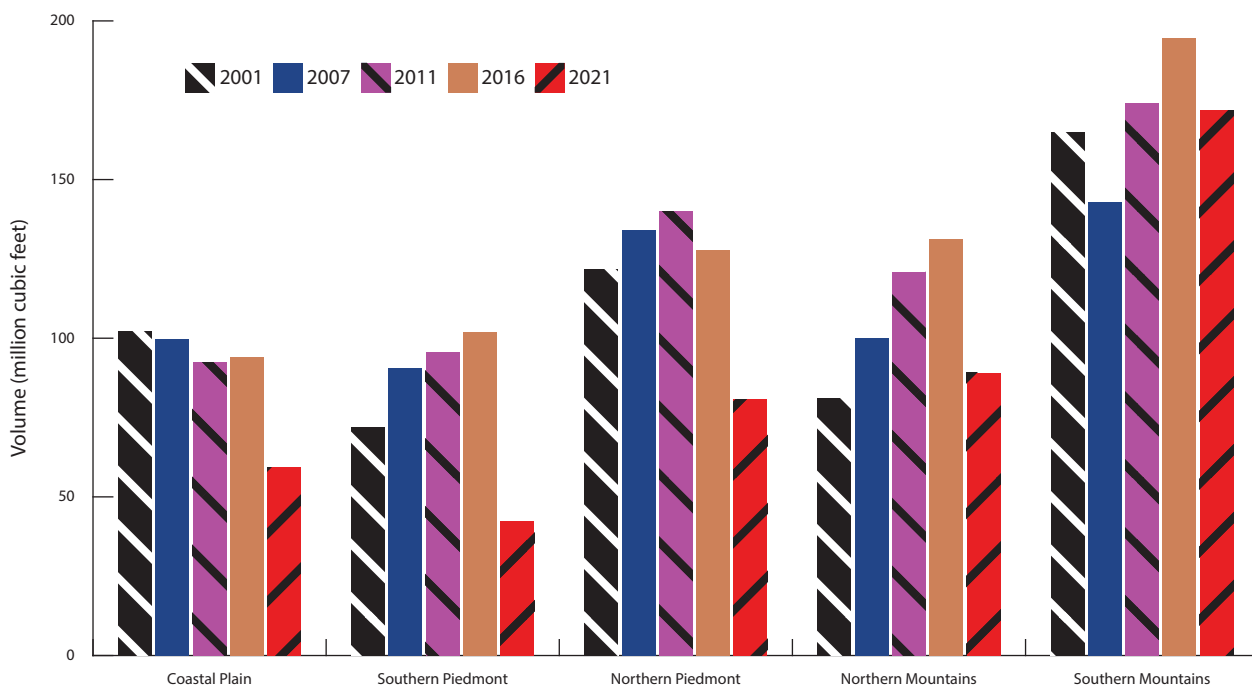


Figure 31—Net merchantable bole volume of live ash (*Fraxinus* spp.) trees (d.b.h. ≥ 5.0 inches) on forest land, by survey unit, Virginia, 2001–2021.

Hemlock Woolly Adelgid

First observed in Eastern North America in Virginia in the 1950s, the hemlock woolly adelgid is a piercing-sucking insect native to Japan that feeds at the base of hemlock (*Tsuga* spp.) needles causing desiccation, defoliation, and eventual mortality of the entire tree, often within 4 to 10 years of infestation (McClure and others 1996). Both eastern hemlock (*Tsuga canadensis*) and Carolina hemlock (*Tsuga caroliniana*) are susceptible. Since its introduction to the United States, the hemlock woolly adelgid has spread throughout the range of hemlock, from Georgia to Maine, and is found in almost all of hemlock's range in Virginia (USDA Forest Service 2022a) (fig. 32). The latest county to be infested in Virginia was Scott County, in 2007 (Virginia Polytechnic Institute and State University 2023b).

Statewide, volume of live hemlock trees ≥ 5.0 inches d.b.h., decreased from 2001 to 2011, increased from 2011 to 2016, and remained relatively unchanged from 2016 to 2021 (fig. 33a). In contrast, the number of live hemlock trees ≥ 5.0 inches d.b.h. declined steadily (fig. 33b). Trends in live hemlock volume and stem count varied among survey units over the last 20 years. In the Southern Mountains, where hemlock is most



Hemlock woolly adelgid infestations can be fatal for hemlock trees. (USDA Forest Service photo by Tom Brandeis)

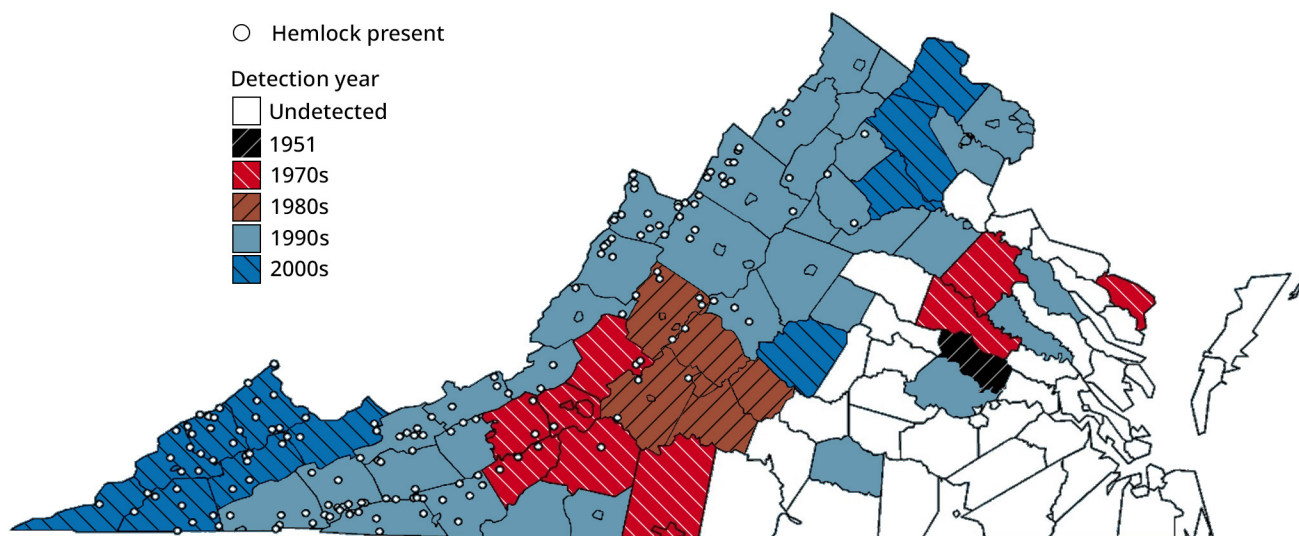


Figure 32—Approximate location of plots where eastern hemlock (*Tsuga canadensis*) was observed during the latest inventory cycle, and location of counties where the hemlock woolly adelgid (*Adelges tsugae*) has been confirmed, by detection year. The last new detection was in 2007. Data source: Virginia Polytechnic Institute and State University (2023b).

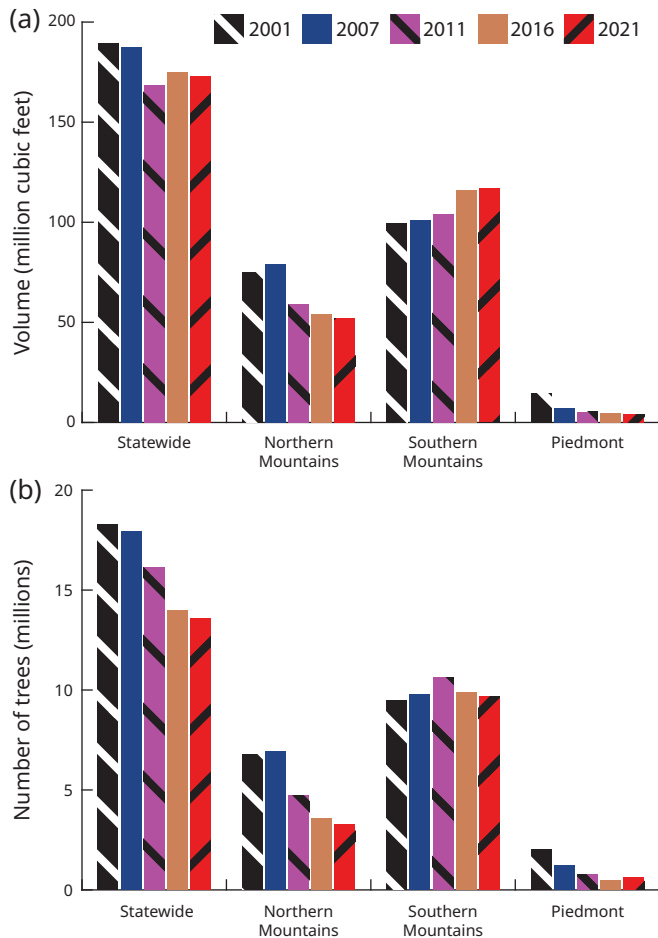


Figure 33—(a) Net merchantable volume and (b) stem count of live eastern hemlock (*Tsuga canadensis*) trees (d.b.h. ≥ 5.0 inches) on forest land, by survey unit, Virginia, 2001–2021. Piedmont represents the Northern Piedmont and Southern Piedmont units combined.

abundant, sound volume of live trees ≥ 5.0 inches d.b.h. increased by 17.1 mmcf from 2001 to 2021 despite only a small net gain in the number of trees. In the Northern Mountains, volume and stem count both increased from 2001 to 2007 before declining from 2007 to 2021. In the Northern Piedmont and Southern Piedmont units combined, hemlock volume and stem count both gradually declined from 2001 to 2016 then remained mostly unchanged from 2016 to 2021.

An overall decline in hemlock saplings from 49.4 million in 2001 to 21.9 million in 2021 likely reflects hemlock woolly adelgid's ability to feed on hemlock trees of all sizes (table A3.8). Although the number of hemlock seedlings has remained

relatively stable over the last 20 years statewide (approximately 30 million stems), the number of seedlings in the Northern Mountains declined significantly from 15.3 million in 2001 to 7.8 million in 2021. Development of management actions to promote hemlock survivorship is advancing, e.g., Brantley and others (2017) and Mayfield and others (2020), but implementation remains complex. Although hemlock is a relatively small component of the overall forest in Virginia (table 3), efforts to sustain the species is crucial to the health of the riparian and cove habitats in which it resides.

New Concerns

Two diseases threaten American beech (*Fagus grandifolia*) trees in Virginia. The first, known as beech leaf disease, is associated with the nematode *Litylenchus crenatae mccannii* and was first discovered in northeast Ohio in 2012 (Carta and others 2020). This disease causes bud abortion and leaf crinkling, curling, and discoloration which leads to crown thinning and eventual tree mortality (Ewing and others 2019). The second, beech bark disease, is caused by a combination of multiple agents, primarily the beech bark scale insect (*Cryptococcus fagisuga*) and phytopathogenic fungi *Neonectria faginata* and *N. ditissima* (Cale and others 2017). This disease results in multiple, often coalescing, bark cankers that cut off nutrient and water flow from the roots to the crown. Weakened trees are subject to mortality through stem girdling, windthrow, or bole breakage (Cale and others 2017). Beech leaf disease has been detected in two Virginia counties and one or more components of beech bark disease have been detected in 13 counties (fig. 34). These diseases pose a serious threat to the 311.8 million American beech trees with d.b.h. ≥ 1.0 inch in Virginia (table 3). However, neither has progressed into areas of Virginia where beech is most abundant (fig. 34), and any effect is not yet evident in the inventory. For instance, during the latest inventory cycle, average annual growth of beech trees ≥ 5.0 inches d.b.h. was 1.8 times greater than it was during the previous inventory cycle (table 6).

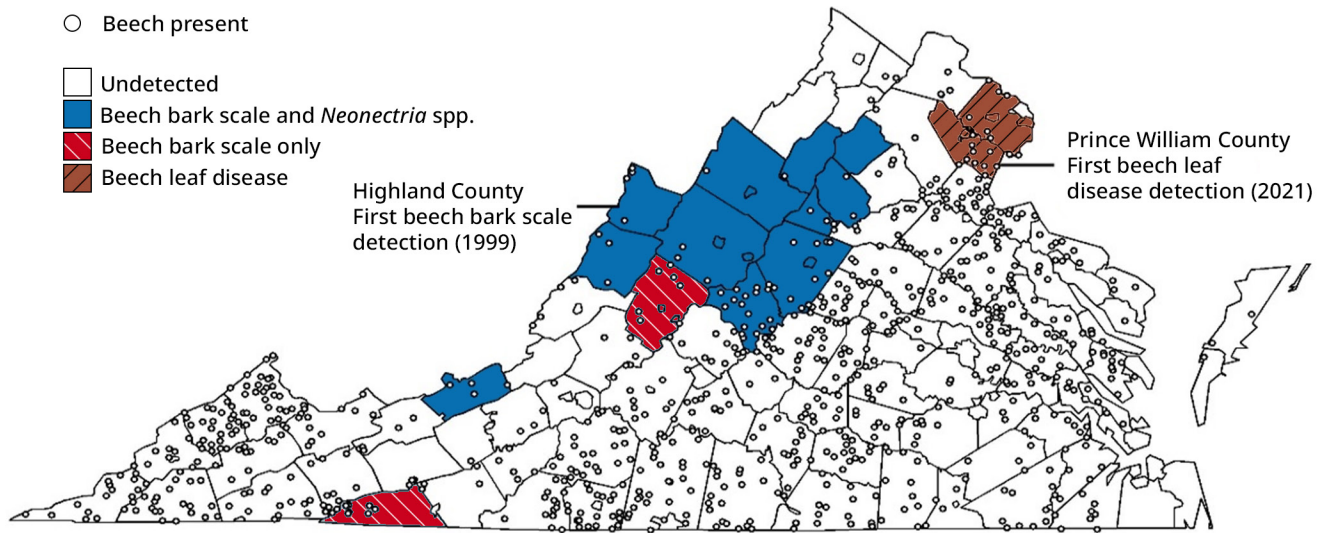


Figure 34—Approximate location of plots where American beech (*Fagus grandifolia*) was observed during the latest inventory cycle, and location of counties where beech leaf disease and components of the beech bark disease complex have been confirmed. Data sources: USDA Forest Service (2022b), USDA Forest Service and Cleveland Metroparks (2023), Virginia Cooperative Extension (2023), Virginia Department of Forestry (2023b).



A broken beech tree bole, a symptom known as beech snap, is characteristic of beech bark disease. (USDA Forest Service photo by Joe O'Brien)

Ongoing investigations into unusual eastern white pine (*P. strobus*) dieback and mortality occurring in western Virginia since 2006 (Virginia DOF 2011) have revealed a complex of causal agents consisting of the eastern white pine bast scale (*Matsucoccus macrocicatrices*), a canker-forming fungal pathogen *Caliciopsis pinea*, and sometimes other saprophytic fungi and cankers (Asaro and others 2018). The interrelationship of these agents, and the influence of abiotic factors, if any, on eastern white pine decline is still not well understood. Symptoms of the complex are visible in the crown, e.g., needle browning, crown thinning, and bottom-up branch dieback, and along the main stem and branches, e.g., resinosis and cankers. Eastern white pine is found throughout Virginia (fig. 35), mostly in the Southern Mountain (45.5 percent) and Northern Mountain (41.3 percent) units. Overall, eastern white pine in Virginia appears to be in good condition. No damage was observed on 95 percent of trees ≥ 5.0 inches d.b.h. and the average annual rate of growth (43.4 mmcf per year) was almost five times greater than the average annual rate of mortality (9.2 mmcf per year). Whitney and others (2018) noted that although all size classes of eastern white pine trees are affected by this scale-pathogen disease complex, smaller trees in the understory are most at risk of mortality. In

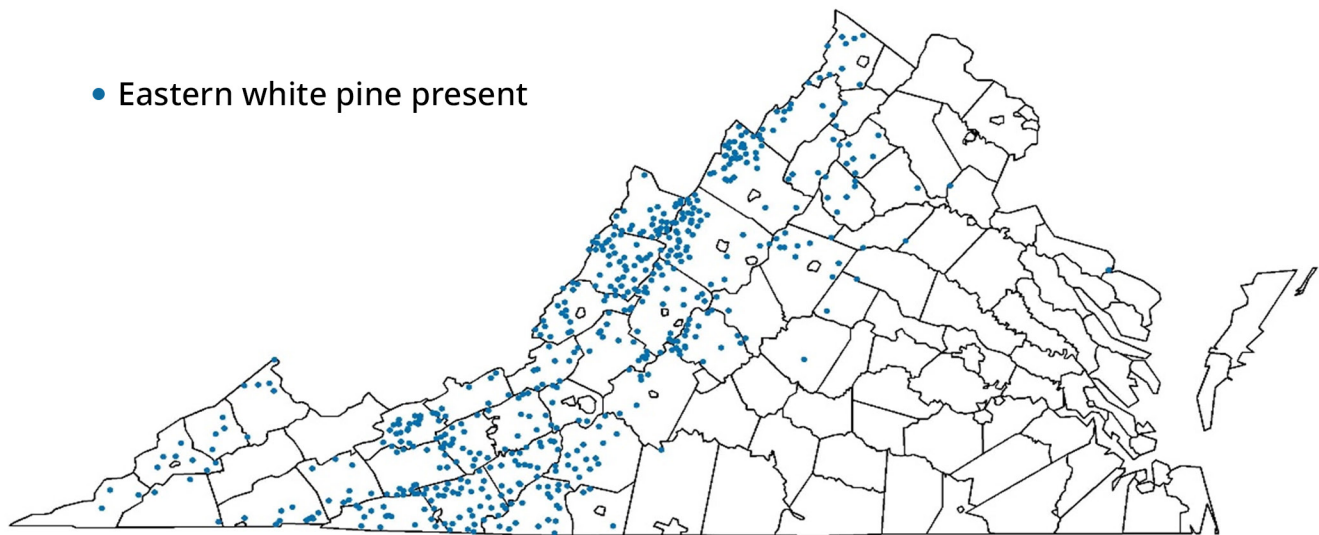


Figure 35—Approximate location of plots where eastern white pine (*Pinus strobus*) was observed during the latest inventory cycle.

general, the current diameter distribution of eastern white pine in areas where the disease complex has been observed, i.e., the Northern and Southern Mountain survey units, does not give any indication of excessive mortality in the small- and medium-diameter classes when compared to all other softwoods (fig. 36).

The elm zigzag sawfly (*Aproceros leucopoda*) was found in Clarke County, VA in 2021, the first such documented occurrence in the United States

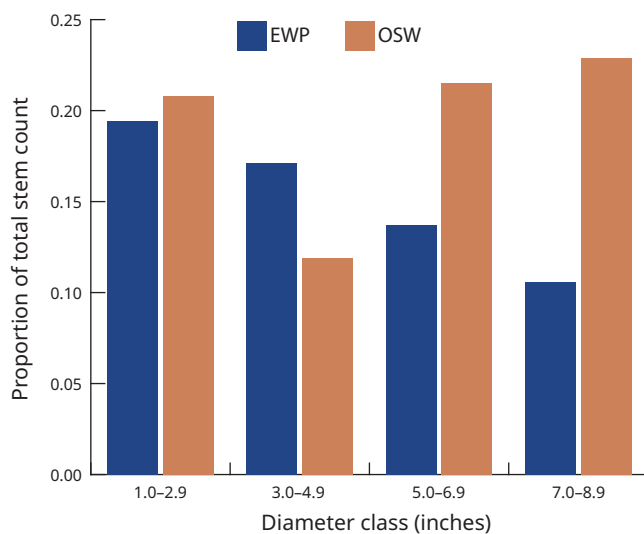


Figure 36—Proportion of eastern white pine (*Pinus strobus*, EWP) and other softwoods (OSW) total stem count (d.b.h. ≥ 1.0 inch) in the sapling and poletimber size classes that was standing dead in the Northern Mountain and Southern Mountain units, 2021.

(Virginia DOF 2021b). The insect is native to east Asia and was reported in Hungary and Poland in 2003 and in Canada in 2020 (Natural Resources Canada 2021). The sawfly gets its name from the way it defoliates elm (*Ulmus* spp.) leaves in a distinctive zigzag pattern during its larval stage. Defoliation is usually light, and mortality does not typically occur unless there are repeated instances of severe defoliation (Natural Resources Canada 2021, Virginia DOF 2021b). In Virginia, full defoliation of Siberian elms (*Ulmus pumilia*) and incomplete defoliation of American elms (*Ulmus americana*) has been observed, but it is too early to know what long-term impacts the insect will have on the elm resource (Virginia DOF 2021b). In 2021 there were 141.6 million elm trees (≥ 1.0 inch d.b.h.) throughout Virginia (USDA Forest Service 2023a). Most were observed in the Southern Piedmont (46.2 percent) and Coastal Plain (31.5 percent) units (fig. 37). Winged elm (*Ulmus alata*) and American elm are the most common elm species in Virginia, comprising 51.0 percent and 33.6 percent of the estimated total stem count, respectively. Slippery elm (*U. rubra*, 15.4 percent), rock elm (*Ulmus thomasii*, <0.1 percent), and Siberian elm (<0.1 percent) have also been observed. Statewide, live volume of elm trees ≥ 5.0 inches d.b.h. steadily increased from 134.9 mmcf in 2007 to 175.3 mmcf in 2021. The growth to mortality ratio increased over time as well, from

0.6 in 2007 to 1.0 in 2011 and 2016 to 1.9 in 2021. At the unit level, live volume of elm trees ≥ 5.0 inches d.b.h. increased steadily in the Coastal Plain, Southern Mountains, and Southern Piedmont from 2007 to 2021. In contrast, live volume in the Northern Mountains and Northern Piedmont fluctuated resulting in net gains of <0.4 mmcf between 2007 and 2021. Attributing the lack of consistent volume accretion in these two units to the elm zigzag sawfly would be tenuous given the recency of the insect's discovery and relative scarcity of elm where it has been found (fig. 37).



Elm zigzag sawfly (*Aproceros leucopoda*) larvae feed on elm leaves in a zigzag pattern. (Virginia Polytechnic Institute and State University photo by Eric R. Day)

Laurel wilt is a vascular disease of plants in the laurel (Lauraceae) family caused by the fungus *Harringtonia lauricola* and vectored by the redbay ambrosia beetle (*Xyleborus glabratus*). Symptoms include wilting leaves, branch dieback, and eventual, often rapid, mortality. First observed in the United States near Savannah, GA, in 2002, this nonnative insect-disease complex was detected in 284 counties in the Southeastern United States by the end of 2022 (Georgia Forestry Commission 2023). The first observation of laurel wilt in Virginia was made in Scott County in 2021 (Virginia DOF 2021c) (fig. 38). Susceptible species of primary concern in Virginia are sassafras (*Sassafras albidum*) and redbay (*Persea borbonia*). There are an estimated 96.2 million sassafras trees (≥ 1.0 inch d.b.h.) scattered throughout the State (USDA Forest Service 2023a). The majority are located in the Southern Mountain (35.8 percent) and Northern Mountain (32.1 percent) units. Sassafras is most commonly found in the oak-hickory forest type group, except in the Coastal Plain survey unit where about half of all sassafras trees occur in the loblolly/shortleaf pine forest type group. There are an estimated 22.2 million redbay trees (≥ 1.0 inch d.b.h.) in Virginia, all in the Coastal Plain and almost all (97 percent) <5.0 inches d.b.h. Redbay is most commonly found in the oak/gum/cypress forest type group. There is

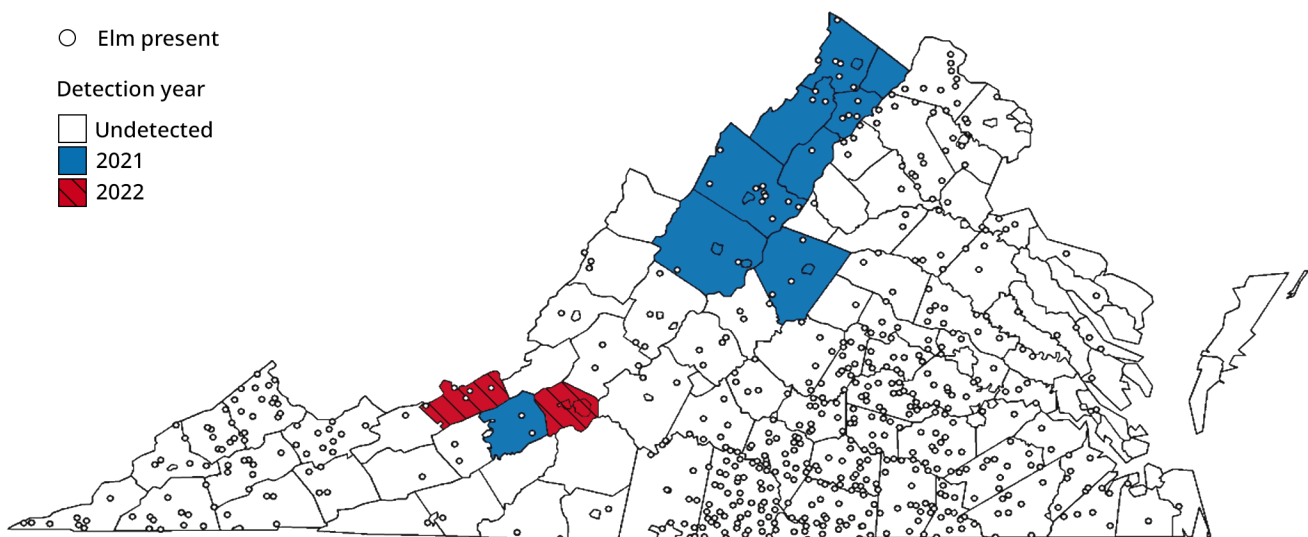


Figure 37—Approximate location of plots where elm (*Ulmus* spp.) was observed during the latest inventory cycle, and location of counties where the elm zigzag sawfly (*Aproceros leucopoda*) has been confirmed, by detection year. Data source: Oten (2023).

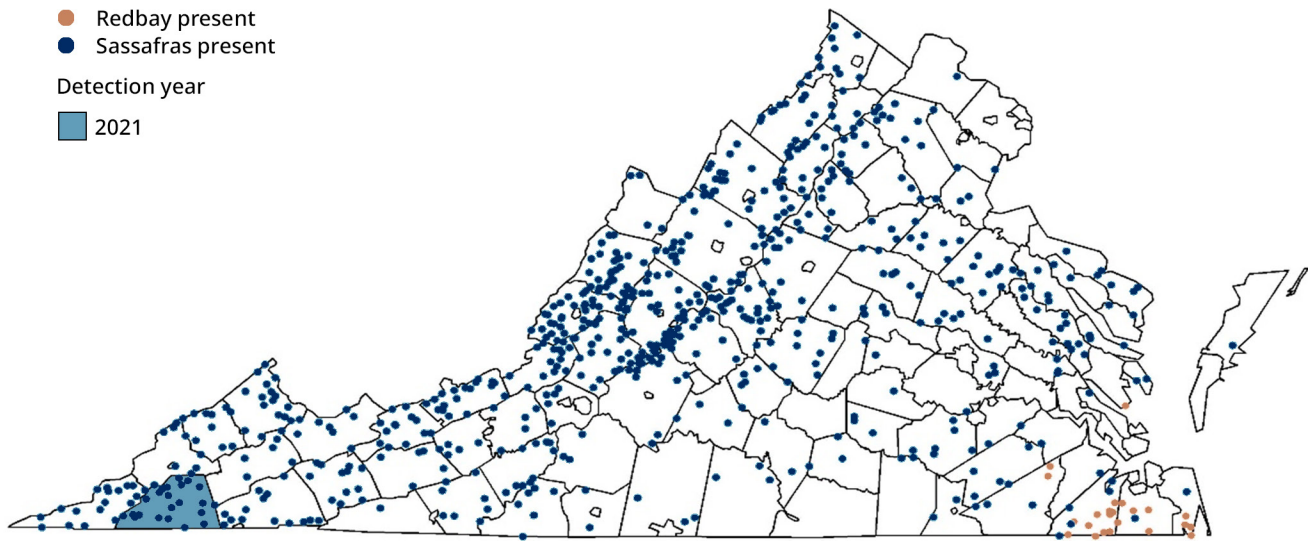
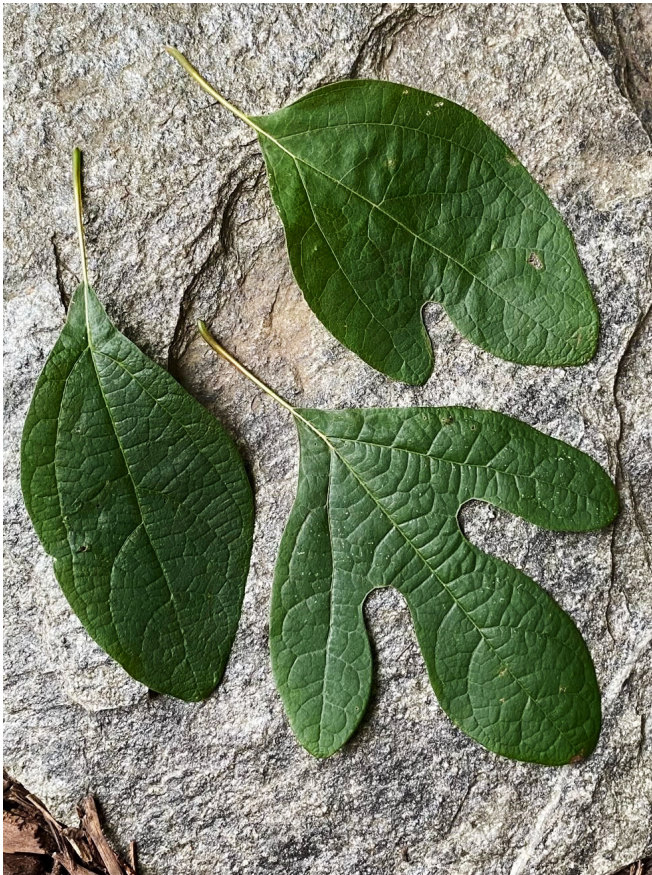


Figure 38—Approximate location of plots where sassafras (*Sassafras albidum*) and redbay (*Persea borbonia*) were observed during the latest inventory cycle, and location of counties where laurel wilt has been confirmed, by detection year. Data source: USDA Forest Service (2023b)



Sassafras (*Sassafras albidum*) leaves form in three distinct patterns: unlobed (oval shaped), bilobed (mitten shaped), and trilobed (fork shaped). (USDA Forest Service photo by KaDonna Randolph)

no indication of damage or mortality due to laurel wilt in Virginia yet, but close monitoring is warranted because the disease has spread rapidly and caused substantial losses in other parts of the Southeastern United States (Olatinwo and others 2021).

Singly and in concert, these insects and diseases have the potential to greatly alter the composition and structure of Virginia's forests. Much remains to be learned about their extent, manner of attack, and what, if any, management actions can be taken toward control. Ongoing inventory and monitoring efforts by the Virginia Department of Forestry and the Forest Service will provide invaluable information about their spread and subsequent forest response.

Spotted Lanternfly

The spotted lanternfly (*Lycorma delicatula*) is a distinctly colorful, phloem feeding insect native to China, Japan, and Vietnam that was discovered in Pennsylvania in 2014 (Urban and Leach 2023). Since its introduction to North America, infestations have been established in several States, including Virginia (fig. 39) (NYS IPM 2023). Due to its ability to feed on a wide variety of cultivated, ornamental, and wild plants, the

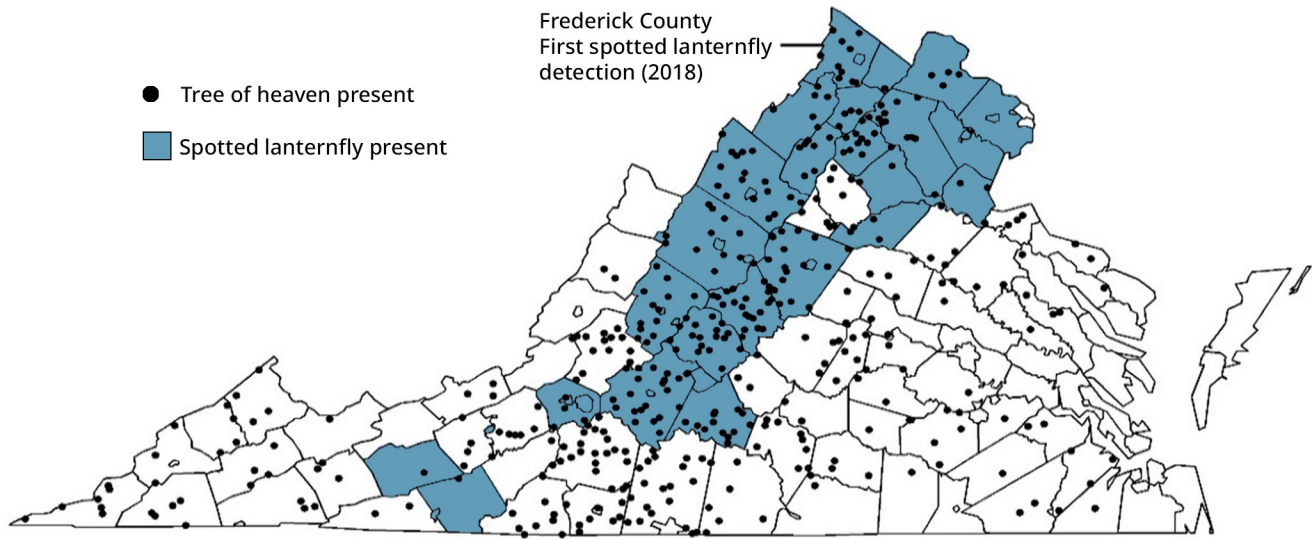


Figure 39—Approximate location of plots where tree of heaven (*Ailanthus altissima*) was tallied in the tree, seedling, or invasive plants protocol during the latest inventory cycle, and location of counties where reproducing populations of spotted lanternfly (*Lycorma delicatula*) have been confirmed. Data source: Virginia Polytechnic Institute and State University (2023a).

spotted lanternfly is a nuisance in multiple habitats. In the forest, it feeds on hardwood tree species, primarily tree of heaven (*Ailanthus altissima*), which is also an invasive species (Virginia DOF 2021a). During the latest inventory, tree of heaven was observed on more than 400 forested plots throughout Virginia (fig. 39) and was the fifth most frequently tallied invasive species in the State (table 20). Under the seedling and tree tallies, tree of heaven ranked 33rd and 32nd, respectively, with an estimated 229.5 million seedlings and 72.8 million trees and saplings. Concentrated in the Piedmont and Northern Mountain survey units, tree of heaven stems ≥ 1.0 inch d.b.h. were found most often in the white oak/red oak/hickory (21 percent), cherry/white ash/yellow-poplar (15 percent), and mixed upland hardwoods (13 percent) forest types (USDA Forest Service 2023a).

In general, the biologic, economic, and social consequences of spotted lanternfly infestations have been difficult to quantify. Evidence of damage in Virginia's forests was lacking in the latest inventory, most likely due to the recency of its detection in the State (January 2018). Although spotted lanternfly feeding may not directly cause mortality, it does weaken trees and make them more susceptible to other insects and diseases

Table 20—Invasive species on Virginia forest land, 2021

Common name	Scientific name	Plots	Percentage of plots
Japanese honeysuckle	<i>Lonicera japonica</i>	1,576	32.57
Japanese stiltgrass	<i>Microstegium vimineum</i>	980	20.25
Rose spp.	<i>Rosa</i> spp.	783	16.18
Japanese privet	<i>Ligustrum japonicum</i>	517	10.68
Tree of heaven	<i>Ailanthus altissima</i>	422	8.72
Autumn olive	<i>Elaeagnus umbellata</i>	399	8.25
Garlic mustard	<i>Alliaria petiolata</i>	253	5.23
Japanese barberry	<i>Berberis thunbergii</i>	236	4.88
Asiatic bittersweet	<i>Celastrus orbiculatus</i>	231	4.77
Sericea lespedeza	<i>Lespedeza cuneata</i>	197	4.07
Lespedeza spp.	<i>Lespedeza</i> spp.	137	2.83
Princesstree	<i>Paulownia tomentosa</i>	94	1.94
Ivy spp.	<i>Hedera</i> spp.	59	1.22
Tall fescue	<i>Schedonorus arundinaceus</i>	59	1.22
Honeysuckle	<i>Lonicera</i> spp.	47	0.97
Callery pear	<i>Pyrus calleryana</i>	39	0.81
Silktree	<i>Albizia julibrissin</i>	38	0.79
Wisteria spp.	<i>Wisteria</i> spp.	37	0.76

Table 20—Invasive species on Virginia forest land, 2021 (continued)

Common name	Scientific name	Plots	Percentage of plots
Burningbush	<i>Euonymus alatus</i>	29	0.60
Periwinkle	<i>Vinca</i> spp.	17	0.35
Winter creeper	<i>Euonymus fortunei</i>	16	0.33
Japanese privet	<i>Ligustrum japonicum</i>	15	0.31
Hardy orange	<i>Poncirus trifoliata</i>	13	0.27
Sacred bamboo	<i>Nandina domestica</i>	9	0.19
Kudzu	<i>Pueraria montana</i> var. <i>lobata</i>	9	0.19
Chinese silvergrass	<i>Miscanthus sinensis</i>	8	0.17
Crownvetch	<i>Securigera varia</i>	6	0.12
Japanese knotweed	<i>Polygonum cuspidatum</i>	4	0.08
Yam spp.	<i>Dioscorea</i> spp.	4	0.08
Bamboo spp.	<i>Bambusa</i> spp.	3	0.06
Thorny olive	<i>Elaeagnus pungens</i>	2	0.04
Beale's barberry	<i>Mahonia bealei</i>	2	0.04
Hen's eyes	<i>Ardisia crenata</i>	1	0.02

Number of species detections and the number and percentage of plots on which they occur.

(Virginia DOF 2022). Given the distribution of tree of heaven across the State, and its co-occurrence with other spotted lanternfly hosts such as walnut (*Juglans* spp.), maple (*Acer* spp.), and oak (*Quercus* spp.), future damages could be significant.

For more information about the spotted lanternfly, visit the Virginia Department of Agriculture and Consumer Services website at <https://www.vdacs.virginia.gov/plant-industry-services-spotted-lanternfly.shtml>.

Nonnative Invasive Plants

Foresters and ecologists have noted the spread of nonnative invasive species onto U.S. forest land for decades. Despite soaring costs and inestimable environmental impacts, nonnative invasive species continue to spread across managed and natural forests. This update describes current results from data collected in Virginia between 2018 and 2021 and provides graphic illustrations of where invasive plants are being observed in



Spotted lanternflies (*Lycorma delicatula*) as eggs and young nymphs (USDA Forest Service photo by Randy Morin), older nymphs (Pennsylvania Department of Agriculture photo by Lawrence Barringer), and adults (Penn State University photo by Emelie Swackhamer).

forests across the State of Virginia. Observations of nonnative invasive plants include only those plants on the SRS FIA invasive plants “watch list” which contains plant species regionally recognized as problematic nonnative invasive plants.

Invasive plants were detected on 2,187 plots across the State, 45 percent of all forested plots monitored for invasive plants. The maximum number of nonnative invasive species detected on an individual plot was seven, which occurred on <1 percent of forested plots. Approximately 50 percent of invaded plots contained only one invasive plant from the SRS FIA watch list, and 76 percent of invaded plots contained only one or two invasive plants.

Japanese honeysuckle (*Lonicera japonica*) was the most frequently detected nonnative species in Virginia (table 20). The seemingly ubiquitous invasive vine was found on 33 percent of all forested plots surveyed. Japanese stiltgrass (*Microstegium vimineum*) was the second most frequently detected species and was noted on 20 percent of measured plots. Nonnative roses (*Rosa* spp.), as a group, was the third most frequently observed invasive plant, and Chinese and European privets (*Ligustrum sinense*/*L. vulgare*) were the fourth most frequently observed nonnative invasive in forests of Virginia. The above-mentioned species along with tree of heaven (*A. altissima*), autumn olive (*Elaeagnus umbellata*), garlic mustard (*Alliaria petiolata*), Japanese barberry (*Berberis thunbergii*), Asiatic bittersweet (*Celastrus orbiculatus*), and serecea lespedeza (*Lespedeza cuneata*) comprise the top 10 most frequently detected invasive plants surveyed on forested plots in Virginia (table 20).

The FIA program monitors both presence of invasives and estimates the area on plots covered by each species. Doing so affords the ability to make estimates of acres impacted by an individual invasive plant. Presence is highly correlated with area impacted, however there are some interesting differences. For example, though Japanese honeysuckle was present on a greater number of plots, Japanese stiltgrass, when present covered more area on a plot. As a result, Japanese stiltgrass is estimated to impact more forest land (509,410 acres) and timberland (504,090 acres) in Virginia (table 21). Another notable difference is tall fescue (*Schedonorus arundinaceus*). Although tall fescue is not in the top 10 based on presence

Table 21— Area of forest land/timberland for each monitored invasive plant species found in Virginia, 2021

Invasive species	Area (forest land)	Area (timberland)
	thousand acres	
Japanese stiltgrass	509.41	504.09
Japanese honeysuckle	469.15	464.63
Autumn olive	131.67	131.41
Rose spp.	110.17	107.82
Tree of heaven	79.04	78.14
Asiatic bittersweet	74.93	72.66
Japanese Privet	67.17	67.03
Japanese barberry	23.96	23.81
Tall fescue	18.60	18.60
Garlic mustard	17.56	15.71
Princesstree	13.78	13.47
Wisteria spp.	13.14	13.14
Sericea lespedeza	11.24	11.19
Lespedeza spp.	11.16	11.13
Ivy spp.	8.89	6.04
Chinese silvergrass	8.15	8.15
Honeysuckle	7.38	6.78
Callery pear	7.11	7.09
Periwinkle	5.17	5.17
Winter creeper	5.08	5.05
Japanese knotweed	3.82	3.82
Kudzu	3.38	3.38
Silktree	2.79	2.78
Japanese privet	1.75	1.75
Bamboo spp.	1.15	1.15
Burningbush	0.94	0.94
Sacred bamboo	0.79	0.79
Hardy orange	0.66	0.66
Crownvetch	0.13	0.13
Yam spp.	0.10	0.10
Thorny olive	0.06	0.06
Beale's barberry	0.06	0.06
Hen's eyes	0.03	0.03

(table 20), the invasive grass, because of its larger coverage when found, is in the top 10 of acres impacted (table 21).

Overall, invasive plants are impacting a total of 1.6 million acres or approximately 10 percent of all forest land in the State (table 22). Invasive plants are more common on private or State and local lands. National forests and other Federal lands have the least area impacted by invasive plants. This result may be due to eradication programs that are active on many Federal forest land holdings. Impacted forest land area tends to be in younger to medium-aged stands across all

species (fig. 40). Though Japanese stiltgrass impact appears to peak in medium-aged stands, Japanese honeysuckle is a very clear issue for younger stands.

In conclusion, invasive species are common on forested plots across the State of Virginia. The prevalence of invasive plants on Virginia forest land illustrates the utility of public education regarding their ecological and economic costs, and the value of concentrated control and management efforts to lessen their impact on forested systems.

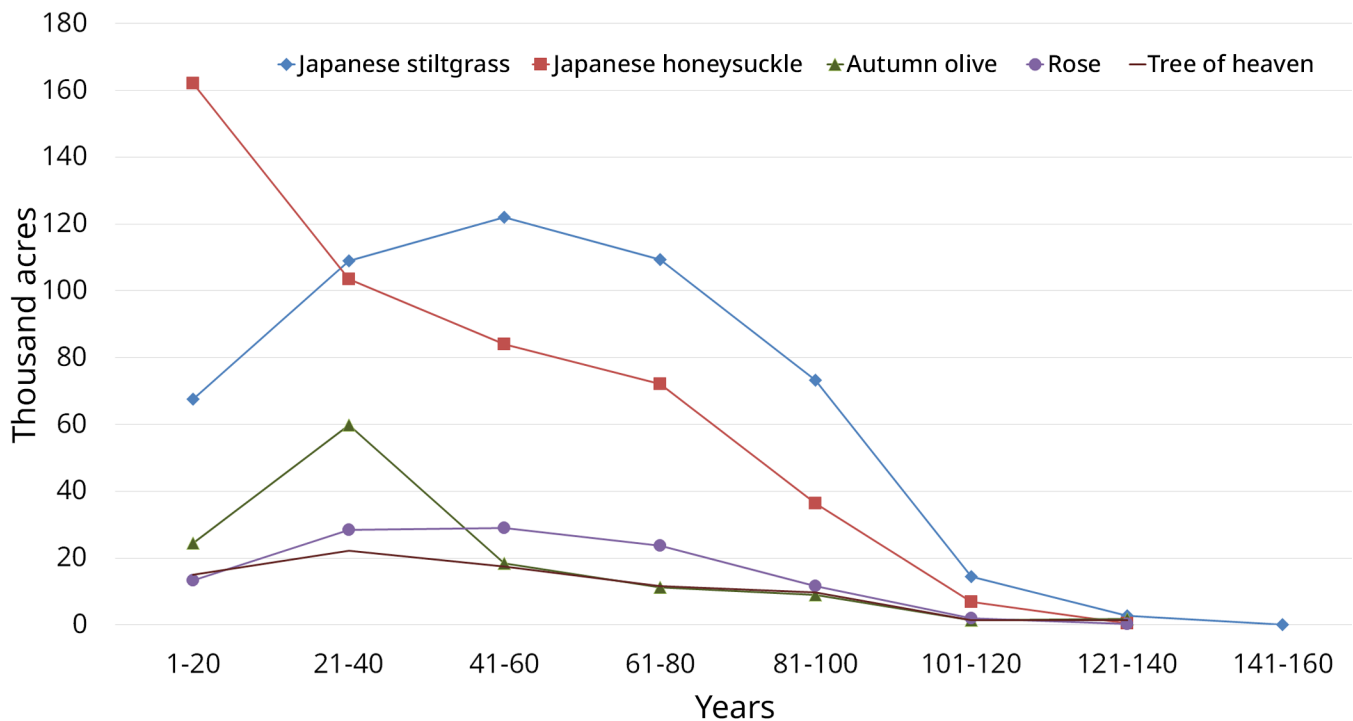


Figure 40—Area of forest land for the top five monitored invasive plant species found in Virginia by stand age, 2021.

VIRGINIA'S FORESTS, 2021

Table 22—Area of forest land for the monitored invasive plant species found in Virginia by ownership group, 2021

Invasive species	All owners	USDA Forest Service	Other Federal	State and local government	Nonindustrial private
<i>thousand acres</i>					
Japanese stiltgrass	509.41	2.81	7.02	15.27	484.32
Japanese honeysuckle	469.15	0.09	8.74	21.59	438.72
Autumn olive	131.67	0.77	0.71	7.37	122.81
Rose spp.	110.17	0.48	0.67	4.51	104.51
Tree of heaven	79.04	0.42	1.05	3.44	74.13
Asiatic bittersweet	74.93	0.30	1.90	4.12	68.61
Japanese privet	67.17	0	0.09	4.15	62.93
Japanese barberry	23.96	0.11	0.20	2.18	21.48
Tall fescue	18.60	0	0	0.04	18.57
Garlic mustard	17.56	0.96	1.80	1.46	13.33
Princesstree	13.78	0.20	0.31	0.37	12.90
Wisteria spp.	13.14	0	0	0	13.14
Sericea lespedeza	11.24	0.03	0.85	0.44	9.92
Lespedeza spp.	11.16	0.01	0.16	0.06	10.93
Ivy spp.	8.89	0	0	3.45	5.44
Chinese silvergrass	8.15	0	0	0	8.15
Honeysuckle	7.38	0	0.03	1.42	5.93
Callery pear	7.11	0	0.02	4.74	2.36
Periwinkle	5.17	0	0	0	5.17
Winter creeper	5.08	0	0.03	0	5.05
Japanese knotweed	3.82	0	0	0	3.82
Kudzu	3.38	0	0	0	3.38
Silktree	2.79	0	0	0.08	2.71
Japanese privet	1.75	0	0	0	1.75
Bamboo spp.	1.15	0	0	0.63	0.51
Burningbush	0.94	0	0	0.02	0.92
Sacred bamboo	0.79	0	0	0.03	0.76
Hardy orange	0.66	0	0	0.03	0.63
Crownvetch	0.13	0.01	0	0	0.12
Yam spp.	0.10	0	0	0.02	0.08
Thorny olive	0.06	0	0	0	0.06
Beale's barberry	0.06	0	0	0	0.06
Hen's eyes	0.03	0	0	0	0.03
Total	1,608.42	6.19	23.58	75.42	1,503.23

LITERATURE CITED

- Asaro, C.; Chamberlin, L.A.; Rose, J.A. [and others]. 2018. Mortality of eastern white pine (*Pinus strobus* L.) in association with a novel scale insect-pathogen complex in Virginia and West Virginia. *Forest Ecology and Management*. 423: 37–48. <https://doi.org/10.1016/j.foreco.2017.12.032>.
- Aubin, I.; Cardou, F.; Ryall, K. [and others]. 2015. Ash regeneration capacity after emerald ash borer (EAB) outbreaks: some early results. *The Forestry Chronicle*. 91(3): 291–298. <https://doi.org/10.5558/tfc2015-050>.
- 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.
- Brandeis, T.J.; Hartsell, A.J.; Randolph, K.C.; Oswalt, C.M. 2018. Virginia's forests, 2016. *Resour. Bull. SRS-223*. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station. 99 p.
- Brantley, S.T.; Mayfield, A.E., III; Jetton, R.M. [and others]. 2017. Elevated light levels reduce hemlock woolly adelgid infestation and improve carbon balance of infested eastern hemlock seedlings. *Forest Ecology and Management*. 385: 150–160. <https://doi.org/10.1016/j.foreco.2016.11.028>.
- Burrill, E.A.; DiTommaso, A.M.; Turner, J.A. [and others]. 2024. The Forest Inventory and Analysis Database, FIADB user guides, volume database description (version 9.2), nationwide forest inventory (NFI). U.S. Department of Agriculture, Forest Service. 1042 p. [Online]. <https://www.fs.usda.gov/research/products/dataandtools/datasets/fia-datamart>.
- Cale, J.A.; Garrison-Johnston, M.T.; Teale, S.A.; Castello, J.D. 2017. Beech bark disease in North America: Over a century of research revisited. *Forest Ecology and Management*. 394: 86–103. <https://doi.org/10.1016/j.foreco.2017.03.031>.
- Carta, L.K.; Handoo, Z.A.; Li, S. [and others]. 2020. Beech leaf disease symptoms caused by newly recognized nematode subspecies *Litylenchus crenatae mccannii* (Anguinata) described from *Fagus grandifolia* in North America. *Forest Pathology*. 50: e12580. <https://doi.org/10.1111/efp.12580>.
- Coulston, J.W. 2022. Timber products output. In: Sampling and estimation documentation for the Enhanced Forest Inventory and Analysis Program: 2022. Gen. Tech. Rep. NRS-207. Madison, WI: U.S. Department of Agriculture, Forest Service, Northern Research Station: 50-61. <https://doi.org/10.2737/NRS-GTR-207>.
- Conner, R. C.; Adams, T.; Butler, B. J. [and others]. 2004. The state of South Carolina's forests, 2001. *Resour. Bull. SRS-96*. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station. 67 p.
- Domke, G.M.; Perry, C.H.; Walter, B.F. [and others]. 2016. Estimating litter carbon stocks on forest land in the United States. *Science of the Total Environment*. 557–558: 469–478. <https://doi.org/10.1016/j.scitotenv.2016.03.090>.
- Domke, G.M.; Woodall, C.W.; Walters, B.F. [and others]. 2013. From models to measurements: comparing downed dead wood carbon stock estimates in the U.S. forest inventory. *PLOS ONE*. 8(3): 1–12. <https://doi.org/10.1371/journal.pone.0059949>.
- Emerald Ash Borer Network. 2023. State and province infestation. <http://www.emeraldashborer.info/>. [Date accessed: June 8, 2023].
- Ewing, C.J.; Hausman, C.E.; Pogacnik, J. [and others]. 2019. Beech leaf disease: An emerging forest epidemic. *Forest Pathology*. 49: e12488. <https://doi.org/10.1111/efp.12488>.
- Georgia Forestry Commission. 2023. Laurel wilt public dashboard. <https://www.arcgis.com/apps/dashboards/d43391c8fdb741b597e6ccf1236d2a02>. [Date accessed: June 23, 2023].
- Hermes, D.A.; McCullough, D.G. 2014. Emerald ash borer invasion of North America: history, biology, ecology, impacts, and management. *Annual Review of Entomology*. 59: 13–30. <https://doi.org/10.1146/annurev-ento-011613-162051>.
- Klooster, W.S.; Hermes, D.A.; Knight, K.S. [and others]. 2014. Ash (*Fraxinus* spp.) mortality, regeneration, and seed bank dynamics in mixed hardwood forests following invasion by emerald ash borer (*Agrilus planipennis*). *Biological Invasions*. 16: 859–873. <https://doi.org/10.1007/s10530-013-0543-7>.
- Mayfield, A.E., III; Salom, S.M.; Sumpter, K. [and others]. 2020. Integrating chemical and biological control of the hemlock woolly adelgid: a resource manager's guide. FHTET-2018-04. Morgantown, WV: U.S. Department of Agriculture, Forest Service, Forest Health Assessment and Applied Sciences Team. 34 p. <https://www.fs.usda.gov/research/treesearch/59529>.
- McClure, M.S.; Salom, S.M.; Shields, K.S. 1996. Hemlock woolly adelgid. FHTET-96-35. Morgantown, WV: U.S. Department of Agriculture, Forest Service, Forest Health Technology Enterprise Team. 18 p.
- Natural Resources Canada. 2021. The sawfly is zigzagging its way across elm leaves. Branching Out. No. 126. Quebec: Her Majesty the Queen in Right of Canada. https://www.nj.gov/dep/parksandforests/forest/foresthealth/elm_zigzag_sawfly_article.pdf. [Date accessed: June 8, 2023].
- New York State Integrated Pest Management Program [NYS IPM]. 2023. Confirmed spotted lanternfly locations. June 6, 2023. <https://www.stopslf.org/where-is-slf/slf-map/>. [Date accessed: August 31, 2023].
- Olatinwo, R.O.; Fraedrich, S.W.; Mayfield, A.E., III. 2021. Laurel wilt: current and potential impacts and possibilities for prevention and management. *Forests*. 12: 181. <https://doi.org/10.3390/f12020181>.
- Oten, K. 2023. New pests, new problems. <https://forestrywebinars.net/webinars/new-pests-new-problems/?sr=hp-trending>. [Date accessed: June 14, 2023].
- Rose, A.K. 2007. Virginia's Forests, 2001. *Resour. Bull. SRS-120*. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station. 140 p.
- Rose, A.K. 2009. Virginia's Forests, 2007. *Resour. Bull. SRS-159*. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station. 77 p.
- Rose, A.K. 2013. Virginia's Forests, 2011. *Resour. Bull. SRS-197*. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station. 92 p.

- Scott, C.T.; Bechtold, W.S.; Westfall, J.A. [and others]. 2005. Sample-based estimators used by the Forest Inventory and Analysis National Information Management System. In Bechtold, W.A.; Patterson, P.L., eds. 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: 43–67.
- Smith, J.E.; Heath, L.S. 2002. A model of forest floor carbon mass for United States forest types. Res. Pap. NE-722. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northeastern Research Station. 37 p. <https://doi.org/10.2737/NE-RP-722>.
- U.S. Department of Agriculture Forest Service [USDA Forest Service]. 1992. Forest Service resource inventories: an overview. Washington, DC: U.S. Department of Agriculture, Forest Service, Forest Inventory, Economics, and Recreation Research. 39 p.
- U.S. Department of Agriculture Forest Service [USDA Forest Service]. 2014. Forest inventory and analysis national core field guide. Volume 1: field data collection procedures for phase 2 plots. Version 6.11. Washington, DC. 305 p. Internal report. On file with: U.S. Department of Agriculture, Forest Service, Forest Inventory and Analysis, 201 14th Street, Washington, DC 20250. <https://research.fs.usda.gov/understory/nationwide-forest-inventory-field-guide>.
- U.S. Department of Agriculture Forest Service [USDA Forest Service]. 2021a. NRUM Toolkit-NRUM Interactive Reporting Tool. <https://public.tableau.com/views/TPOREPORTINGTOOL/MakeSelection?:showVizHome=no> [Date accessed: June 5, 2023].
- U.S. Department of Agriculture Forest Service [USDA Forest Service]. 2021b. NRUM Toolkit-NRUM Data Download. <https://usfs-public.app.box.com/s/y4ziirdb9v7zardus0cuajh7ziy9b2id> [Date accessed: June 6, 2023].
- U.S. Department of Agriculture Forest Service [USDA Forest Service]. 2022a. Hemlock woolly adelgid: years of infestation 1951-2021. http://hiro.ento.vt.edu/hwa/wp-content/uploads/2022/04/YearsInfestedupdated3_22_22.png. [Date accessed: April 28, 2023].
- U.S. Department of Agriculture Forest Service [USDA Forest Service]. 2022b. Region 8 forest health monitoring 2021 summary. <https://storymaps.arcgis.com/stories/85d784ee2bc44b36850ae1cf44f13c88>. [Date accessed: June 14, 2023].
- U.S. Department of Agriculture Forest Service [USDA Forest Service]. 2023a. Forest Inventory EVALIDator web-application. Version 1.9.1.00. St. Paul, MN: U.S. Department of Agriculture, Forest Service, Northern Research Station. <https://apps.fs.usda.gov/fiadb-api/evalidator>. [Date accessed: November 13, 2023].
- U.S. Department of Agriculture Forest Service [USDA Forest Service]. 2023b. Forest pest damage and range: laurel wilt, 2021. <https://www.fs.usda.gov/foresthealth/applied-sciences/mapping-reporting/damage-agent-range-maps.shtml>. [Date accessed: June 14, 2023].
- U.S. Department of Agriculture Forest Service [USDA Forest Service] and Cleveland Metroparks. 2023. Initial beech leaf disease observation. https://www.clevelandmetroparks.com/getmedia/ba78f8e2-a196-46a6-bb8b-b4015ea52872/Feb-2023_BLD-by-year-1.png.ashx. [Date accessed: June 14, 2023].
- U.S. Environmental Protection Agency [EPA]. 2012. Forest sections of the land use, land use change, and forestry chapter, and annex. In: U.S. Environmental Protection Agency, Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2010. EPA 430-R-12-001. <https://www.epa.gov/sites/default/files/2015-12/documents/us-ghg-inventory-2012-main-text.pdf>. [Date accessed: January 8, 2013].
- Urban, J.M.; Leach, H. 2023. Biology and management of the spotted lanternfly, *Lycorma delicatula* (Hemiptera: Fulgoridae), in the United States. Annual Review of Entomology. 68: 151–167. <https://doi.org/10.1146/annurev-ento-120220-111140>.
- Virginia Cooperative Extension. 2023. Plant specimen diagnostic report #2023-57 Beech. Virginia Polytechnic Institute and State University. Report available upon request from <https://ext.vt.edu/>.
- Virginia Department of Forestry [Virginia DOF]. 2008. The “green menace” is back and this time, it’s here to stay. Forest Health Review. November: 2–6. https://dof.virginia.gov/wp-content/uploads/FHR-2008-11_pub.pdf. [Date accessed: July 12, 2023].
- Virginia Department of Forestry [Virginia DOF]. 2011. What’s killing white pine in the highlands of western Virginia? Forest Health Review. May: 9–11. https://dof.virginia.gov/wp-content/uploads/FHR-2011-05_pub.pdf. [Date accessed: May 5, 2023].
- Virginia Department of Forestry [Virginia DOF]. 2021a. *Ailanthus* control methods. Forestry Topic 55. Charlottesville, VA: Virginia Department of Forestry. 2 p. https://dof.virginia.gov/wp-content/uploads/FT0055_Ailanthus-Control-Methods_pub.pdf. [Date accessed: September 1, 2023].
- Virginia Department of Forestry [Virginia DOF]. 2021b. Elm zigzag sawfly. Forest Health Review. December: 8. https://dof.virginia.gov/wp-content/uploads/FHR-2021-12_pub.pdf. [Date accessed: June 8, 2023].
- Virginia Department of Forestry [Virginia DOF]. 2021c. Laurel wilt disease. Forest Health Review. December: 6, 12. https://dof.virginia.gov/wp-content/uploads/FHR-2021-12_pub.pdf. [Date accessed: June 8, 2023].
- Virginia Department of Forestry [Virginia DOF]. 2022. Spotted Lanternfly. Forest Health Review. December: 5. <https://dof.virginia.gov/wp-content/uploads/FHR-2022.pdf>. [Date accessed: October 26, 2023].
- Virginia Department of Forestry [Virginia DOF]. 2023a. Emerald ash borer in Virginia: an introduction. <https://vdof.maps.arcgis.com/apps/MapSeries/index.html?appid=e2660c30d9cd46cc988cc72415101590>. [Date accessed: June 14, 2023].
- Virginia Department of Forestry [Virginia DOF]. 2023b. Beech bark disease confirmed in Augusta County. The Branch. January: 2–3. <https://dof.virginia.gov/wp-content/uploads/Branch-2023-01-03.pdf>. [Date accessed: June 15, 2023].
- Virginia Polytechnic Institute and State University. 2023a. Current distribution of spotted lanternfly populations in Virginia, July 5, 2023. https://www.ento.vt.edu/4-H_Entomology/SpottedLanternfly/map.html. [Date accessed: August 25, 2023].

- Virginia Polytechnic Institute and State University. 2023b. HWA infested counties. [Microsoft Excel file]. Available: <http://hiro.ento.vt.edu/hwa/index.php/distribution-maps/>. [Date accessed: April 28, 2023].
- Westfall, J.A.; Coulston, J.W.; Moisen, G.G.; Andersen, H.-E., comps. 2022. Sampling and estimation documentation for the Enhanced Forest Inventory and Analysis Program: 2022. Gen. Tech. Rep. NRS-207. Madison, WI: U.S. Department of Agriculture, Forest Service, Northern Research Station. 129 p. <https://doi.org/10.2737/NRS-GTR-207>.
- Whitney, T.D.; Cram, M.M.; Barnes, B.F. [and others]. 2018. Tree-level distribution of a novel insect-pathogen complex and its potential contribution to eastern white pine dieback. *Forest Ecology and Management*. 423: 49–58. <https://doi.org/10.1016/j.foreco.2018.02.002>.
- Woodall, C.W.; Monleon, V.J. 2008. Sampling protocol, estimation, and analysis procedures for the down woody materials indicator of the FIA program. Gen. Tech. Rep. NRS-22. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northern Research Station. 68 p. <https://doi.org/10.2737/NRS-GTR-22>.
- Woodall, C.W.; Amacher, M.C.; Bechtold, W.A. [and others]. 2011a. Status and future of the forest health indicators program of the USA. *Environmental Monitoring and Assessment*. 177: 419–436. <https://doi.org/10.1007/s10661-010-1644-8>
- Woodall, C.W.; Heath, L.S.; Domke, G.M. [and others]. 2011b. Methods and equations for estimating aboveground volume, biomass, and carbon for trees in the U.S. forest inventory, 2010. Gen. Tech. Rep. NRS-88. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northern Research Station. 30 p. <https://doi.org/10.2737/NRS-GTR-88>.

GLOSSARY

All-live tree—All living trees. All size classes, all tree classes, and both sawlog and nonsawlog species are included. See: FIA tree species list in the field manual.

Average annual mortality—Average annual volume of trees ≥ 5.0 inches d.b.h. that died from human and natural causes during the intersurvey period, excluding those removed by harvesting, cultural operations, land clearing or changes in land use.

Average annual removals—Average annual volume of trees ≥ 5.0 inches d.b.h. removed from the inventory by harvesting, cultural operations (such as timber-stand improvement), land clearing, or changes in land use during the intersurvey period.

Average net annual growth—Average annual net change in volume of trees ≥ 5.0 inches d.b.h./d.r.c. without taking into account losses from cutting (gross growth minus mortality) during the intersurvey period.

Biomass—For the southern region, total aboveground biomass is estimated using allometric equations and is defined as the aboveground weight of wood and bark in live trees ≥ 1.0 inch d.b.h./d.r.c. from the ground to the tip of the tree, excluding all foliage (leaves, needles, buds, fruit, and limbs < 0.5 inch in diameter). Biomass is expressed as oven-dry weight and the units are tons.

Note: the weight of wood and bark in limbs < 0.5 inch in diameter is included in the biomass of small-diameter trees.

Additionally, biomass in the merchantable stem is estimated regionally, where the main and merchantable stems are defined as follows.

Main stem—The central portion of the tree extending from the ground level to the tip for timber species. Woodland species includes from ground level to the tips of all branches

of qualifying stems. For timber species trees that fork, the main stem refers to the fork that would yield the most merchantable volume.

Merchantable stem—That portion of the main stem of a timber species tree from a 1-foot stump to a minimum 4-inch top diameter inside or outside bark depending on species. That portion of a woodland species tree from the d.r.c. measurements to the 1.5-inch diameters of all the qualifying stems.

Nationally aboveground and belowground biomass is estimated from each tree's sound volume using a component ratio method that is consistently applied in all FIA regions.

Gross aboveground biomass—Total tree biomass excluding foliage and roots with no deductions made for rotten, missing, or broken-top cubic-foot cull.

Net aboveground biomass—Gross aboveground biomass minus deductions for missing cull, broken-top, and a reduction for a proportion of rotten cull for live or standing dead trees ≥ 5.0 inches d.b.h (Rotten cull will have a factor to reduce specific gravity separately from sound wood). Live and standing dead trees 1.0 to 4.9 inches only have deductions for broken-top cull. Additional deductions are made for dead trees ≥ 1.0 inch using decay class.

Belowground biomass—Coarse roots only.

Further, the total net aboveground biomass estimated using the component ratio method is divided into the following components:

Top—That portion of the main stem of a timber species tree above the 4-inch top diameter. For woodland species, this component of the biomass is included with branches.

Branches—All the branches of a timber species tree excluding the main stem. That portion of all the branches of qualifying

stems of woodland species above the 1.5-inch diameter ends.

Bole—See: Merchantable stem.

Stump—That portion of timber species below 1-foot to ground level. That portion of woodland species from all the d.r.c. measurements to ground level.

Bole—Trunk or main stem of a tree. (See: Main stem.)

Board foot—A unit of measure applied to lumber that is 1-foot long, 1-foot wide, and 1-inch thick (or its equivalent) and associated with roundwood as to its potential yield of such products.

Census water—See: Land use.

Coarse woody debris (CWD)—Downed, dead tree and shrub boles, large limbs, and other woody pieces with a minimum small-end diameter of ≥ 3 inches and a length of ≥ 3 feet not attached to a living or standing dead source.

Components of change—Volume increment and decrement values that explain the change in inventory between two points in time. Components of change are usually expressed in terms of growing-stock or all-live merchantable volume. These components can be expressed as average annual values by dividing the component by the number of years in the measurement cycle. FIA inventories are designed to measure net change over time, as well as the individual components of change that constitute net change (e.g., growth, removals, mortality). Change estimates are computed for two sequential measurements of each inventory panel. Upon remeasurement, a new initial inventory is established for remeasurement at the next scheduled inventory. As such, computation of change components is not intended to span more than one inventory cycle. Rather, the change estimation process is repeated cycle by cycle. This simplifies field protocols and ensures that change estimation is based on short and relatively

constant time intervals (e.g., 5 years). Change estimates for individual panels are combined across multiple panels in the same manner as panels are combined to obtain current inventory parameters such as total standing volume. FIA recognizes the following components of change as prescribed core variables; they usually are expressed in terms of growing-stock or all-live volume, where t is the initial inventory of a measurement cycle, and $t + 1$ is the terminal inventory:

Cut—The volume of trees cut between time t and time $t + 1$. The estimate is based on tree size at the midpoint of the measurement interval (includes cut growth). Tree size at the midpoint is modeled from tree size at time t . Trees felled or killed in conjunction with a harvest or silvicultural operation (whether they are utilized or not) are included, but trees on land diverted from forest to nonforest (diversions) are excluded.

Cut growth—The growth of cut trees between time t and the midpoint of the measurement interval. Tree size at the midpoint is modeled from tree size at time t . This term also includes the subsequent growth on ingrowth trees that achieve the minimum diameter threshold prior to being cut.

Diversion—The volume of trees on land diverted from forest to nonforest (or, for some analyses, this may also include land diverted to reserved forest land and other forest land), whether utilized or not, between time t and time $t + 1$. The estimate is based on tree size at the midpoint of the measurement interval (includes diversion growth). Tree size at the midpoint is modeled from tree size at time t .

Diversion growth—The growth of diversion trees from time t to the midpoint of the measurement interval. Tree size at the midpoint is modeled from tree size at time t . This term also includes the subsequent growth on ingrowth trees that achieve the minimum diameter threshold prior to diversion.

Growth on ingrowth—The growth on trees between the time they grow across the minimum d.b.h./d.r.c. threshold and time $t + 1$.

Ingrowth—The volume of trees at the time that they grow across the minimum d.b.h./d.r.c. threshold between time t and time $t + 1$. The estimate is based on the size of trees at the d.b.h./d.r.c. threshold which is 1.0 inch for all-live trees and 5.0 inches for growing-stock trees. This term also includes trees that subsequently die (i.e., ingrowth mortality), are cut (i.e., ingrowth, cut), or diverted to nonforest (i.e., ingrowth diversion); as well as trees that achieve the minimum threshold after an area reverts to a forest land use (i.e., reversion ingrowth).

Mortality—The volume of trees that die from human or natural causes between time t and time $t + 1$. The estimate is based on tree size at the midpoint of the measurement interval (includes mortality growth). Tree size at the midpoint is modeled from tree size at time t .

Mortality growth—The growth of trees that died from human or natural causes between time t and the midpoint of the measurement interval. Tree size at the midpoint is modeled from tree size at time t . This term also includes the subsequent growth on ingrowth trees that achieve the minimum diameter threshold prior to mortality.

Reversion—The volume of trees on land that reverts from a nonforest land use to a forest land-use (or, for some analyses, land that reverts from any source to timberland) between time t and time $t + 1$. The estimate is based on tree size at the midpoint of the measurement interval. Tree size at the midpoint is modeled from tree size at time $t + 1$.

Reversion growth—The growth of reversion trees from the midpoint of the measurement interval to time $t + 1$. Tree size at the midpoint is modeled from tree size at time $t + 1$. This term also includes the subsequent growth on

ingrowth trees that achieve the minimum diameter threshold after reversion.

Survivor growth—The growth on trees tallied at time t that survive until time $t + 1$.

The following components of change may be used to further quantify changes in growing-stock (but not all-live) volume:

Cull decrement—The net gain in growing-stock volume due to reclassification of cull trees to growing-stock trees between two surveys. Cull decrement is the volume of trees that were cull at time t , but growing stock at time $t + 1$. The estimate is based on tree size at the midpoint of the measurement interval. Tree size at the midpoint can be modeled from tree at time t , time $t + 1$, or both.

Cull decrement growth—The growth from the midpoint of the measurement interval to time $t + 1$ on trees that were cull at time t , but growing stock at time $t + 1$. Tree size at the midpoint can be modeled from tree size at time t , time $t + 1$, or both.

Cull increment—The net reduction in growing-stock volume due to reclassification of growing stock trees to cull trees between two surveys. Cull increment is the volume of trees that were growing stock at time t , but cull at time $t + 1$. The estimate is based on tree size at the midpoint of the measurement interval (includes cull increment growth). Tree size at the midpoint can be modeled from tree size at time t , time $t + 1$, or both.

Cull increment growth—The growth to the midpoint of the measurement interval between time t and $t + 1$ of trees that were growing stock at time t , but cull trees at time $t + 1$. Tree size at the midpoint can be modeled from tree size at time t , time $t + 1$, or both.

Composite panel—Roundwood products manufactured into chips, wafers, strands, flakes, shavings, or sawdust and then reconstituted into a variety of panel and engineered lumber products.

Condition class—The combination of discrete landscape and forest attributes that identify, define, and stratify the area associated with a plot. Examples of such attributes include condition status, forest type, stand origin, stand size, owner group, reserve status and stand density.

Cull—Portions of a tree that are unusable for industrial wood products because of rot, form, or other defect. Cull is further categorized as the following:

Broken-top cubic-foot cull—The broken-top proportion of a timber species tree's merchantable portion from the break to the actual or projected 4-inch top diameter outside bark, or to where the central stem forks, where all forks are <4.0 inches diameter. For trees 1.0 to 4.9 inches diameter this is the proportion of the main stem missing due to a broken-top.

Form board-foot cull—The part of the tree's sawlog portion that is sound but not usable for sawn wood products due to sweep, crook, forking, or other physical culls.

Missing cubic-foot cull—The proportion of a tree's merchantable portion that is missing or absent. Does not include any cull deductions above actual length for broken-top timber trees. Does include cull deductions above actual length for broken-top woodland species. Trees with d.b.h./d.r.c. <5.0 inches have a null value in this field.

Percent board-foot cull—Percentage of sound and unsound board-foot volume, to the nearest 1 percent.

Rotten cubic-foot cull—The proportion of a tree's merchantable portion that is in a decayed state. Does not include any cull deductions above actual length for broken-top timber trees. Does include cull deductions above actual length for broken-top woodland species. Trees <5.0 inches d.b.h. have a null value in this field.

Rotten/missing cull—The part of the tree's merchantable portion that is decayed and/or absent due to other factors.

Total board-foot cull—The proportion of a timber species tree's sawlog portion that is rotten, missing, or sound but not useable for sawn wood products due to sweep, crook, forking, or other physical defects (form board-foot cull). Nonsawlog species and softwoods <9.0 inches d.b.h. and hardwoods <11.0 inches d.b.h. have a null value in this field.

Cull tree—Live trees that are unsuitable for the production of some roundwood products, now or prospectively. Cull trees can include those with decay (rotten cull) or poor form, limbiness, or splits (rough cull). Rough cull is suitable for pulpwood and other fiber products.

Cycle—One sequential and complete set of panels.

Diameter at breast height (d.b.h.)—The diameter for tree stem, located at 4.5 feet above the ground (breast height) on the uphill side of a tree. The point of diameter measurement may vary on abnormally formed trees.

Diameter class—A classification of trees based on diameter outside bark, measured at breast height (d.b.h.) above the ground or at root collar (d.r.c.). Note: Diameter classes are commonly in 2-inch increments, beginning with 2 inches. Each class provides a range of values with the class name being the approximate midpoint. For example, the 6-inch class includes trees 5.0 through 6.9 inches d.b.h.

Diameter inside bark (d.i.b.)—Diameter measured at any point on a tree or log that excludes the bark.

Diameter at root collar (d.r.c.)—Diameter measured at the root collar or at the natural ground line, whichever is higher, outside the bark. Measure tree stems only, not branches.

Disturbance—Natural or human-caused disruption that is ≥ 1.0 acre in size and results in mortality and/or damage to 25 percent of all trees in a stand or 50 percent of an individual species' count or, in the case when the disturbance does not initially affect tree growth or health (e.g. grazing, browsing, flooding, etc.), affects 25 percent of the soil surface or understory vegetation. For initial forest plot establishment the disturbance must be within the last 5 years. For remeasured plots only those disturbances that have occurred since the previous inventory are recognized.

Diversion—See: Components of change.

Down woody material (DWM)—DWM is dead material on the ground in various stages of decay. It includes coarse and fine woody material. Previously named down woody debris (DWD). The depth of duff layer, litter layer, and overall fuelbed; fuel loading on the microplot; and residue piles are also measured as part of the DWM indicator for FIA.

Dry weight—The oven-dry weight of biomass.

Federal land—An ownership class of public lands owned by the U.S. Government. See: Ownership.

Fiber products—Byproducts used in the manufacture of pulp, paper, paperboard, and composite products, such as chipboard.

Fine woody debris (FWD)—Downed, dead branches, twigs, and small tree or shrub boles < 3 inches in diameter not attached to a living or standing dead source.

Fixed-radius plot—A circular sampled area with a specified radius in which all trees of a given size, shrubs, or other items are tallied.

Forest floor—The entire thickness of organic material overlying the mineral soil, consisting of the litter and the duff (humus).

Forest industry land—See: Ownership.

Forest land—Land that is at least 10 percent stocked by forest trees of any size, or land formerly having such tree cover, and is not currently developed for a nonforest use. The minimum area for classification as forest land is 1 acre. Roadside, streamside, and shelterbelt strips of timber must be at least 120 feet wide to qualify as forest land. Unimproved roads and trails, streams and other bodies of water, or natural clearings in forested areas shall be classified as forest, if < 120 feet in width or 1.0 acre in size. Forest land is divided into timberland, reserved forest land, and other forest land (such as woodland).

Forest type—A classification of forest land based upon and named for the tree species that forms the plurality of live-tree stocking. A forest-type classification for a field location indicates the predominant live-tree species cover for the field location; hardwoods and softwoods are first grouped to determine predominant group, and forest type is selected from the predominant group.

Forest-type group—A combination of forest types that share closely associated species or site requirements.

Elm-ash-cottonwood—Forests in which elm, ash, or cottonwood, singly or in combination, constitute a plurality of the stocking. (Common associates include willow, sycamore, beech, and maple.)

Loblolly-shortleaf pine—Forests in which loblolly pine, shortleaf pine, or other southern yellow pines, except longleaf or slash pine, singly or in combination, constitute a plurality of the stocking. (Common associates include oak, hickory, and gum.)

Maple-beech-birch—Forests in which maple, beech, or yellow birch, singly or in combination, constitute a plurality of the stocking. (Common associates include hemlock, elm, basswood, and white pine.)

Oak-gum-cypress—Bottomland forests in which tupelo, blackgum, sweetgum, oaks, or

southern cypress, singly or in combination, constitute a plurality of the stocking, except where pines account for 25 to 50 percent of stocking, in which case the stand is classified as oak-pine. (Common associates include cottonwood, willow, ash, elm, hackberry, and maple.)

Oak-hickory—Forests in which upland oaks or hickory, singly or in combination, constitute a plurality of the stocking, except where pines account for 25 to 50 percent, in which case the stand is classified oak-pine. (Common associates include yellow-poplar, elm, maple, and black walnut.)

Oak-pine—Forests in which hardwoods (usually upland oaks) constitute a plurality of the stocking but in which pines account for 25 to 50 percent of the stocking. (Common associates include gum, hickory, and yellow-poplar.)

Growing-stock trees—Live large-diameter timber species (excludes nonsawlog species) trees with one-third or more of the gross board-foot volume in the entire sawlog portion meeting grade, soundness, and size requirements or the potential to do so for medium-diameter and small-diameter trees. A growing-stock tree must have one 12-foot log or two noncontiguous 8-foot merchantable logs, now (large-diameter) or prospectively (medium-diameter and small-diameter), to qualify as growing stock.

Hardwoods—Tree species belonging to the botanical divisions Magnoliophyta, Ginkgophyta, Cycadophyta, or Pteridophyta, usually angiospermic, dicotyledonous, broad-leaved and deciduous.

Soft hardwoods—Hardwood species with an average specific gravity of ≤ 0.50 , such as gums, yellow-poplar, cottonwoods, red maple, basswoods, and willows.

Hard hardwoods—Hardwood species with an average specific gravity > 0.50 , such as oaks, hard maples, hickories, and beech.

Industrial roundwood products—Any primary use of the main stem of a tree, such as sawlogs, pulpwood, veneer logs, intended to be processed into primary wood products such as lumber, wood pulp, and sheathing at primary wood using mills.

International 1/4-inch rule—A log rule or formula for estimating the board-foot volume of logs, allowing 1/2 inch of taper for each 4-foot length. The rule appears in a number of forms that allow for kerf. In the form used by FIA, a 1/4 inch of kerf is assumed. This rule is used as the USDA Forest Service standard log rule in the Eastern United States.

Land—The area of dry land and land temporarily or partly covered by water, such as marshes, swamps, and river flood plains.

Land cover—The dominant vegetation or other kind of material that covers the land surface. A given land cover may have many land uses.

Land-use—The purpose of human activity on the land; it is usually, but not always, related to land cover.

Southern regional present land-use categories are as follows:

Accessible timberland—Land that is within the population of interest, is accessible, is on a subplot that can be occupied at subplot center, can safely be visited, and meets the criteria for forest land (see: forest land).

Accessible other forest land—Land that meets the definition of accessible forest land, but is incapable of producing 20 cubic feet per acre per year of industrial wood under natural conditions because of adverse site conditions. Adverse conditions include sterile soils, dry climate, poor drainage, high elevation, steepness and soil rockiness.

Agricultural land—Land managed for crops, pasture, or other agricultural use. The area must be at least 1.0 acre in size and 120 feet

wide (with the exception of windbreak/shelterbelt, which has no minimum width). This land use includes cropland, pasture (improved through cultural practices), idle farmland, orchard, Christmas tree plantation, maintained wildlife opening, and windbreak/shelterbelt.

Rangeland—Land primarily composed of grasses, forbs, or shrubs. This includes lands vegetated naturally or artificially to provide a plant cover managed like native vegetation and does not meet the definition of pasture. The area must be at least ≥ 1.0 acre in size and ≤ 120 feet wide.

Developed—Land used primarily by humans for purposes other than forestry or agriculture. This land use includes cultural (business, industrial/commercial, residential, and other places of intense human activity), rights-of-way (improved roads, railway, power lines, maintained canal), recreation (parks, skiing, golf courses), and mining.

Other—Land parcels ≥ 1.0 acre in size and ≥ 120 feet wide, which do not fall into one of the uses described above. Examples include undeveloped beaches, barren land (rock, sand), marshes, bogs, ice, and snow. This land use includes nonvegetated, wetland, beach, and nonforest-chaparral.

Census water—Rivers and streams that are >200 feet wide and bodies of water >4.5 acres in size.

Noncensus water—Rivers, streams and other bodies of water that do not meet the requirements for census water.

Nonsampled—Not sampled due to denied access, hazardous conditions, being outside the United States or other reasons.

Large-diameter trees—Softwoods ≥ 9.0 inches d.b.h. and hardwoods ≥ 11.0 inches d.b.h. These trees were called sawtimber-sized trees in prior surveys. See: Stand-size class.

Litter—Undecomposed or only partially decomposed organic material that can be readily identified (e.g., plant leaves, twigs, etc.).

Log—8-foot (2.4-m) or longer tree segment suitable for processing into lumber, veneer, or other wood products.

Logging residues—The unused portions of trees cut or destroyed during harvest and left in the forest.

Main stem—The central portion of the tree extending from the ground level to the tip for timber species. For woodland species the main stem extends from the ground level to the tips of all branches of qualifying stems. For timber species trees that fork, the main stem follows the fork that would yield the most merchantable volume.

Measurement quality objective

(MQO)—A data user's estimate of the precision, bias, and completeness of data necessary to satisfy a prescribed application (e.g., Resource Planning Act, assessments by State foresters, forest planning, forest health analyses). Describes the acceptable tolerance for each data element. MQOs consist of two parts: a statement of the tolerance and a percentage of time when the collected data are required to be within tolerance. MQOs can only be assigned where standard methods of sampling or field measurements exist, or where experience has established upper or lower bounds on precision or bias. MQOs can be set for measured data elements, observed data elements, and derived data elements.

Medium-diameter tree—Softwood timber species 5.0 to 8.9 inches d.b.h. and hardwood timber species 5.0 to 10.9 inches d.b.h. These trees were called poletimber-sized trees in prior surveys. See: Stand-size class.

Merchantable portion—The portion of the main stem of a timber species tree from a 1-foot stump to a minimum 4-inch top diameter inside or outside bark depending on species. The portion of a woodland species tree from the d.r.c.

measurement to the 1.5-inch diameters of all the qualifying stems.

Merchantable volume—Solid-wood volume in the merchantable portion of live trees.

Microplot—A circular, fixed-radius plot with a radius of 6.8 feet (0.003 acre) that is used to sample trees <5.0 inches d.b.h./d.r.c., as well as other vegetation. Point center is 90 degrees and 12 feet offset from point center of each subplot.

Mill residues—Wood material generated in the production of timber products at primary manufacturing plants.

Bark.

Coarse residues—Material, such as slabs, edgings, trim, veneer cores and ends, which is suitable for chipping.

Fine residues—Material, such as sawdust, shavings, and veneer residue, which is not suitable for chipping.

Mortality—See: Components of change.

National forest land—See: Ownership.

Noncensus water—See: Land use.

Nonforest land—Land that does not support or has never supported, forests, and lands formerly forested where use for timber management is precluded by development for other uses. Includes areas used for crops, improved pasture, residential areas, city parks, improved roads of any width and adjoining rights-of-way, power line clearings of any width, and noncensus water. If intermingled in forest areas, unimproved roads and nonforest strips must be ≥ 120 feet wide, and clearings, etc., ≥ 1.0 acre in size, to qualify as nonforest land.

Nonindustrial private forest land—See: Ownership.

Other forest land—Forest land other than timberland and reserved forest land. It includes

available and reserved forest land that is incapable of producing 20 cubic feet per acre per year of wood under natural conditions because of adverse site conditions such as sterile soils, dry climate, poor drainage, high elevation, steepness, or rockiness.

Other public land—See: Ownership.

Other removals—The volume of trees removed from the inventory by cultural operations such as timber stand improvement, land clearing, and other changes in land use, resulting in the removal of the trees from timberland.

Ownership—A legal entity having control of a parcel or group of parcels of land. An ownership may be an individual; a combination of persons; a legal entity such as corporation, partnership, club, or trust; or a public agency.

National forest land—Federal land that has been legally designated as national forests or purchase units, and other land under the administration of the Forest Service, including experimental areas and Bankhead-Jones Title III land.

Forest industry land—An ownership class of private lands owned by a company or an individual(s) operating a primary wood-processing plant.

Nonindustrial private forest (NIPF) land—Privately owned land excluding forest industry land.

Corporate—Owned by corporations, including incorporated farm ownerships.

Individual—All lands owned by individuals, including farm operators.

Other public—An ownership class that includes all public lands except national forests.

Miscellaneous Federal land—Federal land other than national forests.

State, county, and municipal land—Land owned by States, counties, and local public agencies or municipalities, or land leased to these governmental units for 50 years or more.

Plantation—Stands that currently show evidence of being planted or artificially seeded.

Poletimber-sized tree—Softwood timber species 5.0 to 8.9 inches d.b.h. and hardwood timber species 5.0 to 10.9 inches d.b.h. Now referred to as medium-diameter trees.

Posts, poles, and pilings—Roundwood products milled (cut or peeled) into standard sizes (lengths and circumferences) to be put in the ground to provide vertical and lateral support in buildings, foundations, utility lines, and fences. May also include nonindustrial (unmilled) products.

Primary wood using plants—Industries that convert roundwood products (sawlogs, veneer logs, pulpwood, etc.) into primary wood products, such as lumber, veneer or sheathing, and wood pulp.

Private land—See: Ownership.

Productivity class—A classification of forest land in terms of potential annual cubic-foot volume growth per acre at culmination of mean annual increment (MAI) in fully stocked natural stands.

Pulpwood—A roundwood product that will be reduced to individual wood fibers by chemical or mechanical means. The fibers are used to make a broad generic group of pulp products that includes paper products, as well as fiberboard, insulating board, and paperboard.

Quality assurance (QA)—The total integrated program for ensuring that the uncertainties inherent in FIA data are known and do not exceed acceptable magnitudes, within a stated level of confidence. Quality assurance encompasses the plans, specifications, and policies

affecting the collection, processing, and reporting of data. It is the system of activities designed to provide program managers and project leaders with independent assurance that total system quality control is being effectively implemented.

Quality control (QC)—The routine application of prescribed field and laboratory procedures (e.g., random check cruising, periodic calibration, instrument maintenance, use of certified standards, etc.) in order to reduce random and systematic errors and ensure that data are generated within known and acceptable performance limits. Quality control also ensures the use of qualified personnel; reliable equipment and supplies; training of personnel; good field and laboratory practices; and strict adherence to standard operating procedures.

Reserved forest land—Forest land where management for the production of wood products is prohibited through statute or administrative designation. Examples include national forest wilderness areas and national parks and monuments.

Residential fuelwood—The volume of roundwood harvested to produce heat for residential settings.

Reversion—Land that reverts from a nonforest land use to a forest land use. See: Components of change.

Roundwood products—Any primary product, such as lumber, veneer, composite panels, poles, pilings, pulp, or fuelwood that is produced from roundwood.

Roundwood logs—Logs or other round sections cut from trees for industrial manufacture or consumer uses.

Roundwood chipped—Any timber cut primarily for industrial manufacture, delivered to nonpulp mills, chipped, and then sold to pulp mills for use as fiber. Includes tops, whole trees, and pulpwood sticks.

Sapling—Live trees 1.0 to 4.9 inches d.b.h./d.r.c.

Sawlog—A roundwood product, usually ≥ 8 feet in length, processed into a variety of sawn products such as lumber, cants, pallets, railroad ties, and timbers.

Sawlog portion—That portion of the main stem of a timber species tree of large-diameter size from a 1-foot stump to a minimum top d.o.b. 7.0 inches for softwoods and 9.0 inches for hardwoods (equivalent 6.0 inches d.i.b. for softwoods, 8.0 inches d.i.b. for hardwoods).

Sawlog top—The point on the bole of sawtimber trees above which a conventional sawlog cannot be produced. The minimum sawlog top is 7.0 inches d.o.b. for softwoods and 9.0 inches d.o.b. for hardwoods for FIA standards.

Sawtimber-size trees—Softwood timber species ≥ 9.0 inches d.b.h., and hardwood timber species ≥ 11.0 inches d.b.h. Now referred to as large-diameter trees.

Seedling—Live trees < 1.0 inch d.b.h./d.r.c. that are ≥ 6.0 inches in height for softwoods and ≥ 12.0 inches in height for hardwoods and > 0.5 inch d.b.h./d.r.c. at ground level for longleaf pine.

Small-diameter trees—Trees 1.0 to 4.9 inches in d.b.h./d.r.c. These were called sapling-seedling sized trees in prior surveys. See: Stand-size class.

Softwoods—Tree species belonging to the botanical division Coniferophyta, usually evergreen having needles or scale-like leaves.

Species group—A collection of species used for reporting purposes.

Stand—Vegetation or a group of plants occupying a specific area and sufficiently uniform in species composition, age arrangement, structure, and condition as to be distinguished from the vegetation on adjoining areas.

Stand age—A stand descriptor that indicates the average age of the live dominant and

codominant trees in the predominant stand-size class of a condition.

Standard cord—A unit of measure applied to roundwood, usually bolts or split wood. It is a stack of wood 4 feet high, 4 feet wide, and 8 feet long encompassing 128 cubic feet of wood, bark, and air space. This usually translates to approximately 75.0 to 81.0 cubic feet of solid wood for pulpwood, because pulpwood is more uniform.

Standing dead tree—A dead tree ≥ 5.0 inches d.b.h. that has a bole which has an unbroken actual length of at least 4.5 feet, and lean < 45 degrees from vertical as measured from the base of the tree to 4.5 feet.

Stand origin—A classification of forest stands describing their means of origin.

Planted—Planted or artificially seeded.

Natural—No evidence of artificial regeneration.

Stand-size class—A classification of forest land based on the diameter-class distribution of live trees in the stand. See definitions of large-, medium-, and small-diameter trees.

Large-diameter stands—Stands at least 10 percent stocked with live trees, with one-half or more of total stocking in large- and medium-diameter trees, and with large-diameter tree stocking at least equal to medium-diameter tree stocking.

Medium-diameter stands—Stands at least 10-percent stocked with live trees, with one-half or more of total stocking in medium- and large-diameter trees, and with medium-diameter tree stocking exceeding large-diameter tree stocking.

Small-diameter stands—Stands at least 10-percent stocked with live trees, in which small-diameter trees account for more than one-half of total stocking.

Nonstocked stands—Stands <10-percent stocked with live trees.

Stand structure—The predominant canopy structure for the condition, only considering the vertical position of the dominant and codominant trees in the stand and not considering trees that are intermediate or overtopped. As a general rule, a different story should comprise 25 percent of the stand.

Nonstocked—The condition is <10 percent stocked.

Single-storied—Most of the dominant/codominant tree crowns form a single canopy (i.e., most of the trees are approximately the same height).

Multistoried—Two or more recognizable levels characterize the crown canopy. Dominant/codominant trees of many sizes (diameters and heights) for a multilevel canopy.

State, county, and municipal land—See: Ownership.

Stocking—1) At the tree level, stocking is the density value assigned to a sampled tree (usually in terms of numbers of trees or basal area per acre), expressed as a percentage of the total tree density required to fully utilize the growth potential of the land. 2) At the stand level, stocking refers to the sum of the stocking values of all trees sampled.

Subplot—A circular area with a fixed horizontal radius of 24.0 feet (1/24 acre), primarily used to sample trees ≥ 5.0 inches at d.b.h./d.r.c.

Survivor tree—A sample tree alive at both the current and previous inventories.

Timberland—Forest land that is producing or capable of producing 20 cubic feet per acre or more per year of wood at culmination of MAI. Timberland excludes reserved forest lands.

Timber product output—A unit measure applied to roundwood timber products. Board feet (International 1/4-inch rule) are the standard unit used for sawlogs and veneer; cords are used for pulpwood, composite panel, and fuelwood; hundred pieces for poles; thousand pieces for posts; and thousand cubic feet for all other miscellaneous forest products.

Timber products—Roundwood products and byproducts.

Timber removals—The total volume of trees removed from the timberland inventory by harvesting, cultural operations such as stand improvement, land clearing, or changes in land use. (Note: Includes roundwood products, logging residues, and other removals.)

Treatment—Forestry treatments are a form of human disturbance. The term treatment further implies that a silvicultural application has been prescribed. This does not include occasional stumps of unknown origin or sparse removals for firewood, Christmas trees, or other miscellaneous purposes. The area affected by any treatment must be at least 1.0 acre in size.

None—No observable treatment.

Cutting—The removal of one or more trees from a stand. Southern Research Station FIA categories are the following:

Clearcut harvest—The removal of the majority of the merchantable trees in a stand; residual stand stocking is under 50 percent.

Partial harvest—Removal primarily consisting of highest quality trees. Residual consists of lower quality trees because of high grading or selection harvest (e.g. uneven aged, group selection, high grading, species selection).

Seed-tree/shelterwood harvest—Crop trees are harvested leaving seed source trees either in a shelterwood or seed tree. Also includes the final harvest of the seed trees.

Commercial thinning—The removal of trees (usually of medium diameter) from medium-diameter stands leaving sufficient stocking of growing-stock trees to feature in future stand development. Also included are thinning in large-diameter stands where medium-diameter trees have been removed to improve quality of those trees featured in a final harvest.

Timber stand improvement (cut trees only)—The cleaning, release, or other stand improvement involving noncommercial cutting applied to an immature stand that leaves sufficient stocking.

Salvage cutting—The harvesting of dead or damaged trees or of trees in danger of being killed by insects, disease, flooding, or other factors in order to save their economic value.

Site preparation—Clearing, slash burning, chopping, disking, bedding, or other practices clearly intended to prepare a site for either natural or artificial regeneration.

Artificial regeneration—Following a disturbance or treatment (usually cutting), a new stand where at least 50 percent of the live trees present resulted from planting or direct seeding.

Natural regeneration—Following a disturbance or treatment (usually cutting), a new stand where at least 50 percent of the live trees present (of any size) were established through the growth of existing trees and/or natural seeding or sprouting.

Other silvicultural treatment—The use of fertilizers, herbicides, girdling, pruning, or other activities designed to improve the commercial value of the residual stand,

or chaining, which is a practice used on woodlands to encourage wildlife forage.

Tree—A woody perennial plant, typically large, with a single well-defined stem carrying a more or less definite crown; sometimes defined as attaining a minimum diameter of 3 inches and a minimum height of 15 feet at maturity. For FIA, any plant on the tree list in the current field manual is measured as a tree.

Utilization studies—Studies conducted on active logging operations to develop factors for merchantable portions of trees left in the woods (logging residues), logging damage, and utilization of the nonmerchantable portion of growing-stock trees and nongrowing-stock trees.

Veneer log—A roundwood product either rotary cut, sliced, stamped, or sawn into a variety of veneer products such as plywood, finished panels, veneer sheets, or sheathing.

Volume—A measure of the solid content of the tree stem used to measure wood quantity.

Gross board-foot volume—Total board-foot volume of wood inside bark without deductions for total board-foot cull.

Gross cubic-foot volume—Total cubic-foot volume of wood inside bark without deductions for rotten, missing, or broken-top cull.

Net board-foot volume—Gross board-foot volume minus deductions for total board-foot cull.

Net cubic-foot volume—Gross cubic-foot volume minus deductions for rotten, missing, and broken-top cull.

APPENDIX 1—INVENTORY METHODS

What Is Forest Inventory and Analysis?

The Forest Inventory and Analysis (FIA) program of the U.S. Department of Agriculture, Forest Service was created in 1928 to provide comprehensive information on the Nation's forest resources necessary for economic and forest management planning. Forest inventories were conducted periodically in each State until the Agricultural Research, Extension, and Education Reform Act of 1998 (the Farm Bill) mandated a nationally consistent methodology in which a portion of all plots in each State were measured each year. States in the Southern Research Station (SRS) FIA unit are on a 5- to 10-year measurement cycle.

What Is a Tree?

A tree is a perennial woody plant with a central stem and a distinct crown. FIA defines a tree as any perennial woody plant species that can attain a height of 15 feet at maturity. A complete list of the tree species measured in Virginia during this inventory is included in the appendix (table A3.25). Throughout this bulletin, the size of a tree is usually expressed as diameter at breast height (d.b.h.), in inches. This is the diameter, outside the bark, at a point 4.5 feet above the ground.

What Is a Forest?

The FIA collects data only in forested areas; therefore, the definition used for forest land affects the estimates produced in each inventory year. The FIA program defines a forest as currently or formerly (within 30 years) at least 10-percent canopy cover of trees of any size and not currently developed for nonforest use. Forests must be at least 1 acre in size where a minimum width of 120 feet is maintained.

How Do We Estimate a Tree's Volume?

To estimate a live tree's volume, FIA uses volume equations developed for each tree species group

found within the Northeastern United States. Individual tree volumes are based on species, diameter, and height. FIA reports volume in cubic feet and board feet (International ¼-inch rule). Board-foot volume measurements are applicable only for sawtimber-size trees, that is, softwood trees >9 inches d.b.h. and hardwood trees >11 inches d.b.h. Some wood products are often measured in cords (a stack of wood 8 feet long by 4 feet wide and 4 feet high). A cord of wood consists of about 79 to 85 cubic feet of solid wood, with the remaining 43 to 49 cubic feet made up of bark and air.

Annual Inventory

Data used in this bulletin were collected using an annualized inventory method. Virginia's annual inventory began in 1998. Prior to this, all data collection was based on periodic inventories. This information was then compared to older periodic inventories to determine change. For example, average annual change estimates (growth, removals and mortality) in the 1992 Virginia bulletin were derived by comparing tree and plot data obtained from the 1985 periodic inventory to data collected in 1992. The same process was then repeated in 1998, except the 1998 information served as the initial base year and 2000 as the final estimate. An issue with periodic inventories was that the average time between measurements in the south ranged from 6 to 10 years. The demand for newer data and more frequent updates necessitated the move to an annualized inventory design.

Virginia switched to a 5-year annual inventory in 1998. In the 5-year annual inventory 20 percent of the plots across the State were sampled each year. Each year's sample was spatially distributed evenly across the State. Thus, after 5 years, a complete set of data, called a cycle, was obtained. The Virginia 2001, 2007, 2011, 2016, and now 2021 reports (Rose 2007, 2009, 2013; Brandeis and others 2018) are based on this 5-year system. The annual inventory provides users with newer and more up to date information, but only from 20 percent of the full cycle of data each year.

Table A1.1 illustrates how the annual inventory impacts data interpretation. Currently, Virginia's forests contain 43.4 billion cubic feet (bcf) of all-live volume. Table A1.1 illustrates the distribution of the expected sampling intensity of around 20 percent, as the actual yearly rates ranged from 18.5 to 20.9 percent. Table A1.1 reveals that of the 43.4 bcf of all-live volume currently in Virginia, 8.0 billion is from plots measured in 2017, 20.8 billion from 2018 and so on. It is important for users of FIA data to understand that all estimates of current values in this bulletin were derived by summing a series of sequential annual measurements.

Table A1.1—Volume of all-live species by measurement year in Virginia, 2021

Measurement year	Volume (million cubic feet)	Percentage of total volume
2017	8,015.63	18.5
2018	9,031.70	20.8
2019	8,685.07	20.0
2020	9,053.66	20.9
2021	8,595.83	19.8
Total	43,381.90	100.0

The annual inventory has an even greater impact on analysis of change estimates such as average annual growth, removals, and mortality. Computation of these require an initial and terminal inventory for each plot. Table A1.2

Table A1.2—Average annual removals of all-live species by initial and terminal inventory year, Virginia, 2021

Terminal inventory year	Removal volume	Initial inventory year				
		2012	2013	2014	2015	2016
		million cubic feet				
2017	114.55	114.55	0	0	0	0
2018	125.66	0	125.66	0	0	0
2019	144.37	0	0	144.37	0	0
2020	136.91	0	0	0	136.91	0
2021	161.11	0	0	0	2.82	158.29
Total	682.6	114.55	125.66	144.37	139.73	158.29

indicates that on average, 682.6 (table 7 shows 677.1) million cubic feet (mmcf) of all-live volume was removed from Virginia's forests each year. Rows represent the year that the latest data was collected, or the terminal year. Hence, 161.1 million of the 677.1 mmcf estimate was from plots that were visited in 2021, 136.9 million were from 2020, and so on. Each column is the year that the plots were visited in the past, or the initial year. This means that of the 161.1 mmcf of removals assigned to 2021, 158.3 million were from plots that were initially visited in 2016 plus 2.8 mmcf were from plots last visited in 2015. With that exception, Virginia's removals estimates come from plots that were entirely remeasured after 5 years, and the distribution removals estimates are relatively evenly distributed across the years of the cycle, ranging from 16.8 to 23.2 percent (table A1.3). The slight increase in percentage over time is in keeping with the increase in removals volumes in recent years.

Table A1.3—Average annual removals of all-live species expressed as a percentage of total removals by initial and terminal inventory year, Virginia, 2021

Terminal inventory year	Initial inventory year					
	Total	2012	2013	2014	2015	2016
<i>percentage of total removals</i>						
2017	16.78	16.78	0.00	0.00	0.00	0.00
2018	18.41	0.00	18.41	0.00	0.00	0.00
2019	21.15	0.00	0.00	21.15	0.00	0.00
2020	20.06	0.00	0.00	0.00	20.06	0.00
2021	23.60	0.00	0.00	0.00	0.41	23.19
Total	100.00	16.78	18.41	21.15	20.47	23.19

Definitions, methods, location, ownership, precision, scale, and temporal trends are important factors to consider when analyzing FIA data. Estimates are derived from sample plots throughout a State. Larger geographic areas will contain more plots and thus produce more reliable estimates. For example, there may not be a sufficient number of plots within a county or single forest type from which to derive reliable estimates. It is also important to consider the

degree to which a variable can be measured precisely. For instance, a stand variable, such as age, is not as precise as forest type; and a tree variable, such as crown dieback, is not as precise as diameter. Because forest resources vary by geographic unit and ownership group, location and ownership should also be considered when analyzing the status and trends of forests. In addition, because some definitions and procedures have changed between inventories, comparisons and estimates should be made with caution.

What Is in This Bulletin?

This bulletin presents a summary of Virginia's forest resources, highlighting key forest characteristics estimated from inventory field plots sampled across the State over the 5-year period from 2017 through 2021. For the 2021 inventory cycle, 4,839 locations in Virginia were selected for measurement. Of these plots, 3,330 contained forest land, 1,467 were nonforest, and 42 were not sampled due to access constraints. All estimates of current forest area, composition, volume, and other forest statistics are based on the 3,330 sampled plots. To get reliable estimates of change (e.g., forest area change, growth, mortality, and removals), FIA uses only those plots sampled during both the 2021 cycle and the previous cycle (dated as 2016).

Online information pertaining to previous State reports for Virginia, along with additional information and online tools can be found at <https://research.fs.usda.gov/inventory>. An extensive set of 70 summary data tables accompanies this bulletin and can be downloaded from the Web at the above-listed website as well. These tables provide estimates of forest area, number of trees, volume, biomass, carbon and forest change for the State. A reduced list of online tables is available in appendix 3 of this report.

Where To Find Additional Information?

Rose (2007, 2009, 2013) and Brandeis and others (2018) provide detailed information on annual inventory methods and definitions as well as prior

periodic inventories implemented in Virginia. The SRS FIA website has most of the data used in this report accessible through the FIADB (Forest Inventory and Analysis Database) application that contains both national core data and regional variables collected only by the SRS FIA unit. This site has up-to-date reports and statistics for each state in the SRS FIA unit and field guides that include SRS FIA regional variables. The main web page for FIA is at <https://research.fs.usda.gov/programs/fia#overview>. Links lead to resources such as publications or data and tools. EVALIDator and DATIM are the primary estimation tools that allow users to generate custom summaries from the most recent data in FIADB. Definitions of tables and fields are available in the FIADB user manual (Burrill and others 2021), and core FIA field guides contain details on how each data item was collected. A glossary of FIA terms can be found at <https://research.fs.usda.gov/understory/forest-inventory-and-analysis-glossary-standard-terminology>.

Methods Summary

Users wishing to make rigorous comparisons of data between surveys should be aware of any changes in methodologies between measurements and the evolving nature of the FIA program. The most valuable and powerful trend information is obtained when the same plots are revisited from one survey to the next and measured in the same way. Determining the strength of a trend, or determining the level of confidence associated with a trend, is difficult or impossible when sampling methods change over time. Fortunately, FIA data collection in Virginia has followed the national annualized inventory protocols for five full cycles (2001 [Rose 2007], 2007 [Rose 2009], 2011 [Rose 2013], 2016 [Brandeis and others 2018] and now 2021) allowing us to track change over time with a high degree of confidence.

APPENDIX 2—DATA RELIABILITY

A relative standard of accuracy has been incorporated into the forest inventory. This standard satisfies user demands, minimizes human and instrumental sources of error, and keeps costs within prescribed limits. The two primary types of error are measurement error and sampling error.

Measurement Error

There are three elements of measurement error: (1) biased error, caused by instruments that are not properly calibrated; (2) compensating error, caused by instruments of moderate precision; and (3) accidental error, caused by human error in measuring and compiling. All of these are held to a minimum by the Forest Inventory and Analysis (FIA) quality assurance (QA) program. The goal of the QA program is to provide a framework of quality control procedures to assure the production of complete, accurate, and unbiased forest assessments for given standards. These methods include the use of nationally standardized field manuals, the use of portable data recorders, thorough entry-level training, periodic review training, supervision, the use of check plots, editing checks, and an emphasis on careful work. Additionally, data quality is assessed and documented using performance measurements and post-survey assessments. These assessments are then used to identify areas of the data collection process that need improvement or refinement in order to meet the program's quality objectives.

Each variable collected by FIA is assigned a measurement quality objective (MQO) and a measurement tolerance level. The MQOs are documented in the FIA National Field Manual (USDA Forest Service 2014). In some instances, the MQOs are a “best guess” of what experienced field crews should be able to consistently achieve. Tolerances are somewhat arbitrary and are based on the crews' ability to make repeatable measurements or observations within the assigned MQO.

Evaluation of field crew performance is accomplished by calculating the differences between data collected by the field crew and data collected by the QA crew on blind-check plots. Results of these calculations are compared to the established MQOs. In the analysis of blind-check data, an observation is within tolerance when the difference between the field crew observation and the QA crew observation does not exceed the assigned tolerance for that variable. For many categorical variables, the tolerance is “no error” allowed, so only observations that are identical are within the tolerance level.

Sampling Error

Sampling error is associated with the natural and expected deviation of the sample from the true population mean. This deviation is susceptible to a mathematical evaluation of the probability of error. Sampling errors for State totals are based on one standard deviation. That is, there is a 68.27-percent probability that the confidence interval given for each sample estimate will cover the true population mean (tables A2.1–A2.3).

Table A2.1—Statistical reliability of forest land area estimates for Virginia, 2021

Forest land	Sample estimate	68.27-percent confidence interval	Sampling error
		<i>thousand acres</i>	<i>percent</i>
State	15,995.4	±99.5	0.62
Coastal Plain	3,706.2	±52.9	1.43
Southern Piedmont	3,835.8	±49.3	1.29
Northern Piedmont	2,488.0	±46.8	1.88
Northern Mountains	2,854.1	±45.9	1.61
Southern Mountains	3,111.3	±48.8	1.57

Table A2.2—Statistical reliability of all-live volume estimates for Virginia, 2021

All-live volume on forest land	Sample estimate	68.27-percent confidence interval	Sampling error
	<i>million cubic feet</i>		<i>percent</i>
State	43,381.9	±520.1	1.20
Softwoods	11,526.9	±353.1	3.06
Hardwoods	31,852.6	±467.3	1.47

Table A2.3—Statistical reliability of growth, removals, and mortality estimates for Virginia, 2021

Growth, removals, and mortality		Sample estimate	68.27-percent confidence interval	Sampling error
		<i>million cubic feet</i>		<i>percent</i>
Net annual growth	Total	1,431.7	±30.2	2.11
	Softwoods	663.9	±25.7	3.87
	Hardwoods	767.6	±19.5	2.54
Annual removals	Total	677.1	±48.4	7.14
	Softwoods	335.1	±33.9	10.10
	Hardwoods	342.0	±30.7	8.97
Annual mortality	Total	376.8	±13.4	3.57
	Softwoods	102.1	±6.4	6.31
	Hardwoods	274.7	±11.9	4.33

The size of the sampling error generally increases as the size of the area examined decreases. In addition, as area or volume totals are stratified by forest type, species, diameter class, ownership, or other subunits, the sampling error may increase and be greatest for the smallest divisions. However, there may be instances where a smaller component does not have a proportionately larger sampling error. This can happen when the postdefined strata are more homogeneous than the larger strata, thereby having a smaller variance. For specific postdefined strata, the sampling error can be calculated using the following formula.

$$SE_s = SE_t \frac{\sqrt{X_t}}{\sqrt{X_s}}$$

where:

SE_s = sampling error for subdivision of survey unit or State total

SE_t = sampling error for survey unit or State total

X_s = sum of values for the variable of interest (area or volume) for subdivision of survey unit or State

X_t = total area or volume for survey unit or State

For example, the estimate of sampling error for softwood live-tree volume in the Southern Piedmont survey unit is computed as:

$$SE_s = 2.72 \left[\frac{\sqrt{9,510,780,938}}{\sqrt{3,387,592,157}} \right] = 4.55$$

There are 9,510,780,938 cubic feet of softwood volume in the Southern Piedmont survey unit with a sampling error of 2.72 percent and 3,387,592,157 cubic feet of softwood volume in the Southern Piedmont. Thus, the estimated sampling error for softwood volume in the Southern

Piedmont is 4.55 percent, and the resulting 68.27-percent confidence interval for the Southern Piedmont softwood volume is 3,387,592,157 cubic feet $\pm$ 154,220,919 cubic feet.

Sampling errors obtained by this method are only approximations of reliability because this process assumes constant variance across all subdivisions of totals. The resulting errors derived by this approximation method should be considered very liberal, i.e., it usually produces sampling errors much better than those derived by the actual random sampling formula. Users are free to use more conservative variance estimators based on their specific applications.

APPENDIX 3—SUPPLEMENTAL TABLES

Table A3.1—Area by survey unit and land status, Virginia, 2021

Unit	Total area	All forest	Unreserved			Reserved			Nonforest land	Census water
			Total	Timberland	Unproductive	Total	Productive	Unproductive		
thousand acres										
Coastal Plain	8,159.6	3,706.2	3,572.9	3,572.9	—	133.3	133.3	—	2,641.3	1,812.0
Southern Piedmont	5,673.5	3,835.8	3,809.3	3,804.9	4.4	26.4	20.5	5.9	1,757.4	80.3
Northern Piedmont	4,432.5	2,488.0	2,307.7	2,307.7	—	180.3	180.3	—	1,882.3	62.2
Northern Mountains	4,342.0	2,854.1	2,708.4	2,634.8	73.6	145.7	145.7	—	1,468.6	19.3
Southern Mountains	4,768.4	3,111.3	3,017.6	3,010.9	6.7	93.7	90.4	3.4	1,637.3	19.8
All survey units	27,376.0	15,995.4	15,415.9	15,331.2	84.7	579.4	570.2	9.3	9,386.9	1,993.6

Numbers in rows and columns may not sum to totals due to rounding.

— = no sample for the cell or a value of >0.0 but <0.05.

VIRGINIA'S FORESTS, 2021

Table A3.2—Area of forest land by ownership class and land status, Virginia, 2021

Ownership class		All forest land	Unreserved			Reserved		
			Total	Timberland	Unproductive	Total	Productive	Unproductive
thousand acres								
USDA Forest Service	National forest	1,687.7	1,588.6	1,524.0	64.6	99.2	95.8	3.4
	Total	1,687.7	1,588.6	1,524.0	64.6	99.2	95.8	3.4
Other Federal	National Park Service	238.4	—	—	—	238.4	232.5	5.9
	U.S. Fish and Wildlife Service	82.1	—	—	—	82.1	82.1	—
	Dept. of Defense/Dept. of Energy	200.9	200.9	200.9	—	—	—	—
	Other Federal	17.5	17.5	17.5	—	—	—	—
	Total	538.8	218.4	218.4	—	320.5	314.6	5.9
State and local government	State	359.2	290.4	284.1	6.3	68.8	68.8	—
	Local	308.6	217.5	217.5	—	91.2	91.2	—
	Total	667.8	507.9	501.5	6.3	159.9	159.9	—
Forest industry	Corporate	213.9	213.9	213.9	—	—	—	—
	Individual	30.2	30.2	30.2	—	—	—	—
	Total	244.1	244.1	244.1	—	—	—	—
Nonindustrial private	Corporate	3,169.3	3,169.3	3,158.6	10.7	—	—	—
	Conservation/natural resources organization	83.9	83.9	83.9	—	—	—	—
	Unincorporated local partnership/association/club	122.3	122.3	122.3	—	—	—	—
	Individual	9,481.5	9,481.5	9,478.4	3.1	—	—	—
	Total	12,857.0	12,857.0	12,843.2	13.8	—	—	—
All classes		15,995.4	15,415.9	15,331.2	84.7	579.6	570.3	9.3

Numbers in rows and columns may not sum to totals due to rounding.

— = no sample for the cell or a value of >0.0 but <0.05.

VIRGINIA'S FORESTS, 2021

Table A3.3—Area of forest land by forest-type group and ownership group, Virginia, 2021

Forest-type group		Ownership group					
		All ownerships	USDA Forest Service	Other Federal	State and local government	Forest industry	Nonindustrial private
<i>thousand acres</i>							
Softwood types	White-red-jack pine	173.0	32.2	4.0	—	—	136.8
	Spruce-fir	6.2	—	—	6.2	—	—
	Longleaf-slash pine	10.3	—	—	—	—	10.3
	Loblolly-shortleaf pine	3,059.2	58.8	77.9	91.7	111.4	2,719.4
	Other eastern softwoods	81.6	—	—	5.8	6.2	69.5
	Exotic softwoods	4.2	—	—	—	—	4.2
	Total softwoods	3,334.5	91.1	81.9	103.7	117.5	2,940.2
Hardwood types	Oak-pine	1,668.3	164.9	64.1	58.5	28.9	1,351.9
	Oak-hickory	9,698.1	1,359.3	317.9	406.5	87.9	7,526.6
	Oak-gum-cypress	375.2	2.7	53.3	21.7	1.3	296.1
	Elm-ash-cottonwood	400.3	—	15.8	44.8	—	331.3
	Maple-beech-birch	352.9	61.8	—	27.0	—	264.2
	Aspen-birch	1.5	—	—	—	—	1.5
	Other hardwoods	58.2	7.3	5.9	5.5	—	39.5
	Exotic hardwoods	22.8	—	—	—	—	22.8
	Total hardwoods	12,577.3	1,596.0	456.9	564.1	126.6	9,833.8
Nonstocked		83.7	0.7	—	—	—	83.0
All groups		15,995.4	1,687.7	538.8	667.8	244.1	12,857.0

Numbers in rows and columns may not sum to totals due to rounding.

— = no sample for the cell or a value of >0.0 but <0.05.

VIRGINIA'S FORESTS, 2021

Table A3.4—Area of forest land by forest-type group and stand-size class, Virginia, 2021

Forest-type group		All classes	Stand-size class			
			Large diameter	Medium diameter	Small diameter	Nonstocked
thousand acres						
Softwood types	White-red-jack pine	173.0	157.0	10.6	5.4	—
	Spruce-fir	6.2	6.2	—	—	—
	Longleaf-slash pine	10.3	—	—	10.3	—
	Loblolly-shortleaf pine	3,059.2	1,697.9	886.5	474.8	—
	Other eastern softwoods	81.6	27.7	36.1	17.7	—
	Exotic softwoods	4.2	—	4.2	—	—
	Total softwoods	3,334.5	1,888.8	937.4	508.3	—
Hardwood types	Oak-pine	1,668.3	932.5	427.7	308.1	—
	Oak-hickory	9,698.1	7,298.9	1,538.9	860.3	—
	Oak-gum-cypress	375.2	245.9	77.7	51.6	—
	Elm-ash-cottonwood	400.3	253.4	96.0	50.9	—
	Maple-beech-birch	352.9	297.6	37.3	18.1	—
	Aspen-birch	1.5	1.5	—	—	—
	Other hardwoods	58.2	32.8	11.9	13.5	—
	Exotic hardwoods	22.8	4.6	15.1	3.1	—
	Total hardwoods	12,577.3	9,067.2	2,204.6	1,305.5	—
Nonstocked		83.7	—	—	—	83.7
All groups		15,995.4	10,956.0	3,142.0	1,813.8	83.7

Numbers in rows and columns may not sum to totals due to rounding.

— = no sample for the cell or a value of >0.0 but <0.05.

Table A3.5—Area of forest land by forest-type group and stand origin, Virginia, 2021

Forest-type group		Total	Stand origin	
			Natural stands	Artificial regeneration
thousand acres				
Softwood types	White-red-jack pine	173.0	134.9	38.2
	Spruce-fir	6.2	6.2	—
	Longleaf-slash pine	10.3	—	10.3
	Loblolly-shortleaf pine	3,059.2	861.6	2,197.6
	Other eastern softwoods	81.6	81.6	—
	Exotic softwoods	4.2	—	4.2
	Total softwoods	3,334.5	1,084.2	2,250.3
Hardwood types	Oak-pine	1,668.3	1,393.7	274.7
	Oak-hickory	9,698.1	9,563.5	134.7
	Oak-gum-cypress	375.2	375.2	—
	Elm-ash-cottonwood	400.3	394.4	5.9
	Maple-beech-birch	352.9	345.5	7.4
	Aspen-birch	1.5	1.5	—
	Other hardwoods	58.2	58.2	—
	Exotic hardwoods	22.8	21.4	1.4
	Total hardwoods	12,577.3	12,153.2	424.0
Nonstocked		83.7	77.8	6.0
All groups		15,995.4	13,315.2	2,680.3

Numbers in rows and columns may not sum to totals due to rounding.

— = no sample for the cell or a value of >0.0 but <0.05.

VIRGINIA'S FORESTS, 2021

Table A3.6—Area of forest land disturbed annually by forest-type group and disturbance class, Virginia, 2017–2021

Forest-type group ²		Disturbance class ¹							
		Insects	Disease	Weather	Fire	Domestic animals	Wild animals	Human	Other natural
		<i>thousand acres</i>							
Softwood types	White-red-jack pine	0.6	—	—	0.2	—	—	—	—
	Spruce-fir	—	—	—	—	—	—	—	—
	Longleaf-slash pine	—	—	—	—	—	—	—	—
	Loblolly-shortleaf pine	4.5	3.0	3.2	2.4	1.8	0.8	1.5	4.4
	Other eastern softwoods	2.0	—	—	—	1.1	1.1	—	—
	Exotic softwoods	—	—	—	—	—	—	—	—
	Total softwoods	7.2	3.0	3.2	2.6	2.9	1.9	1.5	4.4
Hardwood types	Oak-pine	10.9	—	3.9	3.5	5.8	0.8	—	2.9
	Oak-hickory	191.6	1.6	12.6	14.9	36.9	3.4	4.1	8.8
	Oak-gum-cypress	1.4	—	—	—	—	2.7	0.7	0.9
	Elm-ash-cottonwood	16.8	0.8	1.1	—	1.7	1.3	—	0.4
	Maple-beech-birch	13.3	—	1.1	—	1.0	—	—	1.1
	Aspen-birch	—	—	—	—	—	—	—	—
	Other hardwoods	1.2	—	—	—	1.2	—	—	—
	Exotic hardwoods	0.3	—	—	—	1.5	—	—	—
	Total hardwoods	235.6	2.4	18.7	18.4	48.2	8.2	4.8	14.1
Nonstocked		—	—	—	—	—	—	—	—
All groups		242.7	5.5	21.9	21.0	51.1	10.1	6.3	18.5

Numbers in rows and columns may not sum to totals due to rounding.

— = no sample for the cell or a value of >0.0 but <0.05.

¹ Based on current conditions.² Based on past conditions.

VIRGINIA'S FORESTS, 2021

Table A3.7—Area of forest land treated annually by forest-type group and treatment class (cutting), Virginia, 2017–2021

Forest-type group ²		Treatment class						
		Cutting ¹						
		Total Treated	Final harvest	Partial harvest	Seed-tree/ shelterwood harvest	Commercial thinning	Timber stand improvement	Salvage cutting
thousand acres								
Softwood types	White-red-jack pine	0.3	0.3	—	—	—	—	—
	Spruce-fir	—	—	—	—	—	—	—
	Longleaf-slash pine	—	—	—	—	—	—	—
	Loblolly-shortleaf pine	107.2	71.0	4.0	0.6	29.3	2.3	—
	Other eastern softwoods	0.3	0.3	—	—	—	—	—
	Exotic softwoods	—	—	—	—	—	—	—
	Total softwoods	107.8	71.6	4.0	0.6	29.3	2.3	—
Hardwood types	Oak-pine	15.0	10.3	3.1	0.7	0.3	0.6	—
	Oak-hickory	81.3	45.9	28.3	1.2	2.5	2.2	1.2
	Oak-gum-cypress	3.7	3.7	—	—	—	—	—
	Elm-ash-cottonwood	2.1	1.8	0.3	—	—	—	—
	Maple-beech-birch	1.2	0.3	1.0	—	—	—	—
	Aspen-birch	—	—	—	—	—	—	—
	Other hardwoods	1.2	—	1.2	—	—	—	—
	Exotic hardwoods	0.3	0.3	—	—	—	—	—
	Total hardwoods	104.8	62.2	33.8	1.9	2.8	2.8	1.2
Nonstocked		—	—	—	—	—	—	—
All groups		212.6	133.8	37.8	2.5	32.1	5.1	1.2

Numbers in rows and columns may not sum to totals due to rounding.

— = no sample for the cell or a value of >0.0 but <0.05.

¹ Based on current conditions.² Based on past conditions.

VIRGINIA'S FORESTS, 2021

Table A3.8—Number of live trees on forest land by species group and diameter class, Virginia, 2021

Species group	Diameter class (inches)															
	All classes	1.0–2.9	3.0–4.9	5.0–6.9	7.0–8.9	9.0–10.9	11.0–12.9	13.0–14.9	15.0–16.9	17.0–18.9	19.0–20.9	21.0–24.9	25.0–28.9	29.0–32.9	33.0–36.9	37.0+
<i>million trees</i>																
Softwood																
Longleaf and slash pines	4.1	2.6	1.4	0.1	—	—	—	—	—	—	—	—	—	—	—	—
Loblolly and shortleaf pines	1,138.0	307.4	226.2	173.7	172.5	120.0	66.5	37.7	17.7	9.2	3.5	2.6	1.0	0.1	—	—
Other yellow pines	391.4	164.5	87.9	49.4	32.7	26.3	16.7	8.6	3.8	1.1	0.3	0.2	—	—	—	—
Eastern white and red pines	162.2	76.9	23.2	17.7	11.6	9.5	7.7	5.1	3.7	2.4	1.7	2.0	0.5	0.2	—	—
Spruce and balsam fir	3.3	1.4	0.7	0.3	0.2	0.1	0.1	0.1	0.2	0.2	0.1	0.1	—	—	—	—
Eastern hemlock	35.5	15.0	6.9	5.5	2.7	1.7	1.3	1.2	0.3	0.4	0.1	0.3	0.1	—	—	—
Cypress	5.1	2.2	0.9	0.7	0.4	0.2	0.1	—	—	0.1	0.2	0.2	—	—	—	—
Other eastern softwoods	227.0	141.0	44.2	20.0	10.8	5.6	2.8	1.5	0.5	0.4	—	0.1	—	—	—	—
Total softwoods	1,966.5	710.9	391.3	267.3	230.9	163.5	95.1	54.1	26.2	13.6	5.9	5.5	1.7	0.4	0.1	0.1
Hardwood																
Select white oaks	377.9	177.9	55.1	31.5	25.6	21.7	16.2	15.3	11.3	9.0	6.4	5.3	1.8	0.5	0.1	0.2
Select red oaks	143.6	66.7	14.1	10.4	9.2	7.8	7.3	5.8	5.0	5.3	3.9	4.6	2.1	0.8	0.4	0.2
Other white oaks	321.4	76.0	39.3	42.6	38.9	36.6	27.7	19.6	15.7	9.8	6.5	6.0	1.7	0.7	0.2	0.1
Other red oaks	413.2	198.0	68.6	35.7	26.2	23.3	17.3	13.4	10.6	7.7	4.7	5.0	1.7	0.7	0.2	0.1
Hickory	400.8	225.5	63.4	34.7	25.0	18.0	12.1	8.5	6.0	4.0	1.8	1.4	0.3	0.1	—	—
Yellow birch	7.1	3.1	1.6	1.0	0.4	0.4	0.3	0.2	—	0.1	—	—	—	—	—	—
Hard maple	159.7	98.4	25.4	13.4	6.9	5.7	3.8	2.2	1.6	1.1	0.6	0.5	0.2	0.1	—	—
Soft maple	1,317.0	839.5	241.5	94.8	55.4	33.7	20.3	13.5	7.1	5.0	2.8	2.1	0.8	0.4	0.1	—
Beech	311.8	205.9	54.0	19.4	10.3	7.3	4.6	2.9	2.5	1.6	1.3	1.3	0.4	0.2	—	—
Sweetgum	763.7	514.7	139.7	47.7	24.4	13.7	8.7	5.3	4.6	2.2	1.4	0.9	0.4	—	—	—
Tupelo and blackgum	619.1	428.7	115.0	36.7	15.6	8.5	5.8	4.0	1.7	1.2	1.0	0.6	0.1	0.1	—	—
Ash	148.2	95.4	23.2	9.8	6.9	4.5	2.9	2.1	1.5	0.9	0.5	0.5	0.1	0.1	—	—
Cottonwood and aspen	7.2	3.0	2.2	0.5	0.7	0.5	0.1	0.1	—	0.1	0.1	0.0	—	—	—	—
Basswood	25.8	9.8	4.5	2.4	2.5	2.2	1.3	0.5	0.9	0.7	0.4	0.4	0.1	0.1	—	—
Yellow-poplar	936.0	499.6	152.6	78.8	52.1	38.5	29.5	23.8	19.1	15.4	9.8	10.6	4.0	1.4	0.4	0.3
Black walnut	30.9	12.5	3.1	4.3	3.1	2.4	1.4	1.5	0.8	0.8	0.4	0.4	0.2	—	—	—
Other eastern soft hardwoods	631.9	396.4	110.1	50.9	29.5	16.8	10.2	7.2	4.0	3.0	1.6	1.8	0.2	0.1	0.1	0.1
Other eastern hard hardwoods	980.1	741.9	151.2	43.2	19.9	10.4	6.2	3.7	1.9	0.9	0.3	0.3	—	—	—	—
Eastern noncommercial hardwoods	1,182.4	878.1	202.0	60.2	25.5	9.7	3.5	1.6	1.2	0.3	0.1	0.1	—	—	—	—
Urban-specific hardwoods	4.1	3.4	0.5	—	0.1	0.1	—	—	—	—	—	—	—	—	—	—
Total hardwoods	8,781.8	5,474.4	1,467.3	618.0	378.2	261.9	179.2	131.1	95.3	69.1	43.7	41.7	14.1	5.3	1.5	1.0
All species	10,748.3	6,185.3	1,858.6	885.3	609.1	425.4	274.4	185.2	121.5	82.7	49.5	47.2	15.8	5.6	1.6	1.1

Numbers in rows and columns may not sum to totals due to rounding.

— = no sample for the cell or a value of >0.0 but <0.05.

VIRGINIA'S FORESTS, 2021

Table A3.9—Net¹ volume of live trees on forest land by ownership class and land status, Virginia, 2021

Ownership class		All forest land	Unreserved			Reserved		
			Total	Timberland	Unproductive	Total	Productive	Unproductive
million cubic feet								
USDA Forest Service	National forest	4,688.6	4,393.0	4,286.6	106.4	295.6	290.4	5.1
	Total	4,688.6	4,393.0	4,286.6	106.4	295.6	290.4	5.1
Other Federal	National Park Service	664.5	—	—	—	664.5	654.1	10.4
	U.S. Fish and Wildlife Service	272.4	—	—	—	272.4	272.4	—
	Dept. of Defense/Dept. of Energy	810.7	810.7	810.7	—	—	—	—
	Other Federal	57.4	57.4	57.4	—	—	—	—
	Total	1,805.0	868.2	868.2	—	936.9	926.5	10.4
State and local government	State	1,131.3	886.6	880.6	6.0	244.7	244.7	—
	Local	900.3	575.9	575.9	—	324.4	324.4	—
	Total	2,031.6	1,462.5	1,456.5	6.0	569.1	569.1	—
Forest industry	Corporate	465.9	465.9	465.9	—	—	—	—
	Individual	114.1	114.1	114.1	—	—	—	—
	Total	580.1	580.1	580.1	—	—	—	—
Nonindustrial private	Corporate	7,899.7	7,899.7	7,887.0	12.6	—	—	—
	Conservation/natural resources organization	245.8	245.8	245.8	—	—	—	—
	Unincorporated local partnership/association/club	378.4	378.4	378.4	—	—	—	—
	Individual	25,752.7	25,752.7	25,749.3	3.4	—	—	—
	Total	34,276.6	34,276.6	34,260.6	16.0	—	—	—
All classes		43,381.9	41,580.3	41,451.9	128.5	1,801.6	1,786.0	15.5

Numbers in rows and columns may not sum to totals due to rounding.

— = no sample for the cell or a value of >0.0 but <0.05.

¹ Excludes rotten, missing, and form cull defects volume.

VIRGINIA'S FORESTS, 2021

Table A3.10—Net¹ volume of live trees on forest land by forest-type group and stand-size class, Virginia, 2021

Forest-type group		All classes	Stand-size class			
			Large diameter	Medium diameter	Small diameter	Nonstocked
million cubic feet						
Softwood types	White-red-jack pine	588.1	567.7	19.6	0.7	—
	Spruce-fir	21.1	21.1	—	—	—
	Longleaf-slash pine	0.2	—	—	0.2	—
	Loblolly-shortleaf pine	8,667.4	6,829.6	1,757.1	80.6	—
	Other eastern softwoods	114.1	58.1	49.8	6.2	—
	Exotic softwoods	2.9	—	2.9	—	—
	Total softwoods	9,393.8	7,476.6	1,829.5	87.8	—
Hardwood types	Oak-pine	3,863.0	3,142.1	650.4	70.6	—
	Oak-hickory	27,019.0	24,179.9	2,595.0	244.1	—
	Oak-gum-cypress	1,082.7	955.8	115.2	11.7	—
	Elm-ash-cottonwood	865.6	757.3	89.9	18.4	—
	Maple-beech-birch	999.9	948.8	47.2	3.9	—
	Aspen-birch	6.7	6.7	—	—	—
	Other hardwoods	116.2	87.5	26.2	2.5	—
	Exotic hardwoods	27.5	7.5	19.0	1.0	—
	Total hardwoods	33,980.5	30,085.6	3,542.8	352.1	—
Nonstocked		7.6	—	—	—	7.6
All groups		43,381.9	37,562.2	5,372.2	439.9	7.6

Numbers in rows and columns may not sum to totals due to rounding.

— = no sample for the cell or a value of >0.0 but <0.05.

¹ Excludes rotten, missing, and form cull defects volume.

VIRGINIA'S FORESTS, 2021

Table A3.11—Net¹ volume of live trees on forest land by species group and ownership group, Virginia, 2021

Species group		Ownership group						
		All ownerships	USDA Forest Service	Other Federal	State and local government	Forest industry	Nonindustrial private	
million cubic feet								
Softwood	Longleaf and slash pines	0.1	—	—	—	—	0.1	
	Loblolly and shortleaf pines	8,113.8	14.6	293.5	328.9	216.9	7,259.9	
	Other yellow pines	1,631.0	263.9	67.6	69.2	23.2	1,207.0	
	Eastern white and red pines	1,213.3	297.5	39.3	7.0	5.7	863.9	
	Spruce and balsam fir	30.2	11.1	—	19.1	—	—	
	Eastern hemlock	173.0	29.0	1.6	7.4	—	135.0	
	Cypress	83.0	—	7.1	0.1	1.1	74.7	
	Other eastern softwoods	282.6	1.2	3.1	19.1	8.0	251.2	
	Total softwoods	11,526.9	617.3	412.1	450.8	255.0	9,791.8	
Hardwood	Select white oaks	3,611.2	305.3	88.8	155.3	35.6	3,026.2	
	Select red oaks	2,123.0	631.9	161.1	116.4	4.6	1,208.9	
	Other white oaks	3,837.8	1,322.9	142.5	144.2	37.2	2,191.1	
	Other red oaks	3,182.2	439.5	135.9	142.1	32.6	2,432.1	
	Hickory	1,791.1	148.3	64.4	70.8	16.3	1,491.3	
	Yellow birch	27.9	12.6	—	2.8	0.2	12.3	
	Hard maple	524.8	79.6	5.4	36.1	6.1	397.6	
	Soft maple	2,693.8	322.1	177.9	129.2	29.5	2,035.0	
	Beech	829.4	10.5	21.8	64.3	3.0	729.7	
	Sweetgum	1,441.1	—	134.7	57.3	23.3	1,225.8	
	Tupelo and blackgum	717.1	81.9	56.8	52.0	2.2	524.2	
	Ash	443.5	22.8	26.8	29.4	2.4	362.1	
	Cottonwood and aspen	27.2	—	—	3.8	—	23.3	
	Basswood	267.4	71.1	20.6	28.8	2.9	144.0	
	Yellow-poplar	7,361.7	361.1	262.0	386.8	87.0	6,264.9	
	Black walnut	232.1	2.9	0.1	11.3	0.4	217.3	
	Other eastern soft hardwoods	1,494.8	107.8	46.3	81.9	30.0	1,228.8	
	Other eastern hard hardwoods	694.5	102.8	34.9	28.7	5.8	522.2	
	Eastern noncommercial hardwoods	552.1	48.1	13.2	39.6	5.9	445.3	
	Urban-specific hardwoods	2.4	—	—	—	—	2.4	
	Total hardwoods		31,855.0	4,071.3	1,392.9	1,580.9	325.1	24,484.8
	All species		43,381.9	4,688.6	1,805.0	2,031.6	580.1	34,276.6

Numbers in rows and columns may not sum to totals due to rounding.

— = no sample for the cell or a value of >0.0 but <0.05.

¹ Excludes rotten, missing, and form cull defects volume.

Table A3.12—Net¹ volume of live trees on forest land by species group and diameter class, Virginia, 2021

Species group	All classes	Diameter class (inches)														
		5.0–6.9	7.0–8.9	9.0–10.9	11.0–12.9	13.0–14.9	15.0–16.9	17.0–18.9	19.0–20.9	21.0–24.9	25.0–28.9	29.0–32.9	33.0–36.9	37.0+		
		million cubic feet														
Softwood	Longleaf and slash pines	0.1	0.1	—	—	—	—	—	—	—	—	—	—	—	—	—
	Loblolly and shortleaf pines	8,113.8	477.2	1,192.5	1,558.6	1,463.1	1,260.3	823.2	583.4	287.0	286.4	161.8	12.7	7.6	—	
	Other yellow pines	1,631.0	165.1	253.0	361.6	358.0	248.9	151.9	59.9	17.5	15.1	—	—	—	—	
	Eastern white and red pines	1,213.3	49.8	74.4	111.7	141.1	133.7	139.7	121.6	108.6	189.7	77.0	49.7	9.4	6.9	
	Spruce and balsam fir	30.2	0.7	1.2	1.2	1.1	2.0	5.1	7.3	3.2	8.3	—	—	—	—	
	Eastern hemlock	173.0	10.8	12.6	16.0	20.5	29.1	10.1	16.8	8.1	25.1	17.5	6.4	—	—	
	Cypress	83.0	2.4	2.5	2.4	2.8	—	1.2	2.6	13.7	17.8	4.4	6.7	7.0	19.3	
	Other eastern softwoods	282.6	48.0	58.4	53.3	42.3	36.9	17.3	16.7	1.5	8.2	—	—	—	—	
	Total softwoods	11,526.9	754.1	1,594.5	2,104.8	2,029.0	1,710.8	1,148.6	808.4	439.6	550.6	260.7	75.4	24.1	26.3	
Hardwood	Select white oaks	3,611.2	93.2	176.1	280.2	337.1	461.9	461.9	497.8	433.8	482.7	229.7	91.2	12.5	53.3	
	Select red oaks	2,123.0	32.2	60.0	95.4	138.6	153.6	184.1	262.9	253.4	387.6	258.7	137.1	93.0	66.4	
	Other white oaks	3,837.8	115.3	231.8	392.7	475.4	486.7	540.6	438.3	379.5	435.5	182.6	99.3	34.2	26.0	
	Other red oaks	3,182.2	105.6	168.4	271.9	326.0	367.6	399.5	394.5	312.0	435.8	235.8	112.5	39.1	13.6	
	Hickory	1,791.1	93.6	164.8	220.7	243.4	257.1	250.2	221.6	130.5	129.6	42.4	31.1	—	6.1	
	Yellow birch	27.9	4.0	3.1	5.4	5.2	5.2	1.0	3.1	0.8	—	—	—	—	—	
	Hard maple	524.8	46.0	51.3	72.4	75.3	61.4	61.5	51.9	32.8	39.5	20.0	12.9	—	—	
	Soft maple	2,693.8	297.3	365.6	391.4	359.0	349.3	244.5	228.0	165.2	146.5	88.8	46.6	3.9	7.7	
	Beech	829.4	59.2	69.1	93.1	88.7	80.9	91.7	74.5	81.0	112.9	44.2	24.1	9.8	—	
	Sweetgum	1,441.1	127.0	169.3	186.7	193.9	170.1	211.3	134.0	108.9	95.6	44.4	—	—	—	
	Tupelo and blackgum	717.1	96.0	93.1	97.7	101.1	103.8	58.1	52.9	57.9	41.7	8.8	5.9	—	—	
	Ash	443.5	30.3	45.2	54.0	52.8	60.0	57.1	44.4	32.1	43.9	9.9	13.8	—	—	
	Cottonwood and aspen	27.2	2.0	5.9	6.5	1.5	2.5	—	4.1	4.6	—	—	—	—	—	
	Basswood	267.4	8.6	17.8	28.7	27.1	14.8	37.5	34.3	31.5	36.1	13.2	11.4	6.4	—	
	Yellow-poplar	7,361.7	254.7	394.3	535.6	653.9	776.3	856.1	923.7	767.8	1,103.9	590.5	282.9	82.3	139.5	
	Black walnut	232.1	11.3	18.5	26.4	22.3	37.3	23.2	34.0	23.8	24.2	11.1	—	—	—	
	Other eastern soft hardwoods	1,494.8	144.6	184.5	188.1	184.0	182.1	147.8	140.8	91.8	134.7	28.0	18.9	25.3	24.2	
Other eastern hard hardwoods	694.5	124.7	123.9	114.9	100.4	91.9	58.5	38.4	15.5	20.0	2.8	2.8	0.9	—		
Eastern noncommercial hardwoods	552.1	148.1	141.2	95.4	54.5	34.1	39.2	9.4	6.7	11.0	—	—	—	12.4		
Urban-specific hardwoods	2.4	0.1	0.9	0.6	—	0.7	—	—	—	—	—	—	—	—		
Total hardwoods	31,855.0	1,793.8	2,484.9	3,157.8	3,440.3	3,697.4	3,723.9	3,588.6	2,929.6	3,681.0	1,810.8	890.3	307.5	349.0		
All species	43,381.9	2,547.9	4,079.4	5,262.6	5,469.3	5,408.2	4,872.5	4,397.0	3,369.2	4,231.6	2,071.5	965.8	331.6	375.3		

Numbers in rows and columns may not sum to totals due to rounding.

— = no sample for the cell or a value of >0.0 but <0.05.

¹ Excludes rotten, missing, and form cull defects volume.

VIRGINIA'S FORESTS, 2021

Table A3.13—Net¹ volume of live trees on forest land by forest-type group and stand origin, Virginia, 2021

Forest-type group		Total	Stand origin	
			Natural stands	Artificial regeneration
million cubic feet				
Softwood types	White-red-jack pine	588.1	443.4	144.7
	Spruce-fir	21.1	21.1	—
	Longleaf-slash pine	0.2	—	0.2
	Loblolly-shortleaf pine	8,667.4	2,616.9	6,050.5
	Other eastern softwoods	114.1	114.1	—
	Exotic softwoods	2.9	—	2.9
	Total softwoods	9,393.8	3,195.5	6,198.4
Hardwood types	Oak-pine	3,863.0	3,514.5	348.4
	Oak-hickory	27,019.0	26,941.0	78.1
	Oak-gum-cypress	1,082.7	1,082.7	—
	Elm-ash-cottonwood	865.6	864.0	1.5
	Maple-beech-birch	999.9	998.1	1.8
	Aspen-birch	6.7	6.7	—
	Other hardwoods	116.2	116.2	—
	Exotic hardwoods	27.5	23.9	3.6
	Total hardwoods	33,980.5	33,547.0	433.4
Nonstocked		7.6	7.5	0.1
All groups		43,381.9	36,750.0	6,631.9

Numbers in rows and columns may not sum to totals due to rounding.

— = no sample for the cell or a value of >0.0 but <0.05.

¹ Excludes rotten, missing, and form cull defects volume.

VIRGINIA'S FORESTS, 2021

Table A3.14—Aboveground dry weight¹ of live trees on forest land by ownership class and land status, Virginia, 2021

Ownership class		All forest land	Unreserved			Reserved		
			Total	Timberland	Unproductive	Total	Productive	Unproductive
thousand tons								
USDA Forest Service	National forest	126,078.5	117,990.7	115,041.1	2,949.6	8,087.8	7,962.1	125.7
	Total	126,078.5	117,990.7	115,041.1	2,949.6	8,087.8	7,962.1	125.7
Other Federal	National Park Service	17,443.8	—	—	—	17,443.8	17,072.6	371.3
	U.S. Fish and Wildlife Service	6,943.4	—	—	—	6,943.4	6,943.4	—
	Dept. of Defense/Dept. of Energy	20,365.7	20,365.7	20,365.7	—	—	—	—
	Other Federal	1,372.9	1,372.9	1,372.9	—	—	—	—
	Total	46,125.7	21,738.5	21,738.5	—	24,387.2	24,015.9	371.3
State and local government	State	29,383.1	23,078.7	22,816.9	261.8	6,304.4	6,304.4	—
	Local	23,578.9	15,097.8	15,097.8	—	8,481.1	8,481.1	—
	Total	52,962.0	38,176.5	37,914.7	261.8	14,785.5	14,785.5	—
Forest industry	Corporate	12,304.5	12,304.5	12,304.5	—	—	—	—
	Individual	2,886.1	2,886.1	2,886.1	—	—	—	—
	Total	15,190.6	15,190.6	15,190.6	—	—	—	—
Nonindustrial private	Corporate	205,171.1	205,171.1	204,800.7	370.4	—	—	—
	Conservation/natural resources organization	6,242.4	6,242.4	6,242.4	—	—	—	—
	Unincorporated local partnership/association/club	9,770.8	9,770.8	9,770.8	—	—	—	—
	Individual	671,472.3	671,472.3	671,367.0	105.3	—	—	—
	Total	892,656.5	892,656.5	892,180.9	475.7	—	—	—
All classes		1,133,013.4	1,085,752.8	1,082,065.8	3,687.0	47,260.5	46,763.5	497.0

Numbers in rows and columns may not sum to totals due to rounding.

— = no sample for the cell or a value of >0.0 but <0.05.

¹ Calculations based on TREE_REGIONAL_BIOMASS.REGIONAL_DRYBIOT.

VIRGINIA'S FORESTS, 2021

Table A3.15—Total carbon¹ of live trees on forest land by ownership class and land status, Virginia, 2021

Ownership class		All forest land	Unreserved			Reserved		
			Total	Timberland	Unproductive	Total	Productive	Unproductive
thousand tons								
USDA Forest Service	National forest	63,039.3	58,995.3	57,520.6	1,474.8	4,043.9	3,981.0	62.9
	Total	63,039.3	58,995.3	57,520.6	1,474.8	4,043.9	3,981.0	62.9
Other Federal	National Park Service	8,721.9	—	—	—	8,721.9	8,536.3	185.6
	U.S. Fish and Wildlife Service	3,471.7	—	—	—	3,471.7	3,471.7	—
	Dept. of Defense/Dept. of Energy	10,182.8	10,182.8	10,182.8	—	—	—	—
	Other Federal	686.4	686.4	686.4	—	—	—	—
	Total	23,062.9	10,869.3	10,869.3	—	12,193.6	12,008.0	185.6
State and local government	State	14,691.5	11,539.3	11,408.4	130.9	3,152.2	3,152.2	—
	Local	11,789.4	7,548.9	7,548.9	—	4,240.5	4,240.5	—
	Total	26,481.0	19,088.2	18,957.3	130.9	7,392.7	7,392.7	—
Forest industry	Corporate	6,152.2	6,152.2	6,152.2	—	—	—	—
	Individual	1,443.1	1,443.1	1,443.1	—	—	—	—
	Total	7,595.3	7,595.3	7,595.3	—	—	—	—
Nonindustrial private	Corporate	102,585.5	102,585.5	102,400.3	185.2	—	—	—
	Conservation/natural resources organization	3,121.2	3,121.2	3,121.2	—	—	—	—
	Unincorporated local partnership/association/club	4,885.4	4,885.4	4,885.4	—	—	—	—
	Individual	335,736.1	335,736.1	335,683.5	52.6	—	—	—
	Total	446,328.3	446,328.3	446,090.4	237.8	—	—	—
All classes		566,506.7	542,876.4	541,032.9	1,843.5	23,630.3	23,381.8	248.5

Numbers in rows and columns may not sum to totals due to rounding.

— = no sample for the cell or a value of >0.0 but <0.05.

¹ Estimates of carbon calculated by multiplying aboveground dry tree biomass by 0.5. Calculations based on TREE_REGIONAL_BIOMASS.REGIONAL_DRYBIOT.

VIRGINIA'S FORESTS, 2021

Table A3.16—Average annual net growth of live trees by ownership class and land status, Virginia, 2021 (2011–2016 to 2017–2021)

Ownership class ¹		Land status	
		Timberland	Forest land
<i>million cubic feet per year</i>			
USDA Forest Service	National forest	79.9	75.0
	Total	79.9	75.0
Other Federal	National Park Service	—	7.5
	U.S. Fish and Wildlife Service	—	9.7
	Dept. of Defense/ Dept. of Energy	15.7	15.7
	Other Federal	0.6	0.6
	Total	16.2	33.4
State and local government	State	18.6	21.5
	Local	22.4	27.4
	Total	41.1	48.9
Forest industry	Corporate	29.3	29.3
	Individual	2.5	2.5
	Total	31.8	31.8
Nonindustrial private	Corporate	337.2	335.7
	Conservation/natural resources organization	8.2	7.7
	Unincorporated partnership/ association/club	6.3	6.3
	Individual	886.8	886.9
	Total	1,238.6	1,236.6
All classes		1,407.6	1,425.8

Numbers in rows and columns may not sum to totals due to rounding.

— = no sample for the cell or a value of >0.0 but <0.05.

¹ Based on current conditions.

VIRGINIA'S FORESTS, 2021

Table A3.17—Average annual net growth of live trees on forest land by forest-type group and stand-size class, Virginia, 2021 (2011–2016 to 2017–2021)

Forest-type group ¹		Stand-size class ¹				
		All classes	Large diameter	Medium diameter	Small diameter	Nonstocked
<i>million cubic feet per year</i>						
Softwood types	White-red-jack pine	20.2	15.1	4.3	0.9	—
	Spruce-fir	0.8	0.8	—	—	—
	Longleaf-slash pine	—	—	—	—	—
	Loblolly-shortleaf pine	585.7	251.4	267.3	67.1	—
	Other eastern softwoods	4.4	0.8	2.8	0.7	—
	Exotic softwoods	0.3	—	0.3	—	—
	Total softwoods	611.5	268.1	274.7	68.7	—
Hardwood types	Oak-pine	138.0	71.5	40.4	26.1	—
	Oak-hickory	601.9	431.3	126.6	44.0	—
	Oak-gum-cypress	25.2	21.0	3.5	0.7	—
	Elm-ash-cottonwood	21.7	14.6	2.9	4.2	—
	Maple-beech-birch	21.6	21.0	-0.1	0.7	—
	Aspen-birch	0.2	0.2	—	—	—
	Other hardwoods	3.8	1.2	2.2	0.4	—
	Exotic hardwoods	1.1	—	1.0	—	—
	Total hardwoods	813.4	560.7	176.4	76.2	—
Nonstocked		0.9	—	—	—	0.9
All groups		1,425.8	828.9	451.1	144.9	0.9

Numbers in rows and columns may not sum to totals due to rounding.

— = no sample for the cell or a value of >0.0 but <0.05.

¹ Based on past conditions.

VIRGINIA'S FORESTS, 2021

Table A3.18—Average annual net growth of live trees on forest land by species group and ownership group, Virginia, 2021 (2011–2016 to 2017–2021)

Species group		Ownership group ¹					
		All ownerships	USDA Forest Service	Other Federal	State and local government	Forest industry	Nonindustrial private
<i>million cubic feet per year</i>							
Softwood	Longleaf and slash pines	—	—	—	—	—	—
	Loblolly and shortleaf pines	594.0	0.3	12.1	18.4	24.2	539.0
	Other yellow pines	14.2	3.8	-2.1	-0.4	0.7	12.2
	Eastern white and red pines	43.0	8.5	1.4	-0.2	0.3	33.0
	Spruce and balsam fir	0.8	0.3	—	0.5	—	—
	Eastern hemlock	0.5	-0.4	0.1	—	—	0.9
	Cypress	2.8	—	0.5	—	—	2.2
	Other eastern softwoods	7.4	0.1	0.1	0.4	0.4	6.5
	Total softwoods	662.8	12.5	12.1	18.6	25.7	593.9
Hardwood	Select white oaks	73.9	2.9	0.6	2.1	0.8	67.5
	Select red oaks	38.8	11.2	0.1	1.5	-0.5	26.5
	Other white oaks	56.0	14.2	1.9	2.1	1.0	36.8
	Other red oaks	67.6	6.8	3.1	1.8	0.4	55.5
	Hickory	34.1	2.6	0.8	0.6	0.5	29.6
	Yellow birch	0.8	0.3	—	0.1	—	0.4
	Hard maple	16.7	2.1	0.2	1.2	0.3	12.9
	Soft maple	56.3	7.1	2.9	1.4	0.6	44.4
	Beech	29.6	0.2	0.7	1.8	0.2	26.7
	Sweetgum	50.0	—	2.5	1.8	0.8	44.9
	Tupelo and blackgum	12.9	1.9	1.4	0.6	—	8.9
	Ash	-33.6	-0.4	-2.2	-1.1	-0.1	-29.9
	Cottonwood and aspen	1.0	—	—	0.4	—	0.6
	Basswood	4.0	0.5	-0.2	0.4	0.1	3.2
	Yellow-poplar	269.1	7.9	8.3	11.5	2.1	239.4
	Black walnut	9.0	0.2	—	0.3	—	8.5
	Other eastern soft hardwoods	47.7	2.6	0.6	1.8	0.1	42.6
	Other eastern hard hardwoods	11.2	1.4	0.4	0.1	—	9.3
	Eastern noncommercial hardwoods	17.8	1.0	0.3	1.7	0.1	14.7
	Urban-specific hardwoods	0.2	—	—	—	—	0.2
	Total hardwoods	763.0	62.5	21.4	30.3	6.2	642.7
All species		1,425.8	75.0	33.4	48.9	31.8	1,236.6

Numbers in rows and columns may not sum to totals due to rounding.

— = no sample for the cell or a value of >0.0 but <0.05.

¹ Based on current conditions.

VIRGINIA'S FORESTS, 2021

Table A3.19—Average annual mortality of live trees by ownership class and land status, Virginia, 2021 (2011–2016 to 2017–2021)

Ownership class ¹		Land status	
		Timberland	Forest land
		<i>million cubic feet per year</i>	
USDA Forest Service	National forest	34.2	37.7
	Total	34.2	37.7
Other Federal	National Park Service	—	9.0
	U.S. Fish and Wildlife Service	—	1.9
	Dept. of Defense/ Dept. of Energy	9.0	9.0
	Other Federal	1.5	1.5
	Total	10.5	21.4
State and local government	State	9.2	12.0
	Local	5.6	9.3
	Total	14.8	21.3
Forest industry	Corporate	2.8	2.8
	Individual	1.4	1.4
	Total	4.2	4.2
Nonindustrial private	Corporate	59.4	59.4
	Conservation/natural resources organization	2.5	2.5
	Unincorporated partnership/association/club	5.3	5.3
	Individual	224.9	224.9
	Total	292.1	292.1
All classes		355.9	376.8

Numbers in rows and columns may not sum to totals due to rounding.

— = no sample for the cell or a value of >0.0 but <0.05.

¹ Based on current conditions.

VIRGINIA'S FORESTS, 2021

Table A3.20—Average annual mortality of live trees on forest land by forest-type group and stand-size class, Virginia, 2021 (2011–2016 to 2017–2021)

Forest-type group ¹		All classes	Stand-size class ¹			
			Large diameter	Medium diameter	Small diameter	Nonstocked
million cubic feet per year						
Softwood types	White-red-jack pine	5.8	5.1	0.7	—	—
	Spruce-fir	0.2	0.2	—	—	—
	Longleaf-slash pine	—	—	—	—	—
	Loblolly-shortleaf pine	55.4	45.5	9.5	0.4	—
	Other eastern softwoods	0.6	0.4	0.1	—	—
	Exotic softwoods	0.1	—	0.1	—	—
	Total softwoods	62.0	51.2	10.4	0.4	—
Hardwood types	Oak-pine	43.6	37.6	5.2	0.7	—
	Oak-hickory	236.1	209.8	23.7	2.6	—
	Oak-gum-cypress	12.0	8.2	3.6	0.2	—
	Elm-ash-cottonwood	14.3	12.0	2.3	—	—
	Maple-beech-birch	7.0	4.9	2.1	0.1	—
	Aspen-birch	—	—	—	—	—
	Other hardwoods	1.2	0.7	0.5	—	—
	Exotic hardwoods	0.5	—	0.2	0.3	—
	Total hardwoods	314.7	273.2	37.6	3.9	—
Nonstocked		0.1	—	—	—	0.1
All groups		376.8	324.4	48.0	4.3	0.1

Numbers in rows and columns may not sum to totals due to rounding.

— = no sample for the cell or a value of >0.0 but <0.05.

¹ Based on past conditions.

VIRGINIA'S FORESTS, 2021

Table A3.21—Average annual mortality of live trees on forest land by species group and ownership group, Virginia, 2021 (2011–2016 to 2017–2021)

Species group		Ownership group ¹					
		All ownerships	USDA Forest Service	Other Federal	State and local government	Forest industry	Nonindustrial private
		million cubic feet per year					
Softwood	Longleaf and slash pines	—	—	—	—	—	—
	Loblolly and shortleaf pines	38.2	—	1.7	0.9	0.5	35.1
	Other yellow pines	45.3	2.2	3.5	2.8	0.7	36.0
	Eastern white and red pines	9.2	1.4	—	0.6	—	7.2
	Spruce and balsam fir	—	—	—	—	—	—
	Eastern hemlock	5.0	1.1	—	0.2	—	3.7
	Cypress	—	—	—	—	—	—
	Other eastern softwoods	4.4	—	—	0.3	—	4.1
	Total softwoods	102.1	4.7	5.3	4.7	1.2	86.0
Hardwood	Select white oaks	20.6	2.3	1.8	1.3	0.1	15.0
	Select red oaks	24.6	4.6	3.0	1.9	0.6	14.4
	Other white oaks	29.9	13.2	1.1	1.3	0.1	14.1
	Other red oaks	47.4	5.5	0.8	2.6	0.6	38.0
	Hickory	13.5	0.8	0.7	1.6	—	10.4
	Yellow birch	—	—	—	—	—	—
	Hard maple	0.6	0.1	—	—	—	0.5
	Soft maple	23.1	2.1	1.5	2.5	0.1	16.9
	Beech	0.7	—	—	—	—	0.7
	Sweetgum	5.0	—	1.3	—	0.1	3.5
	Tupelo and blackgum	5.2	0.3	0.1	0.4	—	4.5
	Ash	49.5	1.0	3.0	1.8	0.2	43.6
	Cottonwood and aspen	0.4	—	—	—	—	0.4
	Basswood	2.8	0.7	0.5	0.1	—	1.5
	Yellow-poplar	12.9	0.2	0.3	0.7	0.4	11.4
	Black walnut	1.6	0.1	0.0	0.1	0.1	1.4
	Other eastern soft hardwoods	16.7	0.5	1.0	0.9	0.4	13.9
	Other eastern hard hardwoods	13.9	0.8	0.9	1.0	0.2	10.9
	Eastern noncommercial hardwoods	6.3	0.6	0.3	0.1	0.1	5.1
	Urban-specific hardwoods	—	—	—	—	—	—
	Total hardwoods	274.7	33.0	16.1	16.5	3.0	206.1
All species		376.8	37.7	21.4	21.3	4.2	292.2

Numbers in rows and columns may not sum to totals due to rounding.

— = no sample for the cell or a value of >0.0 but <0.05.

¹ Based on current conditions.

Table A3.22—Average annual net removals of live trees by ownership class and land status, Virginia, 2021 (2011–2016 to 2017–2021)

Ownership class ¹		Land status	
		Timberland	Forest land
<i>million cubic feet per year</i>			
USDA Forest Service	National forest	14.2	8.1
	Total	14.2	8.1
Other Federal	National Park Service	0.4	—
	U.S. Fish and Wildlife Service	—	0.1
	Dept. of Defense/ Dept. of Energy	6.2	6.2
	Total	6.6	6.3
State and local government	State	1.3	1.3
	Local	1.4	3.4
	Total	2.7	4.7
Forest industry	Corporate	23.9	23.9
	Total	23.9	23.9
Nonindustrial private	Corporate	171.9	170.7
	Conservation/natural resources organization	0.9	0.9
	Unincorporated partnership/association/club	15.2	15.2
	Individual	447.4	447.4
	Total	635.3	634.1
All classes		682.6	677.1

Numbers in rows and columns may not sum to totals due to rounding.

— = no sample for the cell or a value of >0.0 but <0.05.

¹ Based on current conditions.

VIRGINIA'S FORESTS, 2021

Table A3.23—Average annual removals of live trees on forest land by forest-type group and stand-size class, Virginia, 2021 (2011–2016 to 2017–2021)

Forest-type group ¹		Stand-size class ¹				
		All classes	Large diameter	Medium diameter	Small diameter	Nonstocked
<i>million cubic feet per year</i>						
Softwood types	White-red-jack pine	1.5	0.9	0.6	—	—
	Spruce-fir	—	—	—	—	—
	Longleaf-slash pine	—	—	—	—	—
	Loblolly-shortleaf pine	333.1	247.3	84.5	1.3	—
	Other eastern softwoods	0.4	—	0.2	0.1	—
	Exotic softwoods	—	—	—	—	—
	Total softwoods	335.0	248.2	85.3	1.5	—
Hardwood types	Oak-pine	40.5	36.2	3.8	0.5	—
	Oak-hickory	276.3	241.6	33.4	1.2	—
	Oak-gum-cypress	9.8	9.8	—	—	—
	Elm-ash-cottonwood	11.8	10.2	1.6	—	—
	Maple-beech-birch	2.4	2.3	0.1	—	—
	Aspen-birch	—	—	—	—	—
	Other hardwoods	0.9	0.7	0.2	—	—
	Exotic hardwoods	0.2	—	0.2	—	—
	Total hardwoods	342.0	300.9	39.4	1.7	—
Nonstocked		0.2	—	—	—	0.2
All groups		677.1	549.1	124.7	3.2	0.2

Numbers in rows and columns may not sum to totals due to rounding.

— = no sample for the cell or a value of >0.0 but <0.05.

¹ Based on past conditions.

VIRGINIA'S FORESTS, 2021

Table A3.24—Average annual removals of live trees on forest land by species group and ownership group, Virginia, 2021 (2011–2016 to 2017–2021)

Species group		Ownership group ¹					
		All ownerships	USDA Forest Service	Other Federal	State and local government	Forest industry	
		million cubic feet per year					
Softwood	Longleaf and slash pines	—	—	—	—	—	—
	Loblolly and shortleaf pines	306.7	—	3.4	—	22.0	281.3
	Other yellow pines	19.0	—	0.4	0.1	0.6	17.8
	Eastern white and red pines	6.4	0.1	—	—	—	6.3
	Spruce and balsam fir	—	—	—	—	—	—
	Eastern hemlock	—	—	—	—	—	—
	Cypress	0.6	—	—	—	—	0.6
	Other eastern softwoods	2.4	—	—	0.3	—	2.1
	Total softwoods	335.1	0.1	3.8	0.3	22.6	308.2
Hardwood	Select white oaks	52.3	0.1	1.3	1.0	—	49.9
	Select red oaks	14.3	—	—	—	—	14.3
	Other white oaks	21.2	4.4	—	0.6	—	16.3
	Other red oaks	45.7	2.1	0.4	—	—	43.1
	Hickory	20.6	0.1	0.2	—	—	20.3
	Yellow birch	0.1	—	—	—	—	0.1
	Hard maple	2.7	—	—	—	—	2.7
	Soft maple	24.7	0.9	—	0.7	0.1	22.9
	Beech	4.8	—	—	—	0.4	4.4
	Sweetgum	25.7	—	0.1	—	0.3	25.3
	Tupelo and blackgum	5.1	0.2	0.3	0.1	—	4.5
	Ash	6.1	—	—	0.2	—	5.9
	Cottonwood and aspen	0.6	—	—	—	—	0.6
	Basswood	0.5	—	—	—	—	0.5
	Yellow-poplar	92.4	0.1	—	—	0.2	92.1
	Black walnut	2.7	—	—	0.2	0.1	2.4
	Other eastern soft hardwoods	12.9	—	—	0.9	—	12.0
	Other eastern hard hardwoods	5.1	—	—	0.3	—	4.7
	Eastern noncommercial hardwoods	4.5	—	0.1	0.5	0.2	3.8
	Urban-specific hardwoods	—	—	—	—	—	—
	Total hardwoods	342.0	8.0	2.5	4.4	1.3	325.9
All species		677.1	8.1	6.3	4.7	23.9	634.1

Numbers in rows and columns may not sum to totals due to rounding.

— = no sample for the cell or a value of >0.0 but <0.05.

¹ Based on current conditions.

Table A3.25—List of tree species ≥ 1.0 inch d.b.h. occurring in the FIA sample and number measured, Virginia, 2017–2021

	Common name	Scientific name	N
Softwoods	Loblolly pine	<i>Pinus taeda</i>	23,022
	Virginia pine	<i>Pinus virginiana</i>	5,689
	Eastern white pine	<i>Pinus strobus</i>	2,907
	Eastern redcedar	<i>Juniperus virginiana</i>	2,142
	Eastern hemlock	<i>Tsuga canadensis</i>	751
	Pitch pine	<i>Pinus rigida</i>	709
	Table Mountain pine	<i>Pinus pungens</i>	655
	Shortleaf pine	<i>Pinus echinata</i>	570
	Baldcypress	<i>Taxodium distichum</i>	71
	Red spruce	<i>Picea rubens</i>	59
	Pine spp.	<i>Pinus</i> spp.	26
	Norway spruce	<i>Picea abies</i>	23
	Scotch pine	<i>Pinus sylvestris</i>	21
	Atlantic white-cedar	<i>Chamaecyparis thyoides</i>	14
	Longleaf pine	<i>Pinus palustris</i>	13
	Fraser fir	<i>Abies fraseri</i>	13
	Pond pine	<i>Pinus serotina</i>	6
	Carolina hemlock	<i>Tsuga caroliniana</i>	4
	Northern white-cedar	<i>Thuja occidentalis</i>	1
Hardwoods	Red maple	<i>Acer rubrum</i>	11,922
	Yellow-poplar	<i>Liriodendron tulipifera</i>	10,978
	Chestnut oak	<i>Quercus prinus</i>	9,121
	White oak	<i>Quercus alba</i>	5,644
	Sweetgum	<i>Liquidambar styraciflua</i>	5,578
	Blackgum	<i>Nyssa sylvatica</i>	3,847
	Scarlet oak	<i>Quercus coccinea</i>	3,052
	Northern red oak	<i>Quercus rubra</i>	2,835
	Sourwood	<i>Oxydendrum arboreum</i>	2,452
	American holly	<i>Ilex opaca</i>	2,341
	American beech	<i>Fagus grandifolia</i>	2,216
	Pignut hickory	<i>Carya glabra</i>	2,080
	Mockernut hickory	<i>Carya alba</i>	1,974

Table A3.25—List of tree species ≥ 1.0 inch d.b.h. occurring in the FIA sample and number measured, Virginia, 2017–2021 (continued)

	Common name	Scientific name	N
Hardwoods (continued)	Black cherry	<i>Prunus serotina</i>	1,908
	Black oak	<i>Quercus velutina</i>	1,874
	Black locust	<i>Robinia pseudoacacia</i>	1,794
	Sweet birch	<i>Betula lenta</i>	1,484
	Sugar maple	<i>Acer saccharum</i>	1,402
	Southern red oak	<i>Quercus falcata</i>	1,223
	American hornbeam, musclewood	<i>Carpinus caroliniana</i>	1,155
	White ash	<i>Fraxinus americana</i>	1,062
	Sassafras	<i>Sassafras albidum</i>	950
	Green ash	<i>Fraxinus pennsylvanica</i>	833
	Ailanthus	<i>Ailanthus altissima</i>	798
	Flowering dogwood	<i>Cornus florida</i>	634
	Eastern redbud	<i>Cercis canadensis</i>	607
	Black walnut	<i>Juglans nigra</i>	558
	American sycamore	<i>Platanus occidentalis</i>	537
	Willow oak	<i>Quercus phellos</i>	489
	Serviceberry spp.	<i>Amelanchier</i> spp.	475
	Swamp tupelo	<i>Nyssa biflora</i>	445
	American elm	<i>Ulmus americana</i>	443
	American basswood	<i>Tilia americana</i>	440
	Striped maple	<i>Acer pensylvanicum</i>	423
	Winged elm	<i>Ulmus alata</i>	390
	River birch	<i>Betula nigra</i>	345
	Cucumbertree	<i>Magnolia acuminata</i>	344
	Water oak	<i>Quercus nigra</i>	311
	Bitternut hickory	<i>Carya cordiformis</i>	310
	Shagbark hickory	<i>Carya ovata</i>	307
	Post oak	<i>Quercus stellata</i>	288
	Mountain or Fraser magnolia	<i>Magnolia fraseri</i>	272
	Boxelder	<i>Acer negundo</i>	265
	Slippery elm	<i>Ulmus rubra</i>	261
	Eastern hophornbeam	<i>Ostrya virginiana</i>	236

Table A3.25—List of tree species ≥ 1.0 inch d.b.h. occurring in the FIA sample and number measured, Virginia, 2017–2021 (continued)

	Common name	Scientific name	N
Hardwoods (continued)	Hackberry	<i>Celtis occidentalis</i>	209
	Pawpaw	<i>Asimina triloba</i>	183
	Yellow buckeye	<i>Aesculus flava</i>	181
	Common persimmon	<i>Diospyros virginiana</i>	154
	Sweetbay	<i>Magnolia virginiana</i>	125
	Yellow birch	<i>Betula alleghaniensis</i>	118
	Swamp chestnut oak	<i>Quercus michauxii</i>	113
	Chinkapin oak	<i>Quercus muehlenbergii</i>	107
	Paulownia, empress-tree	<i>Paulownia tomentosa</i>	106
	Bigtooth aspen	<i>Populus grandidentata</i>	102
	Water tupelo	<i>Nyssa aquatica</i>	92
	Hawthorn spp.	<i>Crataegus</i> spp.	91
	Redbay	<i>Persea borbonia</i>	86
	American chestnut	<i>Castanea dentata</i>	83
	Florida maple	<i>Acer barbatum</i>	78
	Black willow	<i>Salix nigra</i>	78
	Pin cherry	<i>Prunus pensylvanica</i>	66
	Sweet cherry	<i>Prunus avium</i>	60
	Cherrybark oak	<i>Quercus pagoda</i>	57
	Pin oak	<i>Quercus palustris</i>	55
	Other or unknown live tree	Unknown	50
	Blackjack oak	<i>Quercus marilandica</i>	45
	Apple spp.	<i>Malus</i> spp.	43
	Osage-orange	<i>Maclura pomifera</i>	42
	Umbrella magnolia	<i>Magnolia tripetala</i>	37
	Red mulberry	<i>Morus rubra</i>	37
	White willow	<i>Salix alba</i>	25
	Butternut	<i>Juglans cinerea</i>	19
	Laurel oak	<i>Quercus laurifolia</i>	15
	Oak spp.	<i>Quercus</i> spp.	14
	American mountain-ash	<i>Sorbus americana</i>	14
	Scrub oak	<i>Quercus ilicifolia</i>	12

Table A3.25—List of tree species ≥ 1.0 inch d.b.h. occurring in the FIA sample and number measured, Virginia, 2017–2021 (continued)

	Common name	Scientific name	N
Hardwoods (continued)	Overcup oak	<i>Quercus lyrata</i>	11
	Mimosa, silktree	<i>Albizia julibrissin</i>	11
	Pecan	<i>Carya illinoensis</i>	10
	Blue ash	<i>Fraxinus quadrangulata</i>	10
	Honeylocust	<i>Gleditsia triacanthos</i>	10
	White mulberry	<i>Morus alba</i>	10
	Callery pear	<i>Pyrus calleryana</i>	9
	Allegheny chinkapin	<i>Castanea pumila</i>	8
	Sawtooth oak	<i>Quercus acutissima</i>	8
	Eastern cottonwood	<i>Populus deltoides</i>	6
	Alder spp.	<i>Alnus</i> spp.	6
	Chinese chestnut	<i>Castanea mollissima</i>	6
	Swamp white oak	<i>Quercus bicolor</i>	5
	Downy hawthorn	<i>Crataegus mollis</i>	4
	Bigleaf magnolia	<i>Magnolia macrophylla</i>	4
	Shingle oak	<i>Quercus imbricaria</i>	3
	Shellbark hickory	<i>Carya laciniosa</i>	3
	Southern crab apple	<i>Malus angustifolia</i>	3
	American plum	<i>Prunus americana</i>	3
	Shumard oak	<i>Quercus shumardii</i>	2
	Ssugarberry	<i>Celtis laevigata</i>	2
	Southern magnolia	<i>Magnolia grandiflora</i>	2
	Southern catalpa	<i>Catalpa bignonioides</i>	2
	Turkey oak	<i>Quercus laevis</i>	2
	Unknown dead hardwood	Broadleaf tree	2
	Bur oak	<i>Quercus macrocarpa</i>	1
	Northern pin oak	<i>Quercus ellipsoidalis</i>	1
	Hickory spp.	<i>Carya</i> spp.	1
	Red hickory	<i>Carya ovalis</i>	1
	Norway maple	<i>Acer platanoides</i>	1
	Silver maple	<i>Acer saccharinum</i>	1
	Swamp cottonwood	<i>Populus heterophylla</i>	1

Table A3.25—List of tree species ≥ 1.0 inch d.b.h. occurring in the FIA sample and number measured, Virginia, 2017–2021 (continued)

	Common name	Scientific name	N
Hardwoods (continued)	Northern catalpa	<i>Catalpa speciosa</i>	1
	Siberian elm	<i>Ulmus pumila</i>	1
	Rock elm	<i>Ulmus thomasi</i>	1
	Sweet crab apple	<i>Malus coronaria</i>	1
	Chokecherry	<i>Prunus virginiana</i>	1
	Chickasaw plum	<i>Prunus angustifolia</i>	1

N = number of trees measured.

VIRGINIA'S FORESTS, 2021

Table A3.26a—Area of sampled land and water by county and major land use, Virginia, 2021

County code and name	Land class						
	Total	Timberland	Reserved forest land	Other forest land	Nonforest	Non-Census water	Census water
	<i>acres</i>						
51001 Accomack	885,422	101,953	1,714	—	231,566	—	550,190
51003 Albemarle	496,879	281,879	12,342	—	197,271	5,386	—
51005 Alleghany	285,253	235,699	5,674	8,543	33,999	1,338	—
51007 Amelia	219,586	153,324	—	—	62,894	3,367	—
51009 Amherst	301,943	232,218	7,668	—	62,057	—	—
51011 Appomattox	217,018	133,189	1,475	—	80,006	2,348	—
51013 Arlington	12,927	—	—	—	12,927	—	—
51015 Augusta	632,027	305,270	11,866	16,318	298,572	—	—
51017 Bath	339,518	282,575	—	9,995	32,634	—	14,315
51019 Bedford	492,028	284,056	8,738	—	183,714	5,764	9,754
51021 Bland	224,372	153,238	10,953	—	60,180	—	—
51023 Botetourt	351,776	240,372	17,002	4,255	89,535	612	—
51025 Brunswick	364,891	262,573	—	—	95,336	6,982	—
51027 Buchanan	338,893	295,214	—	—	43,679	—	—
51029 Buckingham	376,523	321,356	—	—	54,885	282	—
51031 Campbell	360,496	224,448	—	—	134,364	1,684	—
51033 Caroline	327,794	250,054	—	—	74,224	3,516	—
51035 Carroll	326,927	182,547	9,434	—	131,184	322	3,439
51036 Charles City	139,737	93,675	—	—	37,644	—	8,417
51037 Charlotte	288,657	215,034	—	—	73,623	—	—
51041 Chesterfield	315,697	138,277	8,611	—	160,392	—	8,417
51043 Clarke	111,486	30,813	—	—	80,673	—	—
51045 Craig	213,422	133,158	16,410	15,363	48,491	—	—
51047 Culpeper	235,304	100,744	—	—	128,682	5,879	—
51049 Cumberland	190,624	116,466	—	—	62,701	1,702	9,754
51051 Dickenson	236,966	196,462	—	—	40,504	—	—
51053 Dinwiddie	306,061	236,674	—	—	67,952	—	1,435
51057 Essex	167,395	86,767	—	—	63,772	5,568	11,288
51059 Fairfax	278,008	42,526	31,761	—	203,687	34	—
51061 Fauquier	424,387	216,376	—	—	207,694	316	—

VIRGINIA'S FORESTS, 2021

Table A3.26a—Area of sampled land and water by county and major land use, Virginia, 2021 (continued)

County code and name	Land class						
	Total	Timberland	Reserved forest land	Other forest land	Nonforest	Non-Census water	Census water
	<i>acres</i>						
51063 Floyd	235,369	122,176	—	—	113,192	—	—
51065 Flunna	166,986	99,911	—	—	62,020	171	4,884
51067 Franklin	455,997	255,850	4,426	4,426	190,556	739	—
51069 Frederick	274,687	162,074	—	3,579	109,035	—	—
51071 Giles	256,384	186,340	17,894	—	48,711	—	3,439
51073 Gloucester	195,239	83,266	5,567	—	43,392	—	63,015
51075 Goochland	170,074	109,444	—	—	59,160	—	1,470
51077 Grayson	296,465	147,481	16,453	—	127,629	1,463	3,439
51079 Greene	104,832	56,353	17,637	—	29,527	1,315	—
51081 Greensville	172,237	126,715	—	—	39,347	6,175	—
51083 Halifax	535,898	379,860	—	—	146,283	—	9,754
51085 Hanover	287,427	181,677	—	—	105,749	—	—
51087 Henrico	183,745	54,459	8,762	—	116,740	1,435	2,349
51089 Henry	258,013	184,508	5,901	—	59,655	3,780	4,169
51091 Highland	295,268	232,628	—	—	60,776	1,865	—
51093 Isle of Wight	226,593	116,976	—	—	102,634	—	6,982
51095 James City	130,567	60,369	—	—	56,233	—	13,965
51097 King and Queen	196,452	137,605	—	—	58,848	—	—
51099 King George	110,493	74,877	—	—	35,616	—	—
51101 King William	180,116	110,983	—	—	62,151	—	6,982
51103 Lancaster	133,764	45,412	—	—	52,006	1,435	34,912
51105 Lee	282,749	170,987	12,367	—	99,394	—	—
51107 Loudoun	333,066	92,480	5,879	—	232,675	2,031	—
51109 Louisa	330,454	201,872	—	—	108,209	2,939	17,433
51111 Lunenburg	285,460	244,236	—	—	41,223	—	—
51113 Madison	194,950	66,044	28,346	—	100,559	—	—
51115 Mathews	172,146	26,296	—	—	20,168	—	125,682
51117 Mecklenburg	438,119	304,582	—	—	117,408	575	15,553
51119 Middlesex	133,936	49,710	—	—	43,574	—	40,652
51121 Montgomery	256,025	160,919	7,708	—	87,397	—	—

VIRGINIA'S FORESTS, 2021

Table A3.26a—Area of sampled land and water by county and major land use, Virginia, 2021 (continued)

County code and name	Land class						
	Total	Timberland	Reserved forest land	Other forest land	Nonforest	Non-Census water	Census water
<i>acres</i>							
51125 Nelson	314,876	250,039	6,284	—	54,587	3,966	—
51127 New Kent	123,217	81,935	—	—	29,053	10,483	1,746
51131 Northampton	570,317	26,205	—	—	146,120	—	397,992
51133 Northumberland	195,263	61,658	—	—	66,437	—	67,167
51135 Nottoway	200,559	146,630	—	—	53,929	—	—
51137 Orange	226,551	140,835	—	—	79,071	134	6,512
51139 Page	187,366	86,411	25,295	—	70,647	—	5,013
51141 Patrick	299,784	201,084	5,901	—	84,949	5,764	2,086
51143 Pittsylvania	660,808	400,204	—	—	250,849	—	9,754
51145 Powhatan	177,598	103,794	—	—	62,575	1,475	9,754
51147 Prince Edward	216,282	136,264	—	—	70,264	—	9,754
51149 Prince George	189,775	106,195	—	—	64,711	5,568	13,300
51153 Prince William	225,419	70,340	15,999	—	120,178	—	18,903
51155 Pulaski	208,716	118,853	—	3,092	84,192	—	2,580
51157 Rappahannock	193,792	95,613	41,153	—	57,026	—	—
51159 Richmond	149,214	73,329	5,740	—	49,198	—	20,947
51161 Roanoke	206,734	82,533	2,520	—	120,134	1,548	—
51163 Rockbridge	398,204	263,320	12,197	9,161	113,527	—	—
51165 Rockingham	576,054	330,521	31,619	2,837	210,280	798	—
51167 Russell	284,161	145,193	—	—	138,968	—	—
51169 Scott	344,688	258,922	—	—	80,863	—	4,902
51171 Shenandoah	324,428	187,571	—	3,579	132,575	704	—
51173 Smyth	274,538	175,014	9,020	—	90,503	—	—
51175 Southampton	363,675	247,484	—	—	109,209	—	6,982
51177 Spotsylvania	254,322	141,793	7,349	—	90,687	1,470	13,024
51179 Stafford	167,725	109,234	5,879	—	52,611	—	—
51181 Surry	200,522	138,206	—	—	40,993	377	20,947
51183 Sussex	310,904	257,698	—	—	53,207	—	—
51185 Tazewell	320,167	227,154	5,411	—	86,056	—	1,546
51187 Warren	145,811	61,819	23,145	—	60,847	—	—

VIRGINIA'S FORESTS, 2021

Table A3.26a—Area of sampled land and water by county and major land use, Virginia, 2021 (continued)

County code and name	Land class						
	Total	Timberland	Reserved forest land	Other forest land	Nonforest	Non-Census water	Census water
<i>acres</i>							
51191 Washington	356,834	195,865	4,506	—	155,001	1,463	—
51193 Westmoreland	156,627	82,005	5,740	—	59,082	1,072	8,728
51195 Wise	250,389	164,926	—	—	85,043	—	420
51197 Wythe	274,780	109,630	—	3,579	155,719	5,852	—
51199 York	199,790	32,821	10,014	—	44,115	1,124	111,717
51550 Chesapeake city	302,267	48,937	45,923	—	159,772	—	47,634
51650 Hampton city	89,612	1,297	—	—	39,439	6,982	41,894
51700 Newport News city	73,877	—	5,740	—	40,207	—	27,929
51800 Suffolk city	276,573	142,052	34,443	—	84,420	—	15,659
51810 Virginia Beach city	328,208	34,754	1,087	—	137,321	—	155,046
Total	27,375,956	15,331,166	579,555	84,726	9,269,071	117,807	1,993,630

— = no sample for the cell.

VIRGINIA'S FORESTS, 2021

Table A3.26b—Sampling error for area of sampled land and water by county and major land use, Virginia, 2021

County code and name	Major land use						
	Total	Timberland	Reserved forest land	Other forest land	Nonforest	Non-Census water	Census water
	<i>percent</i>						
51001 Accomack	0.03	0.73	9.28	19.90	1.09	18.07	1.67
51003 Albemarle	7.29	23.07	99.46	—	15.08	—	8.84
51005 Alleghany	10.26	13.39	69.38	—	15.86	65.77	—
51007 Amelia	12.38	13.16	73.79	58.28	35.70	125.01	—
51009 Amherst	16.28	18.86	—	—	28.51	95.02	—
51011 Appomattox	13.03	14.32	79.98	—	27.44	—	—
51013 Arlington	16.40	19.53	101.16	—	24.40	101.16	—
51015 Augusta	67.60	—	—	—	67.60	—	—
51017 Bath	8.41	11.08	62.77	49.40	12.53	—	—
51019 Bedford	10.82	11.69	—	55.61	38.49	—	46.19
51021 Bland	10.55	13.23	76.30	—	16.37	102.57	81.27
51023 Botetourt	14.66	16.98	52.96	—	28.93	—	—
51025 Brunswick	11.90	13.87	56.99	73.79	23.98	94.80	—
51027 Buchanan	12.48	14.49	—	—	23.90	92.85	—
51029 Buckingham	12.59	13.14	—	—	29.59	—	—
51031 Campbell	12.16	12.78	—	—	27.34	101.16	—
51033 Caroline	12.52	15.62	—	—	19.58	95.02	—
51035 Carroll	13.19	14.67	—	—	25.69	64.62	—
51036 Charles City	12.99	16.13	73.52	—	18.57	97.89	151.55
51037 Charlotte	20.55	23.98	—	—	35.91	—	78.97
51041 Chesterfield	14.13	15.94	—	—	26.05	—	—
51043 Clarke	13.44	19.33	76.27	—	18.02	—	78.97
51045 Craig	22.86	41.35	—	—	26.14	—	—
51047 Culpeper	13.98	16.71	43.30	43.37	33.22	—	—
51049 Cumberland	15.41	23.14	—	—	20.18	100.41	—
51051 Dickenson	17.58	21.92	—	—	29.22	95.02	81.27
51053 Dinwiddie	15.12	16.15	—	—	32.35	—	—
51057 Essex	13.68	15.20	—	—	27.35	—	102.39
51059 Fairfax	18.74	25.28	—	—	29.60	104.06	69.45
51061 Fauquier	14.05	34.50	41.45	—	16.11	100.41	—

VIRGINIA'S FORESTS, 2021

Table A3.26b—Sampling error for area of sampled land and water by county and major land use, Virginia, 2021 (continued)

County code and name	Major land use						
	Total	Timberland	Reserved forest land	Other forest land	Nonforest	Non-Census water	Census water
	<i>percent</i>						
51063 Floyd	11.24	15.45	—	—	15.57	95.97	—
51065 Fluvanna	15.46	20.60	—	—	21.22	—	—
51067 Franklin	18.57	22.33	—	—	27.62	100.41	99.98
51069 Frederick	11.03	14.08	101.16	101.16	15.88	95.02	—
51071 Giles	14.18	17.88	—	93.06	21.79	—	—
51073 Gloucester	13.68	15.52	41.22	—	31.29	—	151.55
51075 Goochland	17.34	25.57	102.39	—	34.35	—	30.40
51077 Grayson	18.34	22.21	—	—	29.72	—	100.41
51079 Greene	13.45	17.84	52.91	—	19.53	100.99	151.55
51081 Greensville	23.51	31.57	57.85	—	43.83	100.41	—
51083 Halifax	18.42	20.73	—	—	35.62	77.78	—
51085 Hanover	10.14	11.68	—	—	18.00	—	81.27
51087 Henrico	14.14	16.94	—	—	21.64	—	—
51089 Henry	17.76	30.10	75.76	—	21.60	102.39	102.39
51091 Highland	14.98	17.12	101.16	—	29.03	81.27	63.55
51093 Isle of Wight	12.88	14.06	—	—	30.42	99.45	—
51095 James City	16.05	21.55	—	—	22.87	—	92.85
51097 King and Queen	21.30	30.31	—	—	31.27	—	65.53
51099 King George	17.25	20.20	—	—	30.27	—	—
51101 King William	23.12	26.61	—	—	36.17	—	—
51103 Lancaster	18.06	21.91	—	—	28.23	—	92.85
51105 Lee	21.07	32.94	—	—	31.19	102.39	41.21
51107 Loudoun	13.87	17.18	69.13	—	22.30	—	—
51109 Louisa	12.67	23.44	100.41	—	14.73	77.72	—
51111 Lunenburg	12.91	15.87	—	—	21.35	100.41	55.55
51113 Madison	14.18	15.10	—	—	34.39	—	—
51115 Mathews	17.08	28.56	44.84	—	23.12	—	—
51117 Mecklenburg	18.25	45.80	—	—	51.74	—	21.18
51119 Middlesex	11.33	13.08	—	—	20.19	101.16	59.18
51121 Montgomery	21.05	33.15	—	—	35.15	—	38.23

VIRGINIA'S FORESTS, 2021

Table A3.26b—Sampling error for area of sampled land and water by county and major land use, Virginia, 2021 (continued)

County code and name	Major land use						
	Total	Timberland	Reserved forest land	Other forest land	Nonforest	Non-Census water	Census water
	<i>percent</i>						
51125 Nelson	14.50	18.05	59.89	—	24.52	—	—
51127 New Kent	13.00	14.32	70.24	—	30.79	73.27	—
51131 Northampton	21.89	25.65	—	—	42.02	65.93	92.85
51133 Northumberland	9.33	45.93	—	—	19.44	—	10.93
51135 Nottoway	17.36	29.36	—	—	28.32	—	29.61
51137 Orange	17.08	19.38	—	—	30.37	—	—
51139 Page	15.82	18.99	—	—	24.54	100.41	99.98
51141 Patrick	17.06	23.77	48.58	—	28.19	—	125.01
51143 Pittsylvania	13.82	16.45	101.16	—	25.12	102.57	95.02
51145 Powhatan	8.99	11.15	—	—	13.42	—	81.27
51147 Prince Edward	18.27	22.60	—	—	28.40	101.16	81.27
51149 Prince George	16.43	20.19	—	—	27.42	—	81.27
51153 Prince William	17.54	22.53	—	—	28.91	104.06	60.74
51155 Pulaski	15.86	26.59	58.46	—	20.84	—	55.24
51157 Rappahannock	16.14	19.68	—	97.89	24.09	—	151.55
51159 Richmond	17.10	24.14	37.71	—	31.20	—	—
51161 Roanoke	19.90	27.80	102.39	—	33.42	—	53.40
51163 Rockbridge	16.56	25.52	97.83	—	21.29	99.45	—
51165 Rockingham	11.12	13.15	47.41	74.91	20.77	—	—
51167 Russell	8.91	11.13	43.36	104.65	15.19	125.01	—
51169 Scott	13.91	19.07	—	—	19.18	—	—
51171 Shenandoah	12.31	13.95	—	—	26.06	—	110.51
51173 Smyth	12.43	15.70	—	93.06	19.92	106.83	—
51175 Southampton	13.41	15.63	74.74	—	23.60	—	—
51177 Spotsylvania	12.52	14.70	—	—	21.34	—	92.85
51179 Stafford	14.84	19.03	82.76	—	23.84	100.41	66.13
51181 Surry	18.43	21.86	100.41	—	30.08	—	—
51183 Sussex	17.11	20.20	—	—	35.91	102.39	53.40
51185 Tazewell	13.53	14.69	—	—	31.91	—	—
51187 Warren	13.02	15.07	75.46	—	24.43	—	97.89

VIRGINIA'S FORESTS, 2021

Table A3.26b—Sampling error for area of sampled land and water by county and major land use, Virginia, 2021 (continued)

County code and name	Major land use						
	Total	Timberland	Reserved forest land	Other forest land	Nonforest	Non-Census water	Census water
	<i>percent</i>						
51191 Washington	19.80	27.85	49.95	—	28.65	—	—
51193 Westmoreland	12.22	15.89	97.89	—	18.29	100.99	—
51195 Wise	19.39	24.99	102.39	—	29.16	102.39	76.50
51197 Wythe	14.65	17.01	—	—	22.92	—	97.89
51199 York	13.35	19.69	—	93.06	18.20	100.99	—
51550 Chesapeake city	17.01	39.90	72.57	—	34.95	102.39	22.55
51650 Hampton city	13.81	34.21	36.01	—	18.78	—	35.25
51700 Newport News city	25.72	102.39	—	—	38.42	92.85	37.55
51800 Suffolk city	28.42	—	102.39	—	38.54	—	46.16
51810 Virginia Beach city	14.46	19.67	41.65	—	25.31	—	59.42
Total	0.03	0.73	9.28	19.90	1.09	18.07	1.67

— = no sample for the cell.

Table A3.27a—Area of timberland by county and major ownership group, Virginia, 2021

County code and name	Major ownership group		
	Total	Public	Private
<i>acres</i>			
51001 Accomack	101,953	—	101,953
51003 Albemarle	281,879	13,228	268,652
51005 Alleghany	235,699	121,440	114,259
51007 Amelia	153,324	—	153,324
51009 Amherst	232,218	57,112	175,107
51011 Appomattox	133,189	15,227	117,961
51015 Augusta	305,270	181,134	124,136
51017 Bath	282,575	170,441	112,134
51019 Bedford	284,056	9,307	274,749
51021 Bland	153,238	65,121	88,117
51023 Botetourt	240,372	73,247	167,125
51025 Brunswick	262,573	13,005	249,568
51027 Buchanan	295,214	5,402	289,812
51029 Buckingham	321,356	22,710	298,646
51031 Campbell	224,448	—	224,448
51033 Caroline	250,054	60,524	189,530
51035 Carroll	182,547	8,889	173,658
51036 Charles City	93,675	2,870	90,805
51037 Charlotte	215,034	—	215,034
51041 Chesterfield	138,277	20,291	117,986
51043 Clarke	30,813	—	30,813
51045 Craig	133,158	95,202	37,956
51047 Culpeper	100,744	5,879	94,865
51049 Cumberland	116,466	22,755	93,711
51051 Dickenson	196,462	16,719	179,743
51053 Dinwiddie	236,674	1,642	235,032
51057 Essex	86,767	11,481	75,286
51059 Fairfax	42,526	—	42,526
51061 Fauquier	216,376	17,637	198,739
51063 Floyd	122,176	—	122,176

Table A3.27a—Area of timberland by county and major ownership group, Virginia, 2021 (continued)

County code and name	Major ownership group		
	Total	Public	Private
<i>acres</i>			
51065 Fluvanna	99,911	—	99,911
51067 Franklin	255,850	—	255,850
51069 Frederick	162,074	3,579	158,495
51071 Giles	186,340	82,466	103,874
51073 Gloucester	83,266	—	83,266
51075 Goochland	109,444	—	109,444
51077 Grayson	147,481	27,359	120,122
51079 Greene	56,353	5,879	50,474
51081 Greensville	126,715	—	126,715
51083 Halifax	379,860	17,752	362,108
51085 Hanover	181,677	—	181,677
51087 Henrico	54,459	—	54,459
51089 Henry	184,508	—	184,508
51091 Highland	232,628	106,068	126,560
51093 Isle of Wight	116,976	—	116,976
51095 James City	60,369	11,481	48,888
51097 King and Queen	137,605	11,481	126,124
51099 King George	74,877	4,305	70,572
51101 King William	110,983	3,428	107,555
51103 Lancaster	45,412	1,392	44,020
51105 Lee	170,987	11,216	159,771
51107 Loudoun	92,480	10,596	81,885
51109 Louisa	201,872	—	201,872
51111 Lunenburg	244,236	—	244,236
51113 Madison	66,044	—	66,044
51115 Mathews	26,296	—	26,296
51117 Mecklenburg	304,582	62,578	242,004
51119 Middlesex	49,710	5,740	43,970
51121 Montgomery	160,919	19,019	141,900
51125 Nelson	250,039	26,758	223,281

Table A3.27a—Area of timberland by county and major ownership group, Virginia, 2021 (continued)

County code and name	Major ownership group		
	Total	Public	Private
<i>acres</i>			
51127 New Kent	81,935	4,670	77,266
51131 Northampton	26,205	—	26,205
51133 Northumberland	61,658	—	61,658
51135 Nottoway	146,630	5,901	140,728
51137 Orange	140,835	5,879	134,956
51139 Page	86,411	29,459	56,952
51141 Patrick	201,084	15,737	185,347
51143 Pittsylvania	400,204	11,498	388,707
51145 Powhatan	103,794	8,176	95,618
51147 Prince Edward	136,264	13,750	122,514
51149 Prince George	106,195	1,435	104,760
51153 Prince William	70,340	23,516	46,824
51155 Pulaski	118,853	21,885	96,967
51157 Rappahannock	95,613	—	95,613
51159 Richmond	73,329	—	73,329
51161 Roanoke	82,533	24,239	58,294
51163 Rockbridge	263,320	59,856	203,463
51165 Rockingham	330,521	161,861	168,660
51167 Russell	145,193	11,444	133,748
51169 Scott	258,922	35,634	223,288
51171 Shenandoah	187,571	68,829	118,742
51173 Smyth	175,014	77,817	97,197
51175 Southampton	247,484	—	247,484
51177 Spotsylvania	141,793	20,547	121,247
51179 Stafford	109,234	23,516	85,719
51181 Surry	138,206	7,265	130,941
51183 Sussex	257,698	—	257,698
51185 Tazewell	227,154	2,705	224,448
51187 Warren	61,819	12,608	49,211
51191 Washington	195,865	44,146	151,719

Table A3.27a—Area of timberland by county and major ownership group, Virginia, 2021 (continued)

County code and name	Major ownership group		
	Total	Public	Private
<i>acres</i>			
51193 Westmoreland	82,005	—	82,005
51195 Wise	164,926	22,601	142,325
51197 Wythe	109,630	71,353	38,277
51199 York	32,821	21,340	11,481
51550 Chesapeake city	48,937	5,242	43,696
51650 Hampton city	1,297	—	1,297
51800 Suffolk city	142,052	—	142,052
51810 Virginia Beach city	34,754	8,643	26,111
Total	15,331,166	2,243,910	13,087,256

— = no sample for the cell.

Table A3.27b—Sampling error for area of timberland by county and major ownership group, Virginia, 2021

County code and name	Major ownership group		
	Total	Public	Private
	<i>percent</i>		
51001 Accomack	23.07	—	23.07
51003 Albemarle	13.39	59.97	13.81
51005 Alleghany	13.16	15.24	21.75
51007 Amelia	18.86	—	18.86
51009 Amherst	14.32	24.86	17.22
51011 Appomattox	19.53	60.00	20.73
51015 Augusta	11.08	12.92	19.73
51017 Bath	11.69	12.89	21.86
51019 Bedford	13.23	55.50	13.53
51021 Bland	16.98	22.08	24.67
51023 Botetourt	13.87	19.75	17.95
51025 Brunswick	14.49	64.92	14.91
51027 Buchanan	13.14	97.89	13.25
51029 Buckingham	12.78	50.55	13.30
51031 Campbell	15.62	—	15.62
51033 Caroline	14.67	29.97	16.94
51035 Carroll	16.13	75.49	16.55
51036 Charles City	23.98	102.39	24.54
51037 Charlotte	15.94	—	15.94
51041 Chesterfield	19.33	51.53	20.96
51043 Clarke	41.35	—	41.35
51045 Craig	16.71	17.96	37.67
51047 Culpeper	23.14	100.41	23.83
51049 Cumberland	21.92	50.02	24.54
51051 Dickenson	16.15	48.83	16.98
51053 Dinwiddie	15.20	99.46	15.29
51057 Essex	25.28	72.35	27.06
51059 Fairfax	34.50	—	34.50
51061 Fauquier	15.45	57.85	16.13
51063 Floyd	20.60	—	20.60

Table A3.27b—Sampling error for area of timberland by county and major ownership group, Virginia, 2021 (continued)

County code and name	Major ownership group		
	Total	Public	Private
	<i>percent</i>		
51065 Fluvanna	22.33	—	22.33
51067 Franklin	14.08	—	14.08
51069 Frederick	17.88	93.06	18.17
51071 Giles	15.52	20.69	22.60
51073 Gloucester	25.57	—	25.57
51075 Goochland	22.21	—	22.21
51077 Grayson	17.84	35.37	20.35
51079 Greene	31.57	100.41	33.32
51081 Greensville	20.73	—	20.73
51083 Halifax	11.68	57.20	11.98
51085 Hanover	16.94	—	16.94
51087 Henrico	30.10	—	30.10
51089 Henry	17.12	—	17.12
51091 Highland	14.06	18.15	20.88
51093 Isle of Wight	21.55	—	21.55
51095 James City	30.31	72.35	33.45
51097 King and Queen	20.20	72.35	21.09
51099 King George	26.61	102.39	27.56
51101 King William	21.91	102.39	22.39
51103 Lancaster	32.94	104.06	33.82
51105 Lee	17.18	52.39	18.01
51107 Loudoun	23.44	72.51	24.80
51109 Louisa	15.87	—	15.87
51111 Lunenburg	15.10	—	15.10
51113 Madison	28.56	—	28.56
51115 Mathews	45.80	—	45.80
51117 Mecklenburg	13.08	28.72	14.86
51119 Middlesex	33.15	102.39	35.07
51121 Montgomery	18.05	44.05	19.65
51125 Nelson	14.32	43.00	15.29

Table A3.27b—Sampling error for area of timberland by county and major ownership group, Virginia, 2021 (continued)

County code and name	Major ownership group		
	Total	Public	Private
	<i>percent</i>		
51127 New Kent	25.65	102.39	26.52
51131 Northampton	45.93	—	45.93
51133 Northumberland	29.36	—	29.36
51135 Nottoway	19.38	101.16	19.77
51137 Orange	18.99	100.41	19.37
51139 Page	23.77	32.54	31.89
51141 Patrick	16.45	57.74	17.23
51143 Pittsylvania	11.15	57.70	11.29
51145 Powhatan	22.60	80.33	23.59
51147 Prince Edward	20.19	59.75	21.26
51149 Prince George	22.53	102.39	22.80
51153 Prince William	26.59	50.04	31.39
51155 Pulaski	19.68	36.73	22.65
51157 Rappahannock	24.14	—	24.14
51159 Richmond	27.80	—	27.80
51161 Roanoke	25.52	46.92	30.72
51163 Rockbridge	13.15	24.52	15.55
51165 Rockingham	11.13	13.15	17.75
51167 Russell	19.07	69.35	19.92
51169 Scott	13.95	29.14	15.48
51171 Shenandoah	15.70	21.55	21.49
51173 Smyth	15.63	19.77	23.24
51175 Southampton	14.70	—	14.70
51177 Spotsylvania	19.03	51.60	20.49
51179 Stafford	21.86	50.04	24.45
51181 Surry	20.20	83.55	20.84
51183 Sussex	14.69	—	14.69
51185 Tazewell	15.07	107.07	15.20
51187 Warren	27.85	60.28	31.51
51191 Washington	15.89	32.27	18.41

Table A3.27b—Sampling error for area of timberland by county and major ownership group, Virginia, 2021 (continued)

County code and name	Major ownership group		
	Total	Public	Private
	<i>percent</i>		
51193 Westmoreland	24.99	—	24.99
51195 Wise	17.01	38.51	18.76
51197 Wythe	19.69	22.70	37.51
51199 York	39.90	47.59	72.35
51550 Chesapeake city	34.21	102.39	36.34
51650 Hampton city	102.39	—	102.39
51800 Suffolk city	19.67	—	19.67
51810 Virginia Beach city	38.80	72.35	45.85
Total	0.73	3.05	0.94

— = no sample for the cell.

Table A3.28a—Volume of live trees on timberland by county and major species group, Virginia, 2021

County code and name	Major species group		
	Total	Softwoods	Hardwoods
<i>million cubic feet</i>			
51001 Accomack	385.0	260.9	124.1
51003 Albemarle	777.2	125.2	652.0
51005 Alleghany	559.3	100.6	458.7
51007 Amelia	352.7	152.3	200.3
51009 Amherst	628.7	145.9	482.8
51011 Appomattox	331.0	75.0	256.0
51015 Augusta	729.6	129.9	599.7
51017 Bath	765.3	96.3	669.1
51019 Bedford	751.2	57.5	693.6
51021 Bland	423.9	71.5	352.5
51023 Botetourt	579.7	88.3	491.4
51025 Brunswick	656.9	352.2	304.7
51027 Buchanan	791.9	32.5	759.4
51029 Buckingham	583.0	176.3	406.6
51031 Campbell	517.7	159.9	357.8
51033 Caroline	735.8	258.0	477.8
51035 Carroll	470.6	157.2	313.4
51036 Charles City	332.7	128.9	203.8
51037 Charlotte	475.4	215.6	259.8
51041 Chesterfield	483.6	197.7	285.9
51043 Clarke	110.3	—	110.3
51045 Craig	303.9	56.9	247.0
51047 Culpeper	301.3	48.4	252.9
51049 Cumberland	292.3	119.8	172.5
51051 Dickenson	537.9	26.3	511.5
51053 Dinwiddie	584.7	329.2	255.5
51057 Essex	198.9	98.9	100.1
51059 Fairfax	125.5	6.1	119.4
51061 Fauquier	548.5	65.4	483.0
51063 Floyd	408.2	106.3	301.9

Table A3.28a—Volume of live trees on timberland by county and major species group, Virginia, 2021 (continued)

County code and name	Major species group		
	Total	Softwoods	Hardwoods
<i>million cubic feet</i>			
51065 Fluvanna	222.5	36.5	186.0
51067 Franklin	631.5	112.4	519.0
51069 Frederick	375.6	80.8	294.8
51071 Giles	530.7	14.6	516.1
51073 Gloucester	305.9	97.5	208.4
51075 Goochland	334.7	125.0	209.8
51077 Grayson	476.5	115.2	361.3
51079 Greene	180.8	3.2	177.6
51081 Greensville	356.3	163.0	193.4
51083 Halifax	980.0	554.0	426.1
51085 Hanover	538.3	209.1	329.1
51087 Henrico	117.5	37.2	80.2
51089 Henry	425.7	146.6	279.1
51091 Highland	682.1	107.0	575.1
51093 Isle of Wight	381.7	194.2	187.5
51095 James City	210.0	70.3	139.7
51097 King and Queen	380.5	167.7	212.7
51099 King George	267.0	30.2	236.8
51101 King William	257.1	91.0	166.2
51103 Lancaster	121.7	43.1	78.6
51105 Lee	434.6	22.4	412.2
51107 Loudoun	241.1	11.1	229.9
51109 Louisa	586.5	231.1	355.4
51111 Lunenburg	603.5	362.0	241.5
51113 Madison	227.9	49.0	178.8
51115 Mathews	105.9	62.5	43.3
51117 Mecklenburg	907.4	346.6	560.8
51119 Middlesex	141.7	69.3	72.4
51121 Montgomery	354.8	66.0	288.8
51125 Nelson	713.1	80.6	632.5

Table A3.28a—Volume of live trees on timberland by county and major species group, Virginia, 2021 (continued)

County code and name	Major species group		
	Total	Softwoods	Hardwoods
<i>million cubic feet</i>			
51127 New Kent	258.0	101.6	156.4
51131 Northampton	114.6	95.9	18.7
51133 Northumberland	214.9	60.5	154.4
51135 Nottoway	315.8	165.8	150.1
51137 Orange	450.0	61.1	389.0
51139 Page	194.5	16.2	178.3
51141 Patrick	597.0	61.0	536.0
51143 Pittsylvania	1,024.0	378.2	645.8
51145 Powhatan	302.5	128.8	173.7
51147 Prince Edward	342.7	174.1	168.5
51149 Prince George	263.8	145.6	118.1
51153 Prince William	266.9	22.0	244.9
51155 Pulaski	307.5	52.3	255.1
51157 Rappahannock	303.9	13.0	290.9
51159 Richmond	177.8	65.6	112.2
51161 Roanoke	176.6	28.8	147.8
51163 Rockbridge	656.3	78.7	577.5
51165 Rockingham	816.8	112.5	704.3
51167 Russell	441.6	30.8	410.8
51169 Scott	766.3	42.4	723.9
51171 Shenandoah	404.2	35.1	369.1
51173 Smyth	537.6	43.5	494.1
51175 Southampton	699.1	380.0	319.2
51177 Spotsylvania	550.8	239.3	311.5
51179 Stafford	333.9	16.4	317.5
51181 Surry	332.3	167.4	164.9
51183 Sussex	552.8	383.9	168.9
51185 Tazewell	628.4	3.5	625.0
51187 Warren	187.7	7.3	180.4
51191 Washington	696.5	43.1	653.4

Table A3.28a—Volume of live trees on timberland by county and major species group, Virginia, 2021 (continued)

County code and name	Major species group		
	Total	Softwoods	Hardwoods
<i>million cubic feet</i>			
51193 Westmoreland	243.0	70.4	172.6
51195 Wise	372.4	42.6	329.8
51197 Wythe	267.3	58.7	208.5
51199 York	146.2	39.4	106.8
51550 Chesapeake city	205.0	113.6	91.5
51650 Hampton city	13.5	6.3	7.2
51800 Suffolk city	334.9	187.6	147.3
51810 Virginia Beach city	119.3	89.4	30.0
Total	41,452	11,301	30,149

— = no sample for the cell.

Table A3.28b—Sampling error for volume of live trees on timberland by county and major species group, Virginia, 2021

County code and name	Major species group		
	Total	Softwoods	Hardwoods
	<i>percent</i>		
51001 Accomack	27.73	32.37	32.18
51003 Albemarle	15.33	28.58	16.78
51005 Alleghany	14.82	21.56	16.07
51007 Amelia	24.26	36.61	27.01
51009 Amherst	15.87	30.50	16.95
51011 Appomattox	21.59	33.05	24.48
51015 Augusta	12.16	20.38	12.87
51017 Bath	13.42	23.85	14.22
51019 Bedford	15.68	30.11	16.12
51021 Bland	18.50	34.53	19.13
51023 Botetourt	15.22	28.57	16.15
51025 Brunswick	18.54	20.72	24.13
51027 Buchanan	15.47	39.88	15.57
51029 Buckingham	16.25	27.76	18.81
51031 Campbell	19.52	26.13	23.64
51033 Caroline	17.82	25.57	21.30
51035 Carroll	18.26	28.86	18.58
51036 Charles City	28.32	42.06	31.47
51037 Charlotte	20.39	25.50	28.11
51041 Chesterfield	21.73	33.05	24.44
51043 Clarke	45.45	—	45.45
51045 Craig	17.44	25.95	18.06
51047 Culpeper	25.36	57.81	26.75
51049 Cumberland	25.83	37.70	29.40
51051 Dickenson	17.60	43.61	18.06
51053 Dinwiddie	17.87	21.41	23.06
51057 Essex	29.51	38.80	34.27
51059 Fairfax	39.97	62.54	40.63
51061 Fauquier	18.49	49.30	19.34
51063 Floyd	22.97	32.73	24.29

Table A3.28b—Sampling error for volume of live trees on timberland by county and major species group, Virginia, 2021 (continued)

County code and name	Major species group		
	Total	Softwoods	Hardwoods
	<i>percent</i>		
51065 Fluvanna	23.80	41.29	25.14
51067 Franklin	16.07	26.12	17.18
51069 Frederick	19.33	31.26	20.00
51071 Giles	17.17	37.48	17.22
51073 Gloucester	28.67	42.11	29.62
51075 Goochland	25.42	38.01	29.63
51077 Grayson	19.93	29.32	22.54
51079 Greene	37.98	97.01	38.32
51081 Greensville	26.49	37.63	27.99
51083 Halifax	14.00	17.70	18.04
51085 Hanover	18.75	23.13	22.87
51087 Henrico	33.39	40.08	33.63
51089 Henry	20.97	31.18	22.74
51091 Highland	14.82	29.29	15.56
51093 Isle of Wight	25.63	31.62	28.85
51095 James City	32.40	43.38	34.77
51097 King and Queen	20.79	28.33	26.44
51099 King George	28.72	47.20	30.26
51101 King William	26.42	38.24	31.59
51103 Lancaster	35.79	47.50	40.03
51105 Lee	21.39	49.10	21.95
51107 Loudoun	24.89	51.05	25.28
51109 Louisa	18.72	29.38	21.21
51111 Lunenburg	18.82	23.14	23.61
51113 Madison	33.10	59.46	32.55
51115 Mathews	47.78	53.46	69.59
51117 Mecklenburg	15.96	21.50	19.78
51119 Middlesex	37.58	46.97	44.97
51121 Montgomery	19.72	34.59	20.78
51125 Nelson	15.74	31.58	16.64

Table A3.28b—Sampling error for volume of live trees on timberland by county and major species group, Virginia, 2021 (continued)

County code and name	Major species group		
	Total	Softwoods	Hardwoods
	<i>percent</i>		
51127 New Kent	26.76	37.92	31.35
51131 Northampton	56.75	59.60	56.80
51133 Northumberland	30.01	42.31	31.34
51135 Nottoway	24.42	31.40	27.33
51137 Orange	21.96	40.05	23.85
51139 Page	29.43	51.83	28.48
51141 Patrick	18.21	37.63	18.46
51143 Pittsylvania	14.32	22.93	16.48
51145 Powhatan	25.83	36.87	30.02
51147 Prince Edward	24.03	32.81	28.59
51149 Prince George	26.08	33.29	28.28
51153 Prince William	28.91	63.12	29.40
51155 Pulaski	20.93	26.43	21.65
51157 Rappahannock	26.36	79.69	27.05
51159 Richmond	34.11	52.66	36.65
51161 Roanoke	28.04	38.41	30.90
51163 Rockbridge	15.18	26.84	15.98
51165 Rockingham	12.28	21.27	12.83
51167 Russell	21.14	63.48	21.56
51169 Scott	15.80	39.71	16.14
51171 Shenandoah	17.61	35.41	17.92
51173 Smyth	16.96	54.19	17.12
51175 Southampton	20.11	24.53	25.90
51177 Spotsylvania	20.73	28.24	25.10
51179 Stafford	24.06	54.12	24.43
51181 Surry	24.82	32.05	30.89
51183 Sussex	18.56	20.47	27.03
51185 Tazewell	17.37	49.41	17.40
51187 Warren	30.35	67.98	30.64
51191 Washington	17.88	35.02	18.16

Table A3.28b—Sampling error for volume of live trees on timberland by county and major species group, Virginia, 2021 (continued)

County code and name	Major species group		
	Total	Softwoods	Hardwoods
<i>percent</i>			
51193 Westmoreland	29.54	44.02	31.08
51195 Wise	20.14	35.69	20.50
51197 Wythe	21.27	31.85	22.26
51199 York	45.34	46.11	46.01
51550 Chesapeake city	37.68	40.56	43.48
51650 Hampton city	102.39	102.39	102.39
51800 Suffolk city	26.69	31.91	31.62
51810 Virginia Beach city	46.89	52.83	49.59
Total	1.28	3.13	1.55

— = no sample for the cell.

Table A3.29a—Area of forest land by county and forest-type group, Virginia, 2021

County code and name	Forest-type group															
	Total	White-red-jack pine	Spruce-fir	Longleaf-slash pine	Loblolly-shortleaf pine	Other eastern softwoods	Exotic softwoods	Oak-pine	Oak-hickory	Oak-gum-cypress	Elm-ash-cottonwood	Maple-beech-birch	Aspen-birch	Other hardwoods	Exotic hardwoods	Nonstocked
acres																
51001 Accomack	103,667	—	—	—	64,166	—	—	11,481	17,527	10,493	—	—	—	—	—	—
51003 Albemarle	294,222	4,259	—	—	33,997	4,169	—	28,458	213,181	—	10,159	—	—	—	—	—
51005 Alleghany	249,916	7,809	—	—	21,357	—	—	27,796	166,089	—	9,050	14,979	—	2,837	—	—
51007 Amelia	153,324	—	—	—	58,491	—	—	13,278	60,607	—	15,048	—	—	—	—	5,901
51009 Amherst	239,887	11,758	—	—	37,716	—	—	17,697	166,925	2,705	1,616	—	—	1,470	—	—
51011 Appomattox	134,664	—	—	—	33,825	—	—	11,803	83,958	—	5,028	—	—	—	—	50
51015 Augusta	333,455	9,365	—	—	6,569	1,383	—	56,871	255,453	—	—	2,267	—	—	—	1,548
51017 Bath	292,570	9,944	—	—	17,233	—	—	17,421	244,393	—	—	3,579	—	—	—	—
51019 Bedford	292,794	—	—	—	9,807	—	—	21,647	259,865	—	—	—	—	1,475	—	—
51021 Bland	164,192	6,183	—	—	2,029	—	—	12,367	138,011	—	—	5,601	—	—	—	—
51023 Botetourt	261,629	—	—	—	22,867	—	—	22,331	204,098	—	8,997	1,581	—	1,756	—	—
51025 Brunswick	262,573	—	—	—	141,317	—	—	33,434	65,332	18,907	1,435	—	—	—	—	2,147
51027 Buchanan	295,214	1,368	—	—	4,103	—	—	1,665	229,630	—	5,471	46,962	—	4,552	1,463	—
51029 Buckingham	321,356	—	—	—	87,300	—	—	39,222	178,598	—	5,901	—	—	—	—	10,335
51031 Campbell	224,448	—	—	—	65,122	—	—	32,066	120,526	—	6,735	—	—	—	—	—
51033 Caroline	250,054	—	—	—	67,336	—	—	53,555	102,975	10,046	10,046	—	—	1,524	4,573	—
51035 Carroll	191,981	14,598	—	—	13,712	—	—	31,338	112,726	—	3,092	6,101	—	10,413	—	—
51036 Charles City	93,675	—	—	—	35,706	—	—	7,207	33,179	10,319	7,265	—	—	—	—	—
51037 Charlotte	215,034	—	—	—	88,604	—	—	26,578	85,110	—	10,258	—	—	—	4,484	—
51041 Chesterfield	146,888	—	—	—	48,821	—	—	13,608	65,802	17,683	974	—	—	—	—	—
51043 Clarke	30,813	—	—	—	—	—	—	—	30,813	—	—	—	—	—	—	—
51045 Craig	164,931	—	—	—	16,041	3,165	—	20,050	125,675	—	—	—	—	—	—	—
51047 Culpeper	100,744	—	—	—	5,879	6,955	—	6,983	73,432	—	7,495	—	—	—	—	—
51049 Cumberland	116,466	—	—	—	34,674	—	—	23,197	56,946	—	1,649	—	—	—	—	—
51051 Dickenson	196,462	3,627	—	—	—	—	—	4,460	160,632	—	1,463	26,280	—	—	—	—
51053 Dinwiddie	236,674	—	—	—	111,406	—	—	39,341	55,496	16,167	14,263	—	—	—	—	—

Table A3.29a—Area of forest land by county and forest-type group, Virginia, 2021 (continued)

County code and name	Forest-type group														Total
	White-red-jack pine	Spruce-fir	Longleaf-slash pine	Loblolly-shortleaf pine	Other eastern softwoods	Exotic softwoods	Oak-pine	Oak-hickory	Oak-gum-cypress	Elm-ash-cottonwood	Maple-beech-birch	Aspen-birch	Other hardwoods	Exotic hardwoods	
	acres														
51057 Essex	86,767	—	—	39,694	—	—	11,408	29,924	—	5,740	—	—	—	—	—
51059 Fairfax	74,287	—	—	4,701	3,017	—	—	54,151	—	9,094	—	—	—	—	3,323
51061 Fauquier	216,376	—	—	14,697	1,470	—	3,289	186,544	—	8,906	—	—	—	—	1,470
51063 Floyd	122,176	11,019	—	2,707	—	—	18,349	83,917	—	—	—	—	6,183	—	—
51065 Fluvanna	99,911	—	—	15,400	—	—	9,569	66,064	1,542	7,336	—	—	—	—	—
51067 Franklin	264,702	1,684	—	30,183	—	—	28,735	196,791	2,951	—	—	—	1,441	1,441	1,475
51069 Frederick	165,653	3,579	—	11,471	—	—	10,459	140,144	—	—	—	—	—	—	—
51071 Giles	204,234	—	—	—	—	—	—	167,294	—	—	36,940	—	—	—	—
51073 Gloucester	88,833	—	—	20,416	—	—	11,481	54,065	—	2,870	—	—	—	—	—
51075 Goochland	109,444	—	—	32,773	—	—	18,148	55,795	—	2,728	—	—	—	—	—
51077 Grayson	163,934	21,480	—	—	—	—	8,344	110,613	—	1,850	17,500	—	4,147	—	—
51079 Greene	73,990	—	—	1,470	—	—	—	71,050	—	1,470	—	—	—	—	—
51081 Greensville	126,715	—	—	45,923	—	—	25,097	29,560	13,648	11,659	—	—	—	—	829
51083 Halifax	379,860	—	—	156,847	1,898	—	61,024	135,018	11,803	13,270	—	—	—	—	—
51085 Hanover	181,677	—	—	55,727	—	—	38,748	84,744	—	—	—	—	—	—	2,459
51087 Henrico	63,221	—	—	8,528	—	—	8,510	31,832	5,740	8,611	—	—	—	—	—
51089 Henry	190,409	—	—	59,345	—	—	30,982	95,164	—	4,164	—	—	—	—	754
51091 Highland	232,628	15,376	—	—	—	—	18,254	164,254	—	—	32,454	—	1,581	—	709
51093 Isle of Wight	116,976	—	—	49,599	—	—	18,672	27,686	14,505	5,079	—	—	—	—	1,435
51095 James City	60,369	—	—	12,916	—	—	13,242	29,906	—	4,305	—	—	—	—	—
51097 King and Queen	137,605	—	—	58,839	—	—	23,318	39,661	4,305	11,481	—	—	—	—	—
51099 King George	74,877	—	—	6,228	—	—	11,481	57,168	—	—	—	—	—	—	—
51101 King William	110,983	—	—	39,439	—	—	22,924	45,242	3,378	—	—	—	—	—	—
51103 Lancaster	45,412	—	—	14,695	—	—	6,610	24,107	—	—	—	—	—	—	—
51105 Lee	183,354	1,463	—	—	12,532	—	5,852	149,594	—	4,638	6,183	—	—	3,092	—
51107 Loudoun	98,359	—	—	—	—	—	4,333	84,131	—	4,409	—	—	5,486	—	—
51109 Louisa	201,872	—	—	55,061	—	—	24,808	103,854	1,470	12,964	—	—	—	—	3,715

County code and name	Total	Forest-type group														
		White-red-jack pine	Spruce-fir	Longleaf-slash pine	Loblolly-shortleaf pine	Other eastern softwoods	Exotic softwoods	Oak-pine	Oak-hickory	Oak-gum-cypress	Elm-ash-cottonwood	Maple-beech-birch	Aspen-birch	Other hardwoods	Exotic hardwoods	Nonstocked
acres																
51111 Lunenburg	244,236	—	—	—	125,030	—	—	32,266	70,668	1,475	14,797	—	—	—	—	—
51113 Madison	94,390	—	—	—	—	—	—	16,425	76,496	—	—	—	—	1,470	—	—
51115 Mathews	26,296	—	—	—	16,274	—	—	5,227	—	4,796	—	—	—	—	—	—
51117 Mecklenburg	304,582	—	—	—	118,127	—	—	26,515	147,272	2,916	9,752	—	—	—	—	—
51119 Middlesex	49,710	—	—	—	16,539	—	—	2,491	24,939	5,740	—	—	—	—	—	—
51121 Montgomery	168,627	12,997	—	—	6,893	1,546	—	24,078	103,349	—	5,852	13,913	—	—	—	—
51125 Nelson	256,323	—	—	—	28,918	—	—	24,835	200,554	—	1,913	—	—	—	—	103
51127 New Kent	81,935	—	—	—	21,837	—	—	10,280	49,818	—	—	—	—	—	—	—
51131 Northampton	26,205	—	—	—	16,681	—	—	5,740	—	—	3,784	—	—	—	—	—
51133 Northumberland	61,658	—	—	—	17,221	—	—	13,296	27,382	2,870	888	—	—	—	—	—
51135 Nottoway	146,630	—	—	—	48,749	—	—	29,106	51,744	—	11,130	—	—	—	—	5,901
51137 Orange	140,835	—	—	—	9,534	5,152	—	5,406	109,997	5,879	4,867	—	—	—	—	—
51139 Page	111,706	—	—	—	—	—	—	—	105,383	—	—	6,324	—	—	—	—
51141 Patrick	206,985	3,264	—	—	2,916	—	—	28,987	171,817	—	—	—	—	—	—	—
51143 Pittsylvania	400,204	—	—	—	137,749	—	—	44,518	183,340	10,327	22,794	—	—	—	—	1,475
51145 Powhatan	103,794	—	—	—	32,508	4,298	—	4,239	59,680	3,069	—	—	—	—	—	—
51147 Prince Edward	136,264	—	—	—	45,845	—	—	32,535	41,809	—	10,512	—	—	—	—	5,562
51149 Prince George	106,195	—	—	—	38,132	—	—	15,786	34,124	18,153	—	—	—	—	—	—
51153 Prince William	86,339	—	—	—	7,349	—	—	—	77,520	—	—	—	1,470	—	—	—
51155 Pulaski	121,944	1,463	—	—	2,837	822	—	8,827	107,995	—	—	—	—	—	—	—
51157 Rappahannock	136,766	4,967	—	—	—	—	—	—	125,920	—	—	—	—	5,879	—	—
51159 Richmond	79,070	—	—	—	33,275	—	—	1,435	40,055	4,305	—	—	—	—	—	—
51161 Roanoke	85,052	2,520	—	—	10,966	—	—	7,967	57,276	—	—	—	—	—	6,324	—
51163 Rockbridge	284,677	1,418	—	—	1,335	15,237	—	29,782	226,040	—	5,401	5,465	—	—	—	—
51165 Rockingham	364,977	3,737	—	—	2,476	12,375	4,157	33,553	284,063	—	12,682	11,039	—	895	—	—

Table A3.29a—Area of forest land by county and forest-type group, Virginia, 2021 (continued)

County code and name	Forest-type group															
	Total	White-red-jack pine	Spruce-fir	Longleaf-slash pine	Loblolly-shortleaf pine	Other eastern softwoods	Exotic softwoods	Oak-pine	Oak-hickory	Oak-gum-cypress	Elm-ash-cottonwood	Maple-beech-birch	Aspen-birch	Other hardwoods	Exotic hardwoods	Nonstocked
acres																
51167 Russell	145,193	—	6,183	—	—	—	—	—	110,040	—	—	27,549	—	—	—	1,420
51169 Scott	258,922	—	—	—	—	6,183	—	3,092	225,082	—	—	14,456	—	—	—	10,108
51171 Shenandoah	191,149	—	—	—	11,528	—	—	4,103	171,325	—	3,299	—	—	895	—	—
51173 Smyth	184,035	4,108	—	—	739	1,368	—	2,705	157,700	—	2,542	10,483	—	—	—	4,389
51175 Southampton	247,484	—	—	—	118,180	—	—	41,349	29,281	39,214	7,176	—	—	—	—	12,284
51177 Spotsylvania	149,142	—	—	—	51,570	—	—	24,079	67,614	—	5,879	—	—	—	—	—
51179 Stafford	115,113	—	—	—	9,472	—	—	2,939	99,470	—	3,232	—	—	—	—	—
51181 Surry	138,206	—	—	—	72,594	—	—	23,534	22,340	19,738	—	—	—	—	—	—
51183 Sussex	257,698	—	—	10,313	145,410	—	—	20,520	36,086	36,986	8,200	—	—	—	—	183
51185 Tazewell	232,565	—	—	—	—	—	—	—	183,692	4,638	—	42,815	—	—	—	1,420
51187 Warren	84,964	—	—	—	—	—	—	—	77,440	—	7,525	—	—	—	—	—
51191 Washington	200,370	1,546	—	—	—	—	—	333	189,981	—	—	8,510	—	—	—	—
51193 Westmoreland	87,746	—	—	—	11,165	—	—	20,780	54,408	—	—	—	—	—	1,392	—
51195 Wise	164,926	4,314	—	—	—	—	—	18,734	119,042	—	—	11,946	—	6,183	—	4,706
51197 Wythe	113,209	9,192	—	—	676	—	—	24,408	78,932	—	—	—	—	—	—	—
51199 York	42,834	—	—	—	8,315	—	—	9,811	24,708	—	—	—	—	—	—	—
51550 Chesapeake city	94,861	—	—	—	35,085	—	—	23,898	12,916	17,221	5,740	—	—	—	—	—
51650 Hampton city	1,297	—	—	—	—	—	—	1,297	—	—	—	—	—	—	—	—
51700 Newport News city	5,740	—	—	—	5,740	—	—	—	—	—	—	—	—	—	—	—
51800 Suffolk city	176,494	—	—	—	67,018	—	—	30,528	35,582	41,842	1,524	—	—	—	—	—
51810 Virginia Beach city	35,841	—	—	—	15,786	—	—	5,425	—	10,325	4,305	—	—	—	—	—
Total	15,995,448	173,038	6,183	10,313	3,059,210	81,570	4,157	1,668,319	9,698,136	375,156	400,312	352,927	1,470	58,187	22,768	83,702

— = no sample for the cell.

Table A3.29b—Sampling error for area of forest land by county and forest-type group, Virginia, 2021

County code and name	Total	Forest-type group														
		White-red-jack pine	Spruce-fir	Longleaf-slash pine	Loblolly-shortleaf pine	Other eastern softwoods	Exotic softwoods	Oak-pine	Oak-hickory	Oak-gum-cypress	Elm-ash-cottonwood	Maple-beech-birch	Aspen-birch	Other hardwoods	Exotic hardwoods	Nonstocked
		percent														
51001 Accomack	22.75	—	—	—	29.48	—	—	72.35	47.67	72.67	—	—	—	—	—	—
51003 Albemarle	13.12	100.41	—	—	38.51	100.41	—	43.16	15.51	—	71.15	—	—	—	—	—
51005 Alleghany	12.65	55.57	—	—	42.81	—	—	39.63	14.82	—	61.21	60.60	—	104.65	—	—
51007 Amelia	18.86	—	—	—	30.04	—	—	64.48	28.15	—	54.87	—	—	—	—	101.16
51009 Amherst	14.08	58.75	—	—	38.05	—	—	46.84	16.58	107.07	95.97	—	—	100.41	—	—
51011 Appomattox	19.53	—	—	—	36.67	—	—	64.39	23.62	—	77.35	—	—	—	—	102.57
51015 Augusta	10.60	56.73	—	—	58.76	106.83	—	26.82	12.09	—	—	76.46	—	—	—	99.45
51017 Bath	11.42	66.88	—	—	43.30	—	—	48.05	12.59	—	—	93.06	—	—	—	—
51019 Bedford	13.00	—	—	—	71.80	—	—	45.83	13.68	—	—	—	—	101.16	—	—
51021 Bland	16.17	97.89	—	—	107.07	—	—	69.13	17.33	—	—	87.67	—	—	—	—
51023 Botetourt	13.25	—	—	—	44.24	—	—	40.79	15.02	—	73.82	97.83	—	104.65	—	—
51025 Brunswick	14.49	—	—	—	19.36	—	—	38.29	27.24	48.23	102.39	—	—	—	—	102.39
51027 Buchanan	13.14	104.14	—	—	104.14	—	—	100.99	14.90	—	104.14	33.82	—	100.99	100.99	—
51029 Buckingham	12.78	—	—	—	24.65	—	—	36.96	17.05	—	79.93	—	—	—	—	72.14
51031 Campbell	15.62	—	—	—	28.05	—	—	40.90	20.78	—	95.02	—	—	—	—	—
51033 Caroline	14.67	—	—	—	28.44	—	—	31.22	22.84	73.08	73.08	—	—	99.46	99.46	—
51035 Carroll	15.71	53.51	—	—	58.54	—	—	37.37	20.53	—	97.89	78.26	—	63.89	—	—
51036 Charles City	23.98	—	—	—	40.33	—	—	67.58	39.47	72.05	83.55	—	—	—	—	—
51037 Charlotte	15.94	—	—	—	23.33	—	—	43.28	24.04	—	62.30	—	—	—	95.02	—
51041 Chesterfield	18.69	—	—	—	32.76	—	—	56.76	27.42	51.13	102.39	—	—	—	—	—
51043 Clarke	41.35	—	—	—	—	—	—	—	41.35	—	—	—	—	—	—	—
51045 Craig	14.62	—	—	—	55.83	99.45	—	44.19	16.07	—	—	—	—	—	—	—
51047 Culpeper	23.14	—	—	—	100.41	79.94	—	83.31	27.33	—	81.44	—	—	—	—	—
51049 Cumberland	21.92	-	—	—	35.61	—	—	47.05	30.62	—	101.16	—	—	—	—	—
51051 Dickenson	16.15	100.99	—	—	—	—	—	100.99	17.59	—	100.99	42.46	—	—	—	—
51053 Dinwiddie	15.20	—	—	—	21.88	—	—	37.28	29.46	55.58	61.52	—	—	—	—	—
51057 Essex	25.28	—	—	—	36.50	—	—	72.35	41.14	—	102.39	—	—	—	—	—
51059 Fairfax	26.36	—	—	—	73.05	95.97	—	—	30.88	—	73.77	—	—	—	—	100.41

Table A3.29b—Sampling error for area of forest land by county and forest-type group, Virginia, 2021 (continued)

County code and name	Total	Forest-type group														
		White-red-jack pine	Spruce-fir	Longleaf-slash pine	Loblolly-shortleaf pine	Other eastern softwoods	Exotic softwoods	Oak-pine	Oak-hickory	Oak-gum-cypress	Elm-ash-cottonwood	Maple-beech-birch	Aspen-birch	Other hardwoods	Exotic hardwoods	Nonstocked
		percent														
51061 Fauquier	15.45	—	—	—	60.13	100.41	—	100.41	16.45	—	70.32	—	—	—	—	100.41
51063 Floyd	20.60	54.86	—	—	97.89	—	—	48.82	25.27	—	—	—	—	97.89	—	—
51065 Fluvanna	22.33	—	—	—	56.25	—	—	67.05	27.37	95.97	81.22	—	—	—	—	—
51067 Franklin	13.86	95.02	—	—	37.56	—	—	41.79	16.12	101.16	—	—	—	102.57	102.57	101.16
51069 Frederick	17.61	93.06	—	—	61.75	—	—	69.27	19.18	—	—	—	—	—	—	—
51071 Giles	14.56	—	—	—	—	—	—	—	15.75	—	—	38.54	—	—	—	—
51073 Gloucester	24.77	—	—	—	51.49	—	—	65.19	31.25	—	102.39	—	—	—	—	—
51075 Goochland	22.21	—	—	—	39.85	—	—	52.63	29.88	—	100.41	—	—	—	—	—
51077 Grayson	16.84	40.33	—	—	—	—	—	65.27	21.16	—	104.14	47.90	—	69.98	—	—
51079 Greene	27.57	—	—	—	100.41	—	—	—	27.67	—	100.41	—	—	—	—	—
51081 Greensville	20.73	—	—	—	32.26	—	—	46.19	37.61	51.00	66.87	—	—	—	—	102.39
51083 Halifax	11.68	—	—	—	17.89	101.16	—	29.11	18.55	71.46	51.10	—	—	—	—	—
51085 Hanover	16.94	—	—	—	28.87	—	—	36.39	24.66	—	—	—	—	—	—	102.39
51087 Henrico	27.92	—	—	—	72.32	—	—	76.64	38.76	102.39	72.35	—	—	—	—	—
51089 Henry	16.85	—	—	—	29.33	—	—	42.08	23.61	—	75.31	—	—	—	—	101.16
51091 Highland	14.06	54.09	—	—	—	—	—	39.62	16.97	—	—	35.71	—	97.83	—	104.65
51093 Isle of Wight	21.55	—	—	—	31.07	—	—	45.58	41.07	57.47	102.39	—	—	—	—	102.39
51095 James City	30.31	—	—	—	65.28	—	—	59.73	42.19	—	102.39	—	—	—	—	—
51097 King and Queen	20.20	—	—	—	30.87	—	—	48.35	36.16	102.39	72.35	—	—	—	—	—
51099 King George	26.61	—	—	—	65.63	—	—	72.35	30.91	—	—	—	—	—	—	—
51101 King William	21.91	—	—	—	35.75	—	—	46.67	32.43	74.28	—	—	—	—	—	—
51103 Lancaster	32.94	—	—	—	58.17	—	—	75.15	46.06	—	—	—	—	—	—	—
51105 Lee	16.62	100.99	—	—	—	59.13	—	100.99	18.43	—	97.89	97.89	—	—	97.89	—
51107 Loudoun	22.79	—	—	—	—	—	—	100.41	24.77	—	100.41	—	—	104.24	—	—
51109 Louisa	15.87	—	—	—	29.46	—	—	45.91	21.68	100.41	64.97	—	—	—	—	72.46
51111 Lunenburg	15.10	—	—	—	20.59	—	—	39.47	26.34	101.16	51.70	—	—	—	—	—

Table A3.29b—Sampling error for area of forest land by county and forest-type group, Virginia, 2021 (continued)

County code and name	Total	Forest-type group														
		White-red-jack pine	Spruce-fir	Longleaf-slash pine	Loblolly-shortleaf pine	Other eastern softwoods	Exotic softwoods	Oak-pine	Oak-hickory	Oak-gum-cypress	Elm-ash-cottonwood	Maple-beech-birch	Aspen-birch	Other hardwoods	Exotic hardwoods	Nonstocked
		percent														
51113 Madison	23.92	—	—	—	—	—	57.43	26.44	—	—	—	—	100.41	—	—	
51115 Mathews	45.80	—	—	—	59.23	—	102.39	—	102.39	—	—	—	—	—	—	
51117 Mecklenburg	13.08	—	—	—	20.36	—	43.06	17.95	72.03	71.77	—	—	—	—	—	
51119 Middlesex	33.15	—	—	—	55.09	—	102.39	45.92	80.91	—	—	—	—	—	—	
51121 Montgomery	17.44	56.95	—	—	88.48	97.89	45.36	21.84	—	100.99	62.36	—	—	—	—	
51125 Nelson	14.07	—	—	—	41.51	—	45.38	16.02	—	100.41	—	—	—	—	100.41	
51127 New Kent	25.65	—	—	—	45.14	—	72.84	32.58	—	—	—	—	—	—	—	
51131 Northampton	45.93	—	—	—	58.66	—	102.39	—	—	102.39	—	—	—	—	—	
51133 Northumberland	29.36	—	—	—	53.99	—	60.94	42.39	102.39	99.46	—	—	—	—	—	
51135 Nottoway	19.38	—	—	—	33.01	—	40.59	28.64	—	64.88	—	—	—	—	101.16	
51137 Orange	18.99	—	—	—	57.30	100.41	77.99	21.43	100.41	100.41	—	—	—	—	—	
51139 Page	21.22	—	—	—	—	—	—	21.79	—	—	97.83	—	—	—	—	
51141 Patrick	16.20	101.16	—	—	72.03	—	42.94	17.70	—	—	—	—	—	—	—	
51143 Pittsylvania	11.15	—	—	—	19.65	—	32.03	16.20	66.14	50.17	—	—	—	—	101.16	
51145 Powhatan	22.60	—	—	—	40.17	95.02	67.70	29.82	101.16	—	—	—	—	—	—	
51147 Prince Edward	20.19	—	—	—	30.80	—	38.73	33.77	—	65.77	—	—	—	—	101.16	
51149 Prince George	22.53	—	—	—	37.21	—	59.51	36.61	53.62	—	—	—	—	—	—	
51153 Prince William	24.08	—	—	—	82.76	—	—	25.25	—	—	—	100.41	—	—	—	
51155 Pulaski	19.64	100.99	—	—	104.65	104.14	63.60	21.01	—	—	—	—	—	—	—	
51157 Rappahannock	20.12	100.41	—	—	—	—	—	21.06	—	—	—	—	100.41	—	—	
51159 Richmond	26.80	—	—	—	40.09	—	102.39	36.27	102.39	—	—	—	—	—	—	
51161 Roanoke	24.90	97.83	—	—	61.29	—	80.09	30.12	—	—	—	—	—	97.83	—	
51163 Rockbridge	12.49	104.65	—	—	106.83	59.43	38.15	14.17	—	72.36	73.99	—	—	—	—	
51165 Rockingham	10.67	89.21	—	—	70.95	65.33	33.07	11.80	—	63.60	49.39	—	93.06	—	—	

Table A3.29b—Sampling error for area of forest land by county and forest-type group, Virginia, 2021 (continued)

County code and name	Forest-type group														Total
	White-red-jack pine	Spruce-fir	Longleaf-slash pine	Loblolly-shortleaf pine	Other eastern softwoods	Exotic softwoods	Oak-pine	Oak-hickory	Oak-gum-cypress	Elm-ash-cottonwood	Maple-beech-birch	Aspen-birch	Other hardwoods	Exotic hardwoods	
	<i>percent</i>														
51167 Russell	—	97.89	—	—	—	—	—	21.87	—	—	44.29	—	—	—	102.17
51169 Scott	—	—	—	—	97.89	—	97.89	14.83	—	—	52.32	—	—	—	65.54
51171 Shenandoah	—	—	—	72.79	—	—	70.82	16.33	—	106.83	—	—	93.06	—	—
51173 Smyth	97.89	—	—	97.89	104.14	—	107.07	16.28	—	100.99	65.84	—	—	—	100.99
51175 Southampton	—	—	—	21.49	—	—	36.88	39.55	35.52	84.40	—	—	—	—	58.62
51177 Spotsylvania	—	—	—	29.63	—	—	45.33	27.24	—	100.41	—	—	—	—	—
51179 Stafford	—	—	—	58.12	—	—	100.41	22.63	—	95.97	—	—	—	—	—
51181 Surry	—	—	—	28.09	—	—	48.25	48.51	51.61	—	—	—	—	—	—
51183 Sussex	—	—	72.06	18.77	—	—	45.68	36.19	36.16	75.28	—	—	—	—	102.39
51185 Tazewell	—	—	—	—	—	—	—	16.57	97.89	—	33.65	—	—	—	102.17
51187 Warren	—	—	—	—	—	—	—	25.34	—	83.98	—	—	—	—	—
51191 Washington	97.89	—	—	—	—	—	104.14	16.20	—	—	62.60	—	—	—	—
51193 Westmoreland	—	—	—	67.31	—	—	51.89	29.90	—	—	—	—	—	104.06	—
51195 Wise	17.01	75.47	—	—	—	—	52.41	19.58	—	—	61.62	—	97.89	—	100.99
51197 Wythe	19.29	69.71	—	107.07	—	—	43.82	21.53	—	—	—	—	—	—	—
51199 York	34.89	—	—	75.06	—	—	73.39	46.83	—	—	—	—	—	—	—
51550 Chesapeake city	24.66	—	—	39.57	—	—	49.23	61.18	59.03	102.39	—	—	—	—	—
51650 Hampton city	102.39	—	—	—	—	—	102.39	—	—	—	—	—	—	—	—
51700 Newport News city	102.39	—	—	102.39	—	—	—	—	—	—	—	—	—	—	—
51800 Suffolk city	17.68	—	—	29.40	—	—	42.00	38.09	36.64	99.46	—	—	—	—	—
51810 Virginia Beach city	37.74	—	—	59.51	—	—	84.26	—	63.04	102.39	—	—	—	—	—
Total	0.62	14.53	97.89	72.06	3.50	23.26	106.83	5.09	1.38	10.97	10.50	11.12	100.41	26.66	22.06

— = no sample for the cell.

Brandeis, T.J.; Hartsell, A.J.; Randolph, K.C.; Durham, W.P.; Oswalt, C.M. 2024. Virginia's Forests, 2021. Resour. Bull. SRS-240. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station. 136 p. <https://doi.org/10.2737/SRS-RB-240>.

As in the previous reports on the status of Virginia's forests, forest land and timberland acreage remains stable. There is a gradual increase in the proportion of stands comprised of larger trees, and with that, more wood volume than previously and a greater percentage of that volume in is sawtimber-sized trees. Hardwood average annualized growth had been increasing during the previous three periods of annualized forest inventory but now shows little change since 2016. Softwood growth, however, continues to increase. Removals in both softwood and hardwood species groups have begun to increase after a period of decline, with annualized removals of softwoods now exceeding that observed in 2007. Although the number of wood processing mills has fluctuated (particularly for hardwood sawmills), Virginia's forests support a forest products industry that includes a diverse mix of mills, ranging from small- to large-sized softwood and hardwood sawmills, pole, veneer, composite, bioenergy, and other miscellaneous mills to very large pulpmills. Since the 2007 inventory, natural mortality has remained consistently low and is relatively unchanging in softwoods but hardwood mortality shows a gradual increase. The increase in hardwood mortality is important to note. Insect damage was the predominate disturbance impacting Virginia's forests from 2017 to 2021, with insects and diseases affecting American beech, eastern white pine, elm, sassafras, and redbay in particular.

Keywords: Disturbance, carbon, FIA, forest health monitoring, forest inventory, forest trends, timber volume, Virginia.



In accordance with Federal civil rights law and U.S. Department of Agriculture (USDA) civil rights regulations and policies, the USDA, its Agencies, offices, and employees, and institutions participating in or administering USDA programs are prohibited from discriminating based on race, color, national origin, religion, sex, gender identity (including gender expression), sexual orientation, disability, age, marital status, family/parental status, income derived from a public assistance program, political beliefs, or reprisal or retaliation for prior civil rights activity, in any program or activity conducted or funded by USDA (not all bases apply to all programs). Remedies and complaint filing deadlines vary by program or incident.

Persons with disabilities who require alternative means of communication for program information (e.g., Braille, large print, audiotape, American Sign Language, etc.) should contact the responsible Agency or USDA's TARGET Center at (202) 720-2600 (voice and TTY) or contact USDA through the Federal Relay Service at (800) 877-8339. Additionally, program information may be made available in languages other than English.

To file a program discrimination complaint, complete the USDA Program Discrimination Complaint Form, AD-3027, found online at <https://www.usda.gov/oascr/filing-program-discrimination-complaint-usda-customer> and at any USDA office or write a letter addressed to USDA and provide in the letter all of the information requested in the form. To request a copy of the complaint form, call (866) 632-9992. Submit your completed form or letter to USDA by: (1) mail: U.S. Department of Agriculture, Office of the Assistant Secretary for Civil Rights, 1400 Independence Avenue, SW, Washington, D.C. 20250-9410; (2) fax: (202) 690-7442; or (3) email: program.intake@usda.gov.

USDA is an equal opportunity provider, employer, and lender.

