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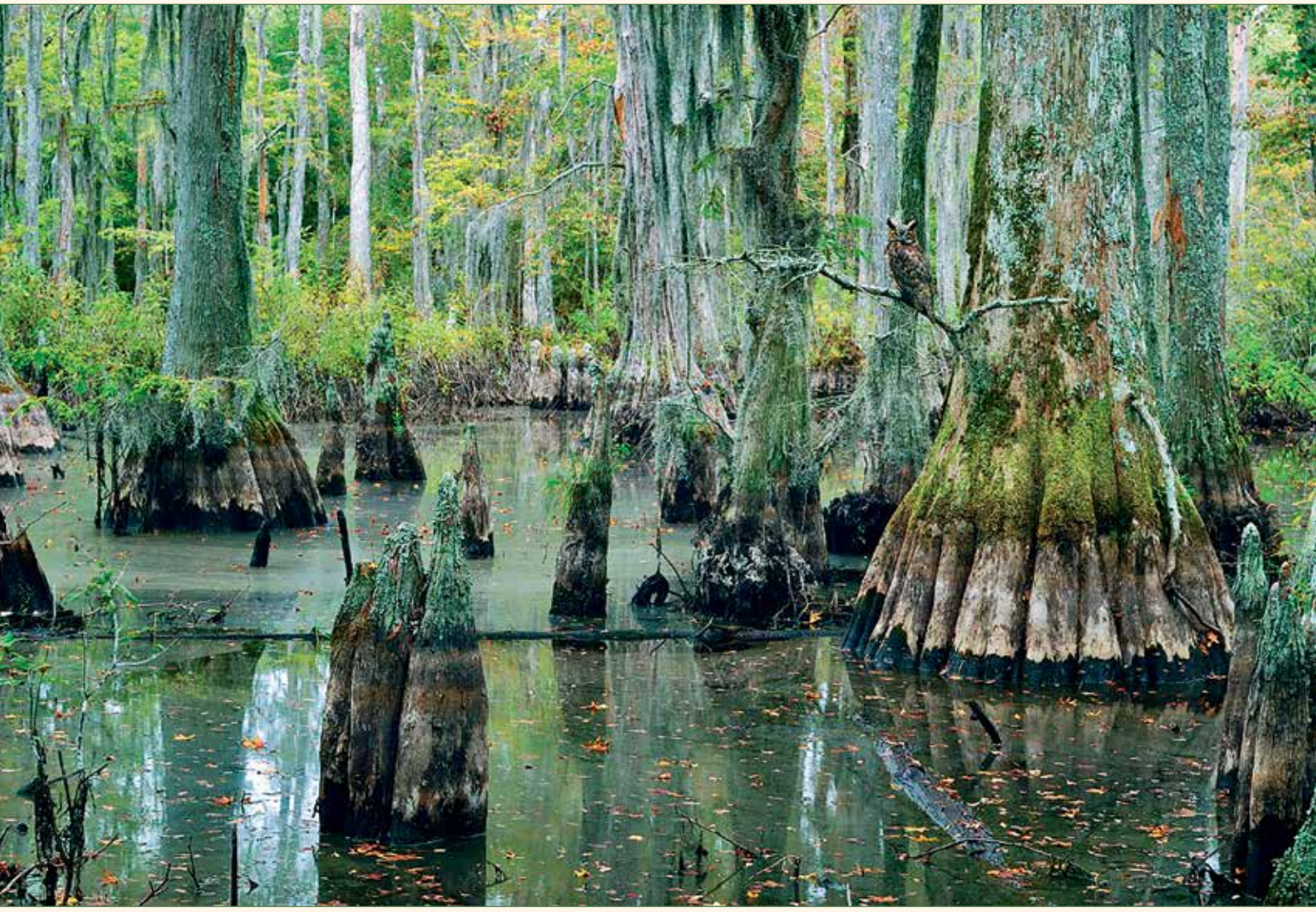
Status and Trends of Bottomland Hardwood Forests in the Mid-Atlantic Region

Anita K. Rose and James S. Meadows



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Cover photo: Maritime swamp with baldcypress, First Landing State Park, Virginia Beach City, VA. (photo© Gary P. Fleming)

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Abstract

Bottomland hardwood forests cover approximately 2.9 million acres of the Coastal Plain and Piedmont region of Virginia and North Carolina. As of 2014, 59 percent of bottomland hardwood forests were in the large-diameter stand-size class. Between 2002 and 2014, area of large-diameter sized stands increased, while that of medium- and small-diameter stands decreased, indicating that the resource is maturing. While total volume of live trees remained steady over the period studied (2002–2014), there were increases in volume for some individual species (for example, white oak) and decreases in volume for others (for example, red oak). Bottomland hardwood forests in the mid-Atlantic support a wide range of tree species. Mortality was at an all-time high in these forests around 2005, but has steadily decreased since then. The Forest Service's Forest Inventory and Analysis program is the only entity that conducts forest assessments across all land in the United States. Increasing demands on the resource and anthropogenic-related impacts on forests have intensified the need to conduct ecosystem-based inventories such as these.

Keywords: Cypress, FIA, forested wetlands, Forest Inventory and Analysis, North Carolina, Virginia.

INTRODUCTION

We used data collected by the U.S. Department of Agriculture Forest Service, Forest Inventory and Analysis (FIA) program to provide an overview of the bottomland hardwood forest resources in the mid-Atlantic region. For the purposes of this report, the mid-Atlantic region was defined as the Piedmont and Coastal Plain of Virginia and North Carolina, not including the northern Piedmont of Virginia (fig. 1). Data were summarized for both the entire area of interest (AOI) and for bottomland hardwood (BLHW) forests, which we defined as plots classified as either the oak / gum / cypress (OGC) forest-type group or the elm / ash / cottonwood (EAC) forest-type group within the AOI. While BLHW forests can be defined in a number of different ways, for simplicity sake we chose to use the forest-type group classification. A discussion of the issues

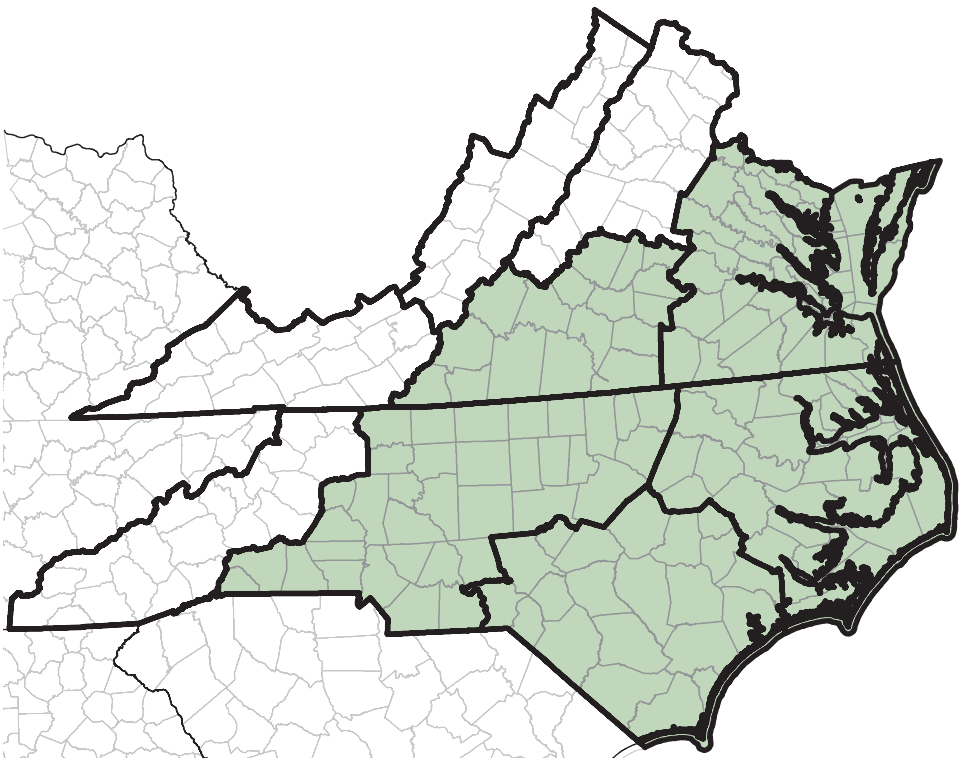

Figure 1—The mid-Atlantic region of interest (in green), which includes the Piedmont and Coastal Plain of Virginia and North Carolina.

surrounding forest-type data reduction can be found in Rose and others (2015). In addition, while not technically a hardwood, cypress was included in the analysis of BLHW.

Total land area, not including census water and non-census water, in the AOI was 37.2 million acres, of which 59 percent was forested as of 2014. Live net volume totaled 45.3 billion cubic feet. BLHW forests occupied 13.3 percent of the total forest land area in the AOI and accounted for 14.8 percent of the live volume.

Definitions of FIA terminology can be found in the FIADB user's manual at http://fia.fs.fed.us/tools-data/docs/default.asp. Additional information about data collection can be found in the FIA field guide at http://www.fia.fs.fed.us/library/field-guides-methods-proc/index.php, as well as the most recent reports for Virginia (Rose 2013) and North Carolina (Brown and Vogt 2015).

FOREST AREA

Total land area in the mid-Atlantic region, not including census water and non-census water, was 37.2 million acres, of which, 59 percent was forested (22.1 million acres) as of 2014 (table 1). The loblolly / shortleaf forest-type group was most prevalent in the AOI at 8.1 million acres (37 percent of the total). BLHW forests occupied 2.9 million acres, or 13.3 percent of the total.

A majority of stands of all forest-type groups in the AOI were in the large-diameter stand-size class (table 1). Just under 60 percent of both OGC and EAC stands were in the large-diameter stand-size class (fig. 2). Oak / pine stands had the most even distribution across the stand-size classes.

In contrast to all other forest-type groups combined, BLHW stands were fairly evenly distributed across

Table 1—Area of forest land and net volume of live trees by forest-type group and stand-size class (large-, medium-, and small-diameter) for the mid-Atlantic region, 2014

	Area of forest land				Live net volume on forest land			
Forest-type group	Total[a]	Large-diameter	Medium-diameter	Small-diameter	Total[a]	Large-diameter	Medium-diameter	Small-diameter
	million acres				*billion cubic feet*			
Loblolly / shortleaf pine	8.12	3.97	2.60	1.55	16.40	12.24	3.90	0.25
Oak / hickory	7.24	4.30	1.41	1.54	16.21	13.76	2.09	0.37
Oak / pine	3.10	1.43	0.64	1.04	5.33	4.27	0.89	0.18
Oak / gum / cypress	2.17	1.27	0.40	0.51	5.10	4.35	0.63	0.11
Elm / ash / cottonwood	0.77	0.46	0.10	0.21	1.61	1.46	0.12	0.03
Longleaf / slash pine	0.38	0.21	0.09	0.08	0.60	0.51	0.08	0.02
Other[b]	0.30	0.01	0.01	0.03	0.05	0.02	0.01	0.01
All groups	22.10	11.65	5.25	4.96	45.30	36.60	7.72	0.97

[a] Includes a small amount of stands classified as nonstocked.

[b] Other includes the following forest-type groups: other eastern softwoods, exotic hardwoods, other hardwoods, and nonstocked.

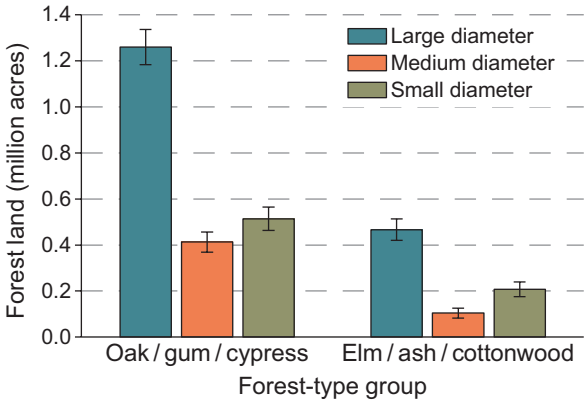

Figure 2—Area of bottomland hardwood forests by forest-type group and stand-size class in the mid-Atlantic region, 2014. Bars represent the sampling error (based on one standard deviation).

stand-age classes (fig. 3). The dip in acreage of stands greater than 80 years old is likely due to harvesting and regeneration of these older stands as a part of standard forest management activities.

Sweetbay / swamp tupelo / red maple was, by far, the most abundant forest type; it occupied about 45 percent of the forest area in BLHW forests within the AOI (table 2). Other frequently occurring forest types included (1) sweetgum / Nuttall oak / willow oak, (2) sugarberry / hackberry / elm / green ash, and (3) baldcypress / water tupelo; together, these four forest types accounted for 79 percent of the bottomland hardwood acreage. Like the forest-type groups, the majority of area of the detailed forest types was in the large-diameter stand-size class (fig. 4).

TRENDS IN FOREST AREA

Area of forest land in the mid-Atlantic region remained steady between 2002 and 2014 at 22.1 million acres (table 3). The loblolly / shortleaf pine forest-type group saw the biggest increase in number of acres over the time period studied (833,735 acres, an 11-percent increase). The oak / hickory group saw the biggest decrease (872,389 acres, an 11-percent decrease). Bottomland hardwood forests declined by 4 percent (121,938 acres). Essentially all of this decline occurred in the oak / gum / cypress forest-type group. A preliminary analysis revealed that this net change in area of BLHW forests was the result of both losses to other forest-type groups

Table 2—Area of bottomland hardwood forests by forest-type group and detailed forest type on forest land in the mid-Atlantic region, 2014

Forest-type group and detailed forest type	Area	Sampling error
	thousand acres	*percent*
Oak / gum / cypress		
Swamp chestnut oak / cherrybark oak	64.3	27.2
Sweetgum / Nuttall oak / willow oak	521.8	9.4
Overcup oak / water hickory	20.8	50.8
Atlantic white-cedar	11.0	69.6
Baldcypress / water tupelo	215.2	15.2
Sweetbay / swamp tupelo / red maple	1,320.6	5.9
Baldcypress / pondcypress	18.4	55.6
Total oak / gum / cypress	2,172.0	4.5
Elm / ash / cottonwood		
River birch / sycamore	179.5	16.0
Willow	40.9	35.4
Sycamore / pecan / American elm	174.5	16.7
Sugarberry / hackberry / elm / green ash	271.0	13.5
Red maple / lowland	97.6	20.8
Cottonwood / willow	8.7	72.5
Total elm / ash / cottonwood	772.3	7.8
All types	2,944.3	3.8

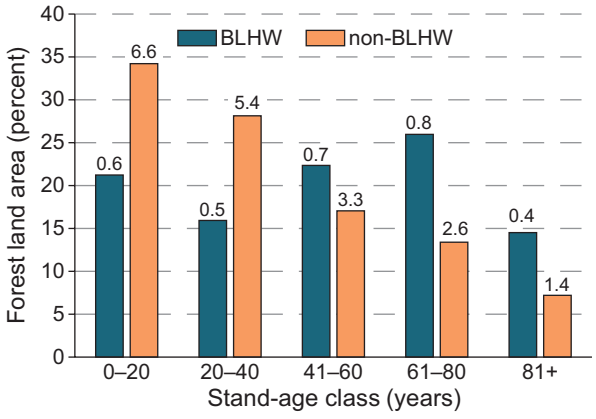

Figure 3—Distribution of forest land area by stand-age class and major forest-type group (BLHW vs non-BLHW) in the mid-Atlantic region, 2014. Numbers above bars are the actual area in million acres. Sampling error was about 3 percent for non-BLHW and about 15 percent for BLHW.

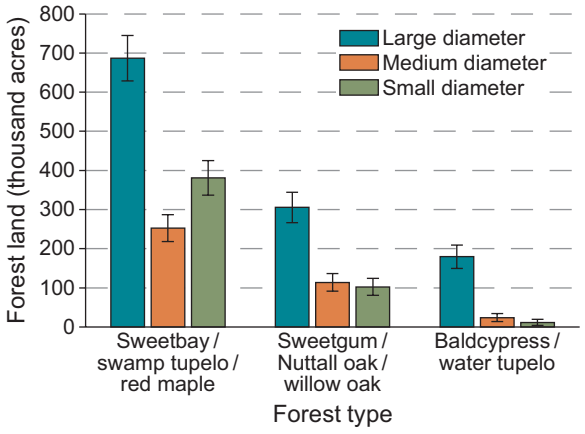

Figure 4—Area of the top three (for volume) detailed forest types within bottomland hardwood forests in the mid-Atlantic region, 2014. Bars represent the sampling error (based on one standard deviation).

Table 3—Trend in area of forest land by forest-type group and survey year for forest land in the mid-Atlantic region

Forest-type group	2002	2003	2005	2006	2007	2009	2010	2011	2012	2013	2014
						million acres					
Loblolly / shortleaf pine	7.28	7.38	7.48	7.48	7.63	7.67	7.65	7.77	7.85	7.94	8.12
Oak / hickory	8.12	8.01	7.96	7.81	7.67	7.56	7.47	7.33	7.26	7.21	7.24
Oak / pine	3.00	3.08	2.95	2.95	2.97	2.93	3.04	3.08	3.11	3.03	3.10
Oak / gum / cypress	2.33	2.23	2.18	2.23	2.22	2.28	2.25	2.22	2.16	2.19	2.17
Elm / ash / cottonwood	0.74	0.77	0.76	0.74	0.74	0.76	0.75	0.76	0.77	0.76	0.77
Longleaf / slash pine	0.27	0.27	0.30	0.28	0.29	0.29	0.29	0.31	0.32	0.35	0.38
Other	0.40	0.40	0.35	0.35	0.30	0.30	0.32	0.32	0.31	0.30	0.30
All groups	22.13	22.13	21.98	21.85	21.83	21.78	21.78	21.79	21.78	21.77	22.10

(primarily oak / hickory and oak / pine) and gains from other forest-type groups (primarily oak / hickory and loblolly / shortleaf). However, given the sampling error (approximately 4 percent, depending on survey period) for BLHW forests, this may not represent a statistically significant change.

Forest land in the AOI is maturing (fig. 5). Area of large-diameter sized stands has been increasing, while that of medium-and small-diameter stands has been decreasing. Large-diameter stands now account for 53 percent of the forest land in the AOI. Since 2002, forest land area in large-diameter stands increased by 16 percent. This is in contrast to decreases in medium- and small-diameter stands. Bottomland hardwood stands showed the same trends (fig. 6). Large-diameter stands now account for 59 percent of the forest land area occupied by stands of this type. Area of large-diameter stands increased by 7 percent between 2002 and 2014, whereas the area of medium-diameter stands decreased by 21 percent, and the area of small-diameter stands decreased by 12 percent over the same time period.

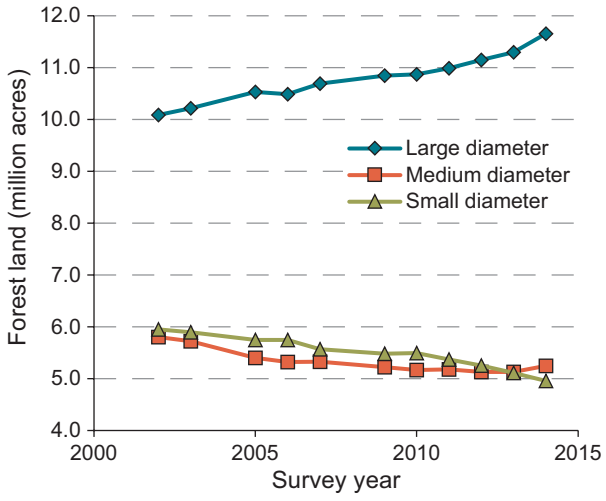

Figure 5—Trend in forest land area in the mid-Atlantic region by survey year and stand-size class. (Sampling error (2014): large-diameter stands = 1.4 percent, medium-diameter stands = 2.7 percent, small-diameter stands = 2.9 percent).

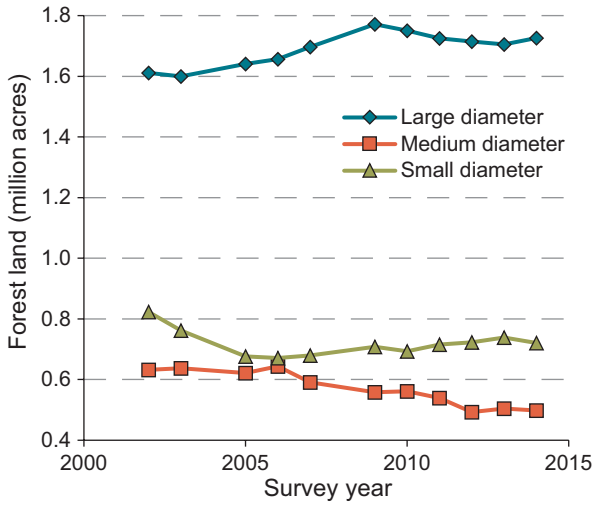

Figure 6—Trend in bottomland hardwood forest land area in the mid-Atlantic region by survey year and stand-size class. (Sampling error (2014): large-diameter stands = 5.1 percent, medium-diameter stands = 9.0 percent, small-diameter stands = 8.5 percent).

VOLUME

Volume of live trees ≥5.0 inches diameter at breast height (d.b.h.) on forest land in the AOI in 2014 totaled 45.3 billion cubic feet (table 1). Volume in bottomland hardwood forests accounted for 6.7 billion cubic feet, or 14.8 percent of the total (tables 1 and 4). As expected, volume by stand-size class paralleled that of area, with the majority of volume in large-diameter sized stands. In fact, 87 percent of the live volume in bottomland hardwood stands was in that stand-size class (fig. 7).

Tupelo and blackgum accounted for 24 percent of the volume in BLHW forests (table 5). Sixty-five percent of the ash volume in the AOI was in BLHW forests. In addition, ash made up 14 percent of the volume of the elm / ash / cottonwood group.

Table 4—Volume of bottomland hardwood forests by forest-type group and detailed forest type on forest land in the mid-Atlantic region, 2014

Forest-type group and detailed forest type	Volume	Sampling error
	million cubic feet	*percent*
Oak / gum / cypress		
Swamp chestnut oak / cherrybark oak	254.2	29.3
Sweetgum / Nuttall oak / willow oak	1,173.9	11.8
Overcup oak / water hickory	68.1	60.1
Atlantic white-cedar	1.5	79.6
Baldcypress / water tupelo	1,000.4	17.3
Sweetbay / swamp tupelo / red maple	2,546.5	7.9
Baldcypress / pondcypress	54.7	56.7
Total oak / gum / cypress	5,099.1	5.9
Elm / ash / cottonwood		
River birch / sycamore	357.5	19.1
Willow	7.7	59.7
Sycamore / pecan / American elm	474.9	19.5
Sugarberry / hackberry / elm / green ash	597.1	17.3
Red maple / lowland	163.1	31.3
Cottonwood / willow	6.0	73.5
Total elm / ash / cottonwood	1,606.4	10.1
All types	6,705.5	5.1

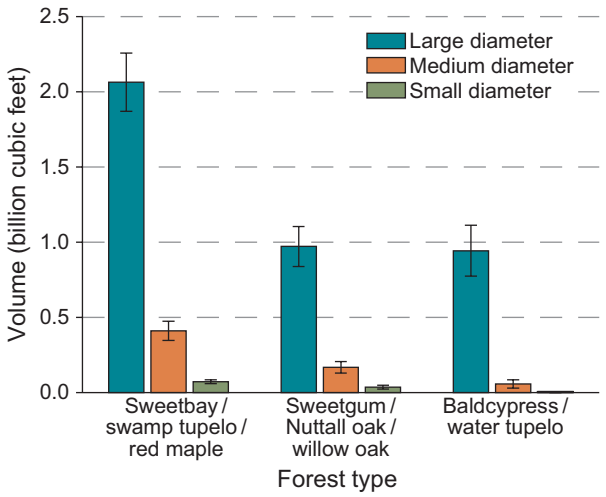

Figure 7—Net volume of live trees by forest type and stand-size class for the top three detailed forest types in bottomland hardwood forests on forest land in the mid-Atlantic region, 2014. Bars represent the sampling error (based on one standard deviation).

TRENDS IN VOLUME

Volume of live trees ≥5.0 inches d.b.h. on forest land in the AOI increased by 15.6 percent between 2002 and 2014 (table 6). Volume in the BLHW forests increased by 1.2 percent. Although relatively stable overall, this net change represented both an increase in volume of some species and a decrease in volume of other species (table 7). The most notable increases in volume in BLHW forests were for the other hardwoods (an increase of 44.8 million cubic feet, or 6.2 percent) and the white oaks (and increase of 43.1 million cubic feet, or 34 percent). Notable decreases occurred for the tupelo and blackgum group (a decrease of 46.6 million cubic feet, or 2.8 percent) and cypress (a decrease of 42.2 million cubic feet, or 8.7 percent).

Volume of red oak, an important species group for both timber and wildlife, declined by 27.3 million cubic feet between 2002 and 2014 (table 7), representing a decrease of 5.6 percent.

NUMBER OF TREES

There were 91 tree species recorded in BLHW forests in the mid-Atlantic region. The top species for number of trees were red maple, sweetgum, and swamp tupelo (table 8). The top 20 species recorded accounted for 88 percent of the total number of live trees in BLHW forests.

Table 5—Volume of all-live trees by species group and forest-type group on forest land in the mid-Atlantic region, 2014

Species group	Loblolly / shortleaf pine	Oak / hickory	Oak / pine	Oak / gum / cypress	Elm / ash / cottonwood	Longleaf / slash pine	Other	All groups
				million cubic feet				
Loblolly and shortleaf pines	12,664.0	617.0	1,705.4	120.7	42.6	43.1	2.2	15,195.0
Yellow-poplar	470.3	4,151.8	697.3	230.0	136.3	—	1.9	5,687.7
White oak	188.4	3,285.6	501.6	155.5	12.8	0.8	0.4	4,145.2
Sweetgum	553.4	1,606.4	513.0	637.0	280.2	1.5	3.0	3,594.4
Red oak	346.6	2,238.2	465.2	431.2	30.7	9.4	0.3	3,521.5
Other pines and softwoods	1,487.3	365.6	568.4	58.1	10.8	537.1	24.1	3,051.4
Maple	308.9	1,183.8	343.1	813.4	275.3	0.1	3.3	2,928.1
Other hardwoods[a]	256.2	1,375.8	271.8	323.3	556.6	7.9	13.2	2,804.7
Tupelo and blackgum	49.1	253.0	129.3	1,608.1	4.4	—	0.8	2,044.8
Hickory	47.0	919.9	103.4	30.5	31.1	3.4	0.7	1,136.0
Ash	22.8	209.3	20.9	250.8	222.0	—	0.3	726.1
Cypress	1.5	3.8	13.3	440.6	3.5	—	—	462.8
All species	16,395.5	16,210.2	5,333.0	5,099.1	1,606.4	603.4	50.2	45,297.7

— = no value for the cell.

[a]Other hardwoods (for all groups combined) included 63 species, the top 5 of which were: American beech, American sycamore, sourwood, black cherry, and river birch.

Table 6—Trend in volume of all-live trees by forest-type group and survey year on forest land in the mid-Atlantic region

Forest-type group	2002	2003	2005	2006	2007	2009	2010	2011	2012	2013	2014
						billion cubic feet					
Loblolly / shortleaf pine	12.85	12.95	13.21	13.10	13.53	13.62	13.83	14.18	14.80	15.51	16.40
Oak / hickory	14.48	14.44	14.62	14.50	14.73	14.91	15.02	15.13	15.31	15.65	16.21
Oak / pine	4.72	4.86	4.73	4.78	4.89	4.94	5.05	5.18	5.16	5.18	5.33
Oak / gum / cypress	5.21	5.08	5.02	5.05	5.10	5.24	5.23	5.21	5.13	5.08	5.10
Elm / ash / cottonwood	1.42	1.41	1.42	1.47	1.48	1.55	1.49	1.54	1.55	1.52	1.61
Longleaf / slash pine	0.42	0.40	0.44	0.46	0.50	0.50	0.50	0.52	0.52	0.55	0.60
Other	0.10	0.08	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
All groups	39.19	39.23	39.49	39.41	40.27	40.82	41.16	41.82	42.51	43.54	45.30

Table 7—Trend in volume of live trees in bottomland hardwood forests by species group and survey year on forest land in the mid-Atlantic region

Species group	2002	2007	2014
	million cubic feet		
Tupelo and blackgum	1,659.1	1,678.7	1,612.5
Maple	1,076.9	1,090.9	1,088.7
Sweetgum	896.5	899.0	917.1
Other hardwoods[a]	727.8	706.1	772.6
Ash	459.2	432.7	472.8
Red oak	489.2	473.6	461.9
Cypress	486.4	414.8	444.2
Yellow-poplar	330.7	345.8	366.3
Pine and other softwoods	261.7	265.3	232.2
White oak	125.2	142.9	168.3
Hickory	48.6	46.8	61.6
Beech	24.7	38.7	43.2
Cottonwood and aspen	20.8	23.6	32.4
Black walnut	17.3	22.4	31.6
All groups	6,624.3	6,581.3	6,705.5

Sampling error (2014) ranged from a low of 10.3 percent for tupelo and blackgum to a high of 34.4 percent for black walnut.

[a] Other hardwoods includes a list of 39 species, the top 5 of which were American sycamore, river birch, American elm, hackberry, and sweetbay.

Table 8—Number of live trees by species (top 20) and diameter class in bottomland hardwood forests on forest land in the mid-Atlantic region, 2014

	Diameter class (inches d.b.h.)			
Species	1.0–4.9	5.0–10.9	≥11.0	Total
		million trees		
Red maple	411.6	69.9	23.6	505.1
Sweetgum	181.9	37.9	17.2	237.1
Swamp tupelo	106.4	44.1	23.5	174.0
Green ash	141.7	23.0	7.9	172.6
Sweetbay	116.0	7.3	0.6	124.0
American hornbeam	108.0	6.3	0.0	114.4
Redbay	104.4	8.9	0.2	113.5
American holly	79.4	7.6	0.5	87.6
Yellow-poplar	41.3	8.3	6.5	56.1
Black willow	43.8	3.8	0.3	47.9
Water oak	31.1	5.5	2.0	38.5
Water tupelo	9.1	13.4	11.7	34.1
Loblolly pine	24.3	5.6	2.6	32.6
American elm	22.0	5.1	1.8	28.9
Baldcypress	13.4	7.9	6.1	27.4
River birch	18.8	4.8	3.1	26.6
Pumpkin ash	18.6	2.5	0.3	21.4
Loblolly-bay	14.3	3.7	0.3	18.3
Blackgum	13.6	2.8	1.4	17.8
Laurel oak	10.8	3.9	2.4	17.1
Total (for top 20)	1,510.6	272.3	112.1	1,895.0
Total (all species)	1,702.3	314.8	133.6	2,150.7

Sampling error for number of live stems ranged from a low of 7.6 percent for red maple to a high of 40.9 percent for pumpkin ash.

GROWTH, REMOVALS, AND MORTALITY

Average annual gross growth in BLHW stands averaged between 73.0 and 83.8 cubic feet per acre per year between the mid-1970s and 2014 (fig. 8). In contrast, average annual net growth in BLHW forests declined between the mid-1980s and the mid-2000s. In comparison, gross growth and net growth across the AOI increased from 71.9 to 109.4 cubic feet per acre per year and from 62.1 to 93.1 cubic feet per acre per year, respectively, during the same time period (fig. 9).

Despite some fluctuations, removals from BLHW forests have remained fairly constant since 1974, averaging between 37.6 and 55.3 cubic feet per acre per year (fig. 8). In comparison, removals in the AOI increased from 46.0 cubic feet per acre per year in 1975 to 74.5 in 2007, and declined to 53.5 in 2014 (fig. 9).

Mortality in BLHW stands increased from a low of 14.5 cubic feet per acre per year in 1975 to a high of 41.5 cubic feet per acre per year in 2007. Mortality has declined since then. In comparison, mortality in the AOI averaged between 9.8 and 22.2 cubic feet per acre per year over the same time period.

The ratio of net growth to removals in the AOI never dropped below 1:1 for the time period considered (fig. 10). In contrast, the ratio for BLHW forests began to decline in the mid 1980s (fig. 10), coincident with the increase in average annual mortality (fig. 8).

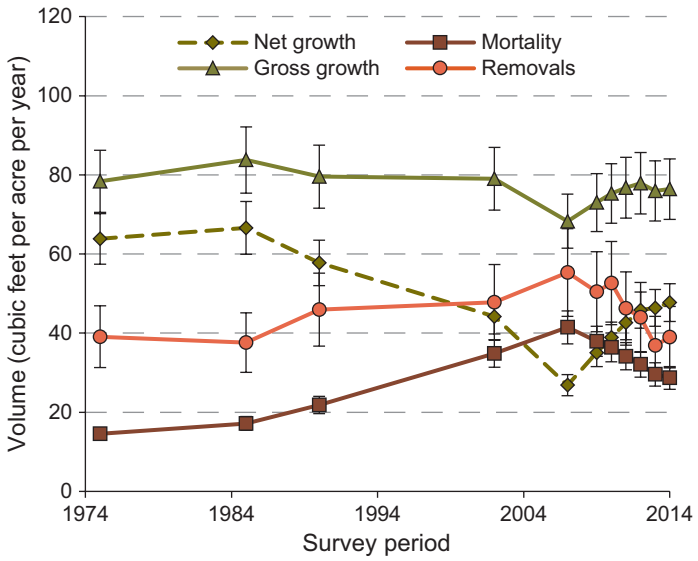

Figure 8—Trend in average annual growth, removals, and mortality (per acre per year) on timberland in BLHW stands. Net growth is shown as a dashed line since it reflects both gross growth and mortality. Bars represent the sampling error (based on one standard deviation).

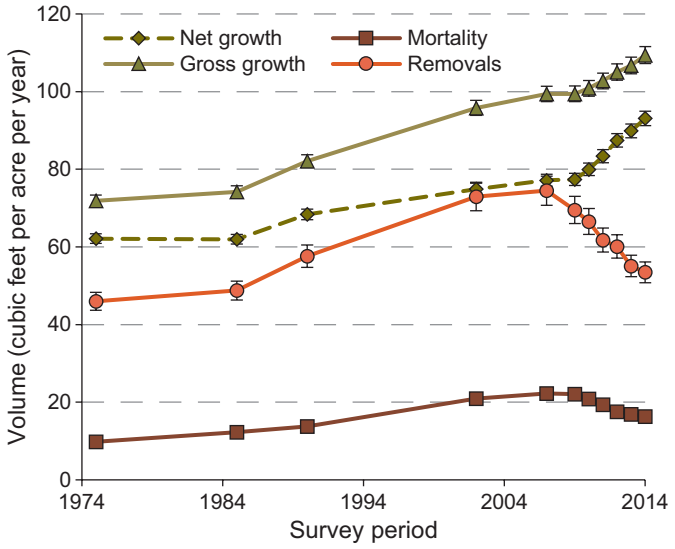

Figure 9—Trend in average annual growth, removals, and mortality (per acre per year) on timberland in the AOI. Net growth is shown as a dashed line since it reflects both gross growth and mortality. Bars represent the sampling error (based on one standard deviation).

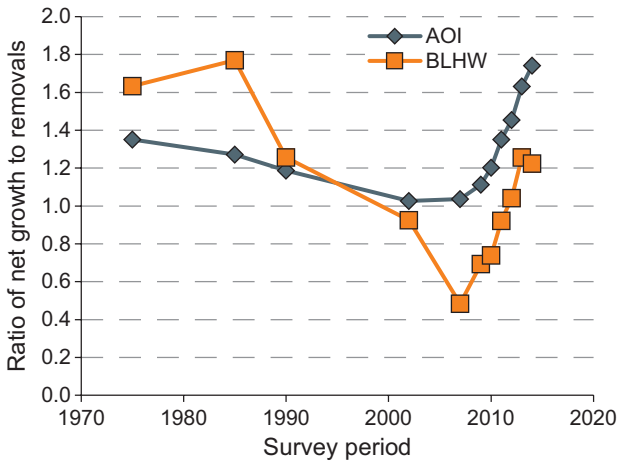

Figure 10—Ratio of net growth to removals by survey period for both the AOI and BLHWs.

DISCUSSION

No single indicator is available to determine sustainability or predict the future of any given forest area, forest type, or species. Rather, a more comprehensive look at the resource is required. Utilizing FIA data, we examined several metrics to assess the current status and previous trends in forest resources in BLHW forests of the mid-Atlantic region. Of particular note in these analyses were the distribution of area and volume by stand-age class and stand-size class, as well as growth, removals, and mortality. While the even distribution of forest land area by stand-age class seems to indicate that the BLHW resources should continue to be sustainable over time, the unbalanced distribution of stand-size classes within many of the BLHW forest types, especially the cypress / tupelo forest type, is of particular concern. The data seem to indicate that within the BLHW forests, there is a shortage of forest land in small- and medium-diameter sized stands relative to large-diameter sized stands. If these trends continue and the distribution of stand-size classes across the landscape becomes even more unbalanced, sustainability of the BLHW resources in the mid-Atlantic region may be threatened.

Cypress / tupelo stands are of particular concern because as these large-diameter sized stands begin to die and break up over time, they may or may not regenerate to cypress / tupelo. Both species are intolerant of shade, especially as seedlings, and require some form of fairly large-scale stand disturbance in order to regenerate successfully. In addition, developing seedlings of both species need at least a few years of dry conditions to grow tall enough to survive future flooding during the growing season. Large-diameter stands that die and break up in the absence of stand disturbance and/or during wet periods often regenerate to

privet and buttonbush, resulting in a decline in the acreage of the cypress / tupelo forest type (Conner and Buford 1998). Planned regeneration of suitable, large-diameter stands during dry periods will increase the likelihood that the site will regenerate successfully to cypress / tupelo and, thus, sustain the acreage of this forest type. Successful replacement of appropriate large-diameter cypress / tupelo stands with even-aged, small-diameter cypress / tupelo stands would sustain the progression over time from small-diameter stands to medium-diameter stands to large-diameter stands. The end result would be a more balanced and more sustainable distribution of stand-size classes within the cypress / tupelo forest type.

In addition to an uneven stand-size distribution, forest type conversion and invasive species have the potential to impact the sustainability of BLHW forests. At this point, it is unclear (and outside the scope of this report) whether the detected changes in forest-type groups were due to natural or purposeful conversion. As for invasive species, the ash genus is at risk from the emerald ash borer, an insect native to Asia that was first detected in Virginia in 2008 (Asaro 2014). All species of ash are at risk from being killed by this insect. The elm / ash / cottonwood forest-type group is especially vulnerable, as ash made up 14 percent of the volume in this group.

The data are insufficient to draw definitive conclusions that might explain the decrease in red oak volume. However, possible explanations include (1) increased harvesting of red oaks in recent years, (2) decreased growth of red oaks as a result of poor management practices or even a lack of management, and (3) some combination of these two factors.

Both the increase in net growth and the decline in removals across the AOI are due, in part, to the economic downturn that took place 2007–08 (Lorber and Rose 2015). In addition, the drop in net growth starting in the mid 1980s in BLHW stands was likely exacerbated by Hurricane Floyd in 1999 and Hurricane Isabel in 2003. Hurricane Isabel impacted stands on the coast more so than on the Piedmont (Randolph and Rose 2009), thereby causing more damage to BLHW stands than to the AOI as a whole.

Average annual gross growth of BLHW stands in our study, about 80 cubic feet per acre per year, was typical of other BLHW stands in the Coastal Plain of the mid-Atlantic region (Smith and others 1975). The decline in net growth depicted in figure 8 was due primarily to the increase in mortality that occurred between 1985 and the mid-2000s. This increase in mortality may have been caused by a combination of factors including, but not limited to: weather and/or climatic events (such as hurricanes as previously mentioned), an abundance of over-stocked stands, an abundance of senescent overmature stands, and/or above-average incidence of insect and disease. However, it is not clear at this time which if any of these factors played a role in the noted mortality. A more detailed study into the mortality trends noted here is warranted.

Another measure of sustainability for forest resources is the net growth-to-removals ratio. When this number drops below 1:1, it means that removals are exceeding net growth, a practice which is considered unsustainable in the long run. In contrast to the AOI, the ratio for BLHW forests fell below 1:1 sometime in the late 1990s and has only recently returned to a more sustainable level. The data indicate that average annual mortality, the primary causal factor for the decline in net growth in BLHW stands, played a significant role in the decline in the net growth-to-removals ratio.

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GLOSSARY

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. (gross growth minus mortality) without taking into account losses from cutting during the intersurvey period.

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).

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.

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.

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.

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.

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.

Rose, A.K.; Meadows, J.S. 2016. Status and trends of bottomland hardwood forests in the mid-Atlantic Region. e-Gen. Tech. Rep. SRS–217. Asheville, NC: U.S. Department of Agriculture Forest Service, Southern Research Station. 10 p.

Bottomland hardwood forests cover approximately 2.9 million acres of the Coastal Plain and Piedmont region of Virginia and North Carolina. As of 2014, 59 percent of bottomland hardwood forests were in the large-diameter stand-size class. Between 2002 and 2014, area of large-diameter sized stands increased, while that of medium- and small-diameter stands decreased, indicating that the resource is maturing. While total volume of live trees remained steady over the period studied (2002–2014), there were increases in volume for some individual species (for example, white oak) and decreases in volume for others (for example, red oak). Bottomland hardwood forests in the mid-Atlantic support a wide range of tree species. Mortality was at an all-time high in these forests around 2005, but has steadily decreased since then. The Forest Service's Forest Inventory and Analysis program is the only entity that conducts forest assessments across all land in the United States. Increasing demands on the resource and anthropogenic-related impacts on forests have intensified the need to conduct ecosystem-based inventories such as these.

Keywords: Cypress, FIA, forested wetlands, Forest Inventory and Analysis, North Carolina, Virginia.

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