Forest sustainability in the state of Virginia, USA

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1. Introduction

The combustion of wood for energy purpose is not considered to contribute to the augmentation of greenhouse gases concentration in the atmosphere, as long as the CO2 emissions released during the combustion of wood are balanced by the growth of new trees. It is therefore essential to investigate if the forests in the region where the wood used for energy purpose are managed in a sustainable way, avoiding resources associated with overexploitation of forests, land use change, depletion of carbon stocks, etc...

In this framework, literature research was carried out to produce a summary of forest management in Virginia, including general condition, management and sustainability assessment.

2. Virginia forests overview

2.1. Location and distribution

Virginia is located in the East of the USA and covers a total surface area of 110 785 km². The State of Virginia is divided into 95 counties and is bordered by Maryland on the north and on the east, by Atlantic Ocean on the east, by North Carolina and Tennessee on the south, by Kentucky on the west and by West Virginia on the north and on the west.

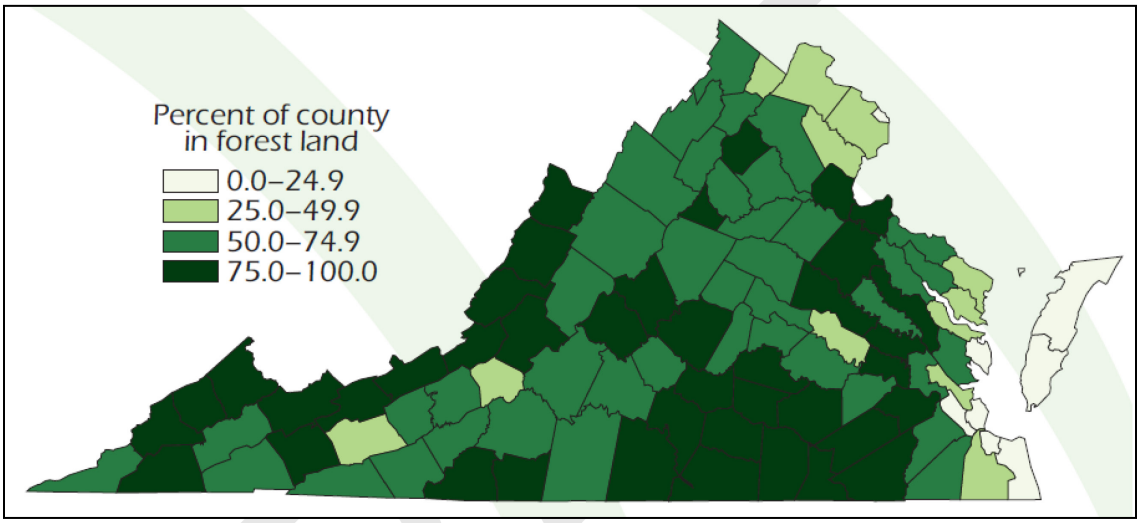
Figure 1: General maps of Virginia

Source: NETSTATE – North Carolina
(http://www.netstate.com/states/geography/mapcom/va_mapscom.htm)

The forests of Virginia are part of the large forest area of the South East USA. Nowadays, Virginia's forest covers about 62% of the State's land area with 6.43 million ha[1]. Nearly all of the forest land (96%) is considered available for timber production (timberland).

As seen on the figure below and according to the inventory[2] conducted in 2010 by the US Department of Agriculture (USDA) – Forest Service, the majority of counties in Virginia are at least 50% forested. The least forested counties are located in the northern portion of the State and along the coast.

Figure 2 : Percent of county in forest land (Virginia, 2010)



Source: Forest Inventory & Analysis factsheet (Virginia 2010) - USDA – Forest Service

2.1. Ecological zones

Virginia's lower elevations and lowest points (sea level) are in the east along the Chesapeake Bay and the Atlantic Ocean. The land rises to the west where the Blue Ridge Mountains run along Virginia's western border with West Virginia and Kentucky. The highest point in Virginia is Mount Rogers, at 1746 m above sea level, located in Grayson County in the south-western part of the state.

The climate of Virginia becomes increasingly warmer and more humid southwards and eastwards. Most of Virginia (east of the Blue Ridge Mountains, the southern part of the Shenandoah Valley, and the Roanoke Valley), has a humid subtropical climate. In the mountainous areas (west of the Blue Ridge), the climate becomes humid continental and maritime temperate.

Depending on the place, the typical high temperatures recorded in July are in the range 30°C to 31°C while the typical low temperatures recorded in January are in the range -4°C to 0°C[3].

[1] Source: situation as per 2012 Forest Inventory and Analysis, USDA – Forest service
[2] Forest inventory & Analysis Factsheet 2010 – USDA, Forest Service-http://www.srs.fs.usda.gov/pubs/41104
[3] Source : http://www.ustravelweather.com/virginia/

Depending on the place, the average precipitations range generally from 900 to 1350 mm per year[4].

Virginia is divided by the 7 following ecoregions[5]:

A. **Piedmont** (n°45 on Figure 3)

The northeast-southwest trending Piedmont ecoregion comprises a transitional area between the mostly mountainous ecoregions of the Appalachians to the northwest and the relatively flat coastal plain to the southeast. Once largely cultivated, much of this region has reverted to successional pine and hardwood woodlands, with an increasing conversion to an urban and suburban land cover.

B. **Middle Atlantic Coastal Plain** (n°63 on Figure 3)

The Middle Atlantic Coastal Plain ecoregion stretches from Delaware to the South Carolina/Georgia border and consists of low elevation flat plains, with many swamps, marshes, and estuaries. Forest cover in the region, once dominated by longleaf pine in the Carolinas, is now mostly loblolly and some shortleaf pine, with patches of oak, gum, and cypress near major streams, as compared to the mainly longleaf-slash pine forests of the warmer Southern Coastal Plain (n°75).

C. **Northern Piedmont** (n°64 on Figure 3)

The Northern Piedmont is a transitional region of low rounded hills, irregular plains, and open valleys. Potential natural vegetation here was predominantly Appalachian oak forest as compared to the mostly oak-hickory-pine forests of the Piedmont (n°45) ecoregion to the southwest. The region now contains a higher proportion of cropland compared to the Piedmont.

D. **South-eastern Plains** (n°65 on Figure 3)

These irregular plains have a mosaic of cropland, pasture, woodland, and forest. Natural vegetation is mostly oak-hickory-pine and Southern mixed forest. The Cretaceous or Tertiary-age sands, silts, and clays of the region contrast geologically to the older igneous and metamorphic rocks of the Piedmont, and the older limestone, chert, and shale found in the Interior Plateau. Streams in this area are relatively low-gradient and sandy-bottomed.

E. **Blue Ridge Mountain** (n°66 on Figure 3)

The Blue Ridge extends from southern Pennsylvania to northern Georgia, varying from narrow ridges to hilly plateaus to more massive mountainous areas, with high peaks reaching over 2000 m. The mostly forested slopes, high-gradient, cool, clear streams, and rugged terrain occur primarily on metamorphic rocks, with minor areas of igneous and sedimentary geology. The southern Blue Ridge

[4]Source : http://average-rainfall.weatherdb.com/

[5]Source: Primary Distinguishing Characteristics of Level III Ecoregions of the Continental United States (http://www.hort.purdue.edu/newcrop/cropmap/ecoreg/descript.html)

is one of the richest centers of biodiversity in the eastern U.S. It is one of the most floristically diverse ecoregions, and includes Appalachian oak forests, northern hardwoods, and, at the highest elevations, Southeastern spruce-fir forests. Shrub, grass, and heath balds, hemlock, cove hardwoods, and oak-pine communities are also significant.

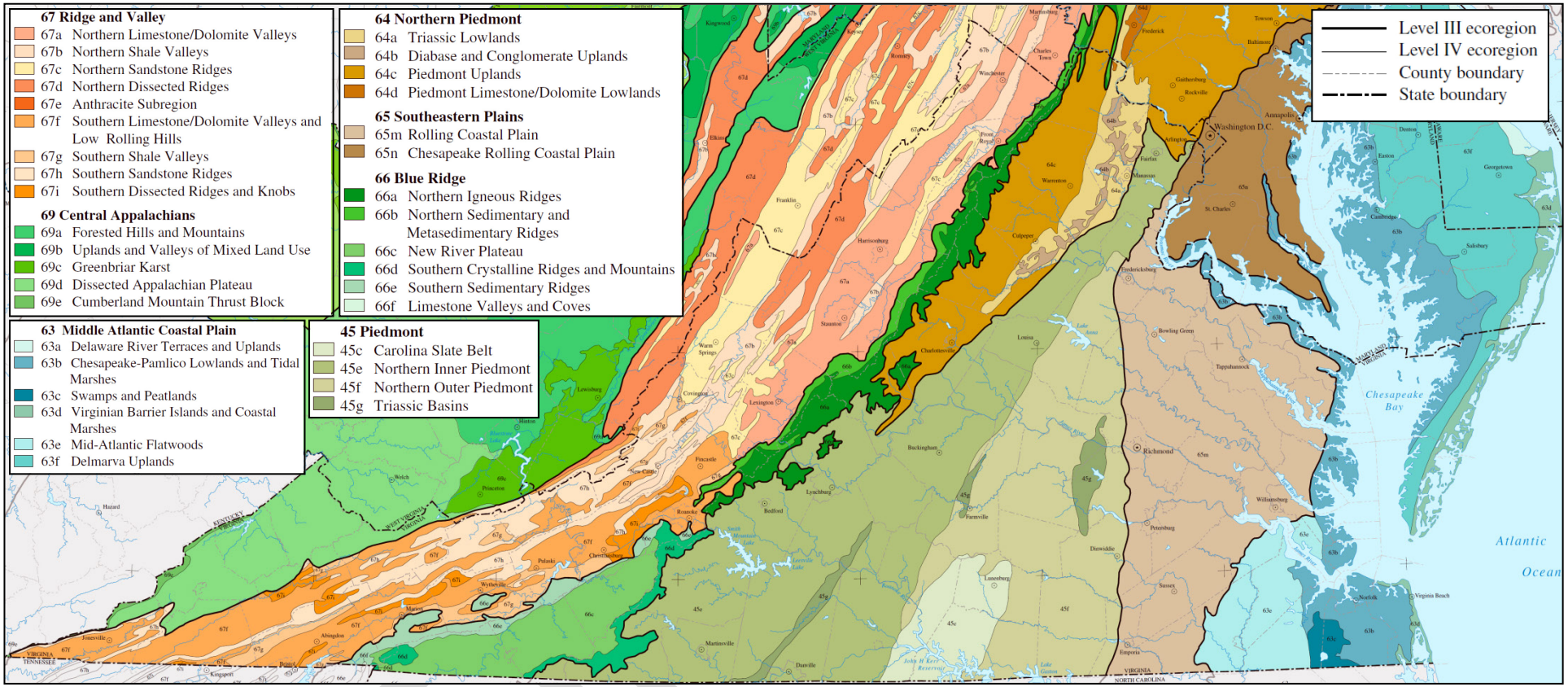
F. Ridge and Valley (n°67 on Figure 3)

This northeast-southwest trending, relatively low-lying, but diverse ecoregion is sandwiched between generally higher, more rugged mountainous regions with greater forest cover. As a result of extreme folding and faulting events, the region's roughly parallel ridges and valleys have a variety of widths, heights, and geologic materials, including limestone, dolomite, shale, siltstone, sandstone, chert, mudstone, and marble. Springs and caves are relatively numerous. Present-day forests cover about 50% of the region. The ecoregion has a great diversity of aquatic habitats and species of fish.

G. Central Appalachians (n°69 on Figure 3)

The Central Appalachian ecoregion, stretching from central Pennsylvania to northern Tennessee, is primarily a high, dissected, rugged plateau composed of sandstone, shale, conglomerate, and coal. The rugged terrain, cool climate, and infertile soils limit agriculture, resulting in a mostly forested land cover. The high hills and low mountains are covered by a mixed mesophytic forest with areas of Appalachian oak and northern hardwood forest.

Figure 3: Ecoregions of Virginia (Levels III & IV)

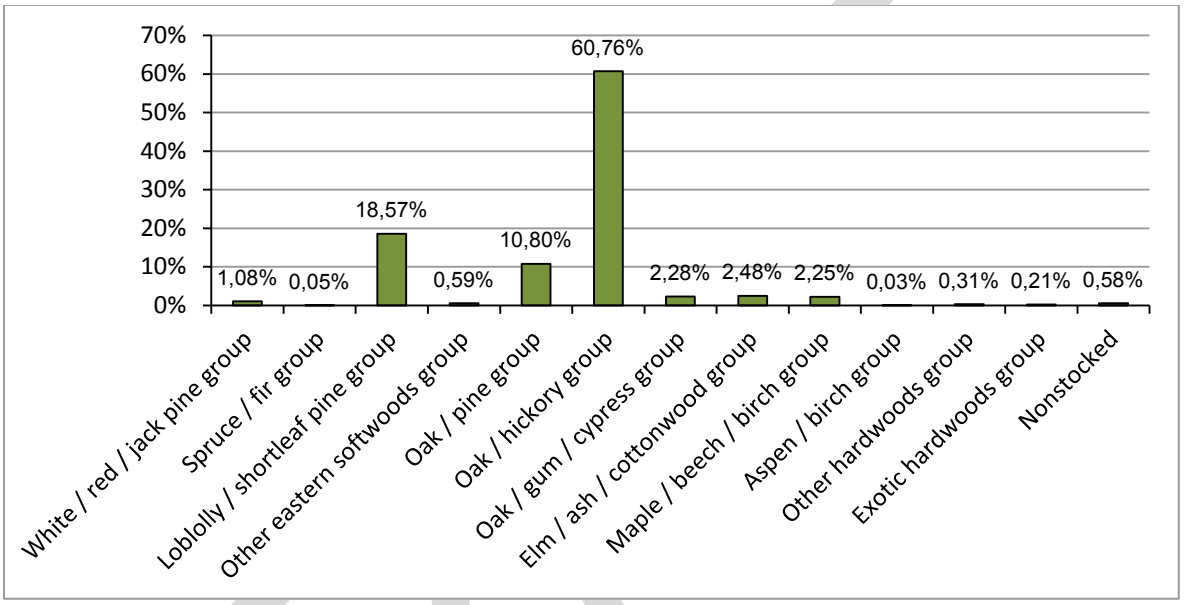


Source: Environmental Protection Agency – Western Ecology Division (http://www.epa.gov/wed/pages/ecoregions/ncsc_eco.htm)

2.2. Forest species

The Oak-hickory forest type group occupies the largest proportion of forest land in Virginia with 60.8%. The loblolly-shortleaf pine group is second with 18.6%, followed by the oak-pine group (10.8%). The area distribution (2012) occupied by the different species is presented on the figure and table below.

Figure 4: Area distribution of forest land by forest-type group (2012)



Source: adapted from US Forest service, FIA Program (http://apps.fs.fed.us/fido/standardrpt.html)

Table 1 : Area of forest land by forest-type group (2012)

Forest type group	Area (ha)	% of total forestland area
Oak / hickory	3905485	60.76%
Loblolly / shortleaf pine	1193894	18.57%
Oak / pine	693989	10.80%
Elm / ash / cottonwood	159709	2.48%
Oak / gum / cypress	146633	2.28%
Maple / beech / birch	144904	2.25%
White / red / jack pine	69674	1.08%
Other eastern softwoods	38226	0.59%
Other hardwoods	19947	0.31%
Exotic hardwoods	13529	0.21%
Spruce / fir	3095	0.05%
Aspen / birch	1637	0.03%
Nonstocked	37002	0.58%
Total	6427724	

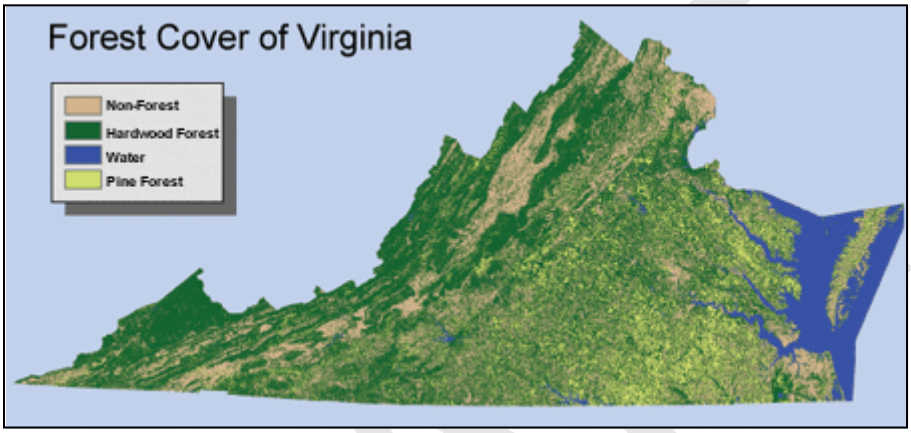
Source: adapted from US Forest service, FIA Program (http://apps.fs.fed.us/fido/standardrpt.html)

Altogether, hardwood forest types makes up about 79% of the forest land in Virginia. Softwood forest types occupy 20% and non-stocked areas make up the remaining.

According to the USDA – Forest Service[6], in 2011, 84% of stands were considered naturally regenerated and 16% artificially regenerated. The majority (68%) of the loblolly-shortleaf pine forest-type group was artificially regenerated, in comparison to other forest-type groups, where the majority was naturally regenerated.

The Figure 5 gives an overview of the distribution of major forest types in Virginia. We can see that eh pines are in the coastal areas while the deciduous dominates in the mountains and higher elevation land.

Figure 5 : Distribution of major forest types of Virginia



Source: Virginia Department of Conservation & Recreation – from Virginia Department of Forestry (2001)

2.3. Forest ownership

Approximately 82% of Virginia's forest land area is privately-owned and the 18% remaining is publicly-owned (federal, state and local public owners). Forest industry, owns only about 1% of forest land across the State. Most of the privately owned forests are owned by individuals non forest related companies.

Virginia's timberland and forestland ownership patterns (2012) are given in the following table.

[6] Forest inventory & Analysis Factsheet (2011) – USDA, Forest Service-http://www.srs.fs.usda.gov/pubs/45264

Table 2 : Area of forest land and timberland by ownership groups

Forest land / Ownership groups		Area (ha)		% of total forest land area
Forest Service	National forest	708151	708151	11%
Other federal	National Park Service	88941	210591	3%
	Fish and Wildlife Service	34313		
	Department of Defense or Energy	84868		
	Other federal	2469		
State and local gov't	State	141263	241318	4%
	Local (county, municipal, etc.)	100055		
Private	Undifferentiated private	5267665	5267665	82%
Total			6427724	
Timberland / Owner ship groups		**Area (ha)**		**% of total timberland area**
Forest Service	National forest	664549	664549	11%
Other federal	National Park Service	0	87337	1%
	Fish and Wildlife Service	0		
	Department of Defense or Energy	84868		
	Other federal	2469		
State and local gov't	State	111355	173558	3%
	Local (county, municipal, etc.)	62203		
Private	Undifferentiated private	5260376	5260376	85%
Total			6185819	

Source: adapted from US Forest service, FIA Program (http://apps.fs.fed.us/fido/standardrpt.html)

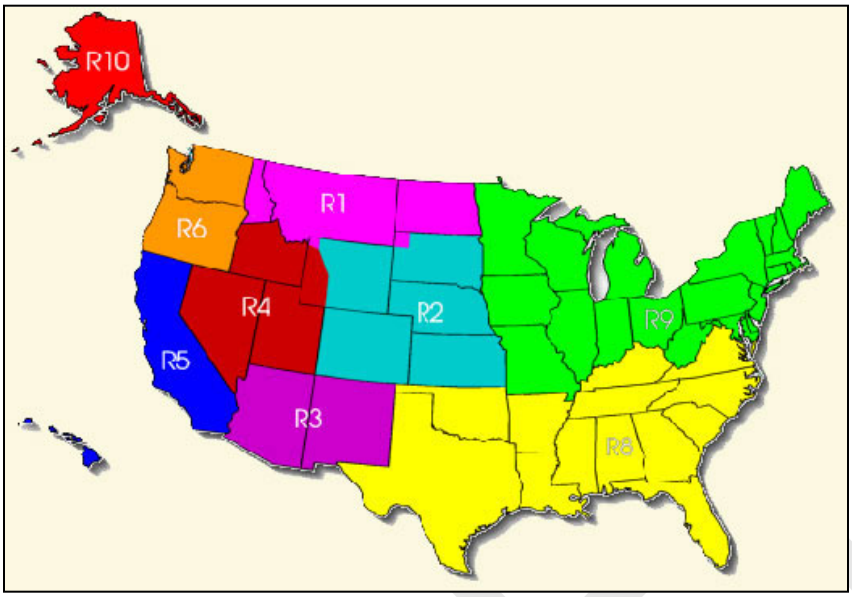
2.4. Competent authorities

Forest management in the United States of America, at the federal level is under the authority of the US Department of Agriculture and more specifically it's agency of the US Forest Service whose mission is to: *"Sustain the health, diversity, and productivity of the Nation's forests and grasslands to meet the needs of present and future generation"* [7]

Forest management of the territory of the United States is shared in 10 different parts belonging to regional divisions of the Forest Service. As shown on the figure below, Virginia and other States like Alabama and Louisiana belongs to the R8 region: Southern Region.

[7] Forest Service Agency Financial report- Fiscal Year 2008

Figure 6 : Regional areas of the Forest Service



Source : http://www.fs.fed.us/

The authority responsible for forest management in North Carolina is split into two levels: federal and state. The Forest Service – an agency of the Department of Agriculture – is responsible at federal level for the coordination of forest policies and the management of federal forests. At state level, the Virginia Department of Forestry (VDOF) is in charge of forest resources management. The VDOF was established in 1914 to prevent and suppress forest fires and reforest bare lands[8]. Since its inception, the VDOF has grown and evolved to encompass other protection and management duties:

- Protecting Virginia's Forests from Wildfire
- Managing the Forest Resource
- Protecting Virginia's Waters
- Conservation of Virginia's Forests
- Manage the State Lands and Nurseries
- Regulated Incentive Programs for Forest Landowners

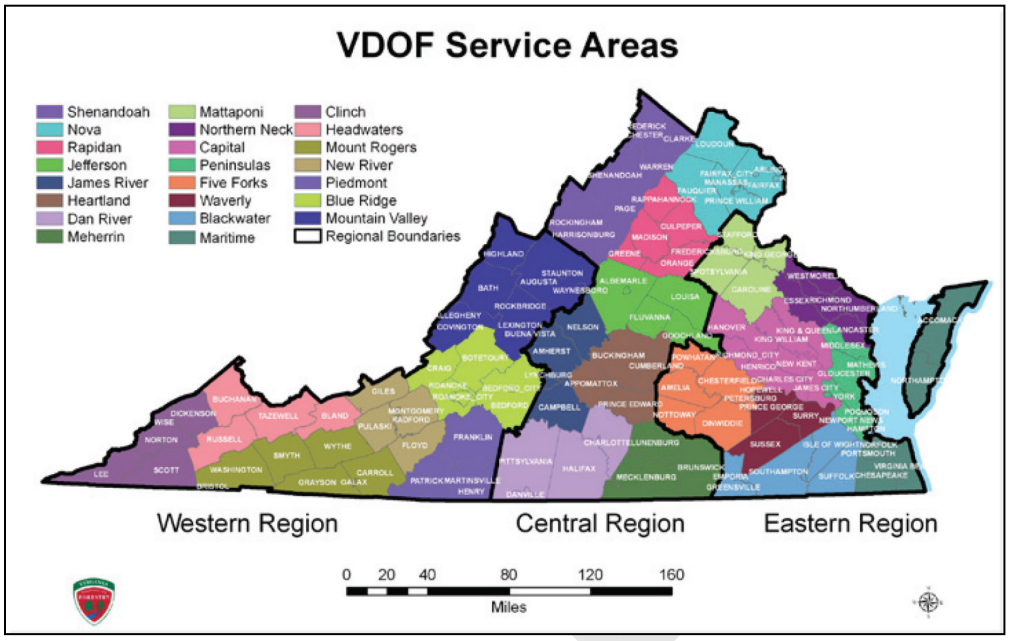
The VDOF contains several main services in relation with its core missions:

- Resources protection (fire prevention and operations)
- Resources Management (forest management, forest health, water quality)
- Forest conservation (forestland assistance, utilization & marketing)
- State lands (forestry centers, state forests, research/tree improvement)

The VDOF is organized into 3 administrative regions (including 23 service areas - Figure 7) within the state which receives oversight and support from a central headquarters facility.

[8] http://www.dof.virginia.gov/aboutus/intro-vdof.htm

Figure 7 : Virginia VDOF administrative regions



Source: Virginia Department of Forestry

2.5. *Overview of wood-related industry*

A recently (2013) released report on "The Economic Impacts of Agriculture and Forest Industries in Virginia[9]" calculated the overall economic output of Virginia's forest industry at more than $17 billion and 103,000 jobs, annually. Other documented values, such as wildlife and forest-based recreational activities, environmental benefits, such as water quality and quantity, air pollution reductions and other services, provide an additional $9 billion dollars and tens of thousands of jobs, annually.

Virginia's forest product industries, like elsewhere in the U.S., have been affected by a severe contraction in demand caused by the national housing slump, the recent recession and slow growth economy, and long-term structural changes induced by new technology and international competition. The logging industry has also been hampered by supply issues such as increased fuel costs, the steep costs of capital equipment, an aging workforce, difficulties recruiting employees, and the need to adapt logging practices to deal with an increasingly smaller forest tract sizes.

Employment declined substantially in the furniture and paper manufacturing industries before the recent recession. Although primary wood product establishments had been closing and consolidating earlier (shrinking from 259 sawmills in 1999 to 168 in 2005), the changes resulted in larger, more efficient firms. Because of a buoyant housing market, overall employment did not decrease.

The information below present a few highlights about Virginia's timber product output (TPO)[10] and the main available figures related to the period 2007-2009. Between 2007 and 2009, TPO from

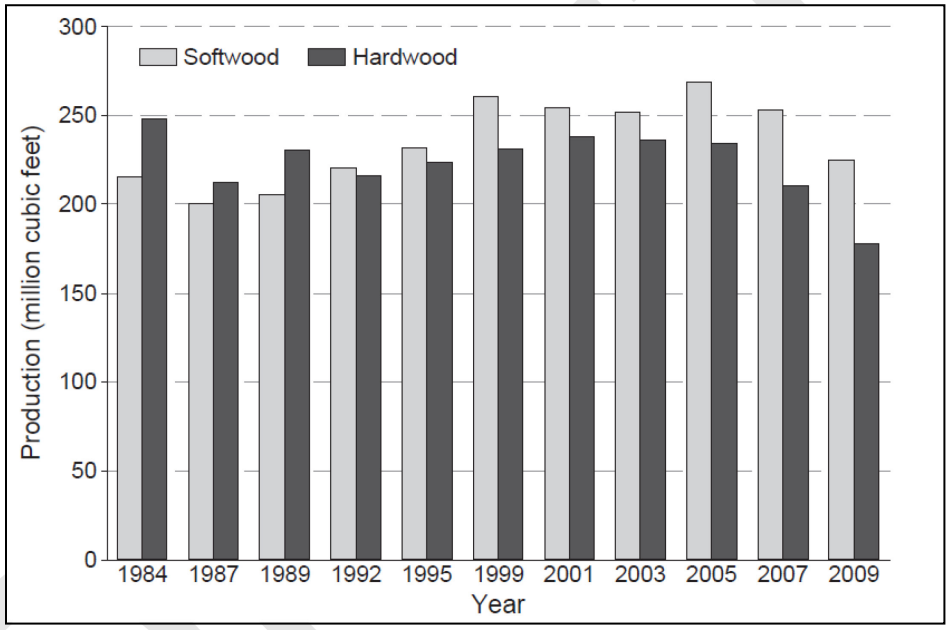
[9] http://www.dof.virginia.gov/print/index.htm - from University of Virginia
[10] Virginia's Timber Industry-An Assessment of Timber Product Output and Use, 2009 (http://www.srs.fs.usda.gov/pubs/38651)

roundwood decreased by 13% (from 13.1 million m³ to 11.4 million m³). Products from softwood processing decreased by 11% and output from hardwood processing declined by 16% (Figure 8). The impact of the subprime crisis is clearly visible.

Saw logs and pulpwood are the main products (Figure 9). Combined output of these products accounted for 83% (9.4 million m³) of Virginia's total output from roundwood processsing.
³.

At the same time, the number of primary roundwood-using plants in Virginia declined from 179 in 2007 to 151 in 2009. The location of wood processing industries in Virginia is presented on Figure 10.

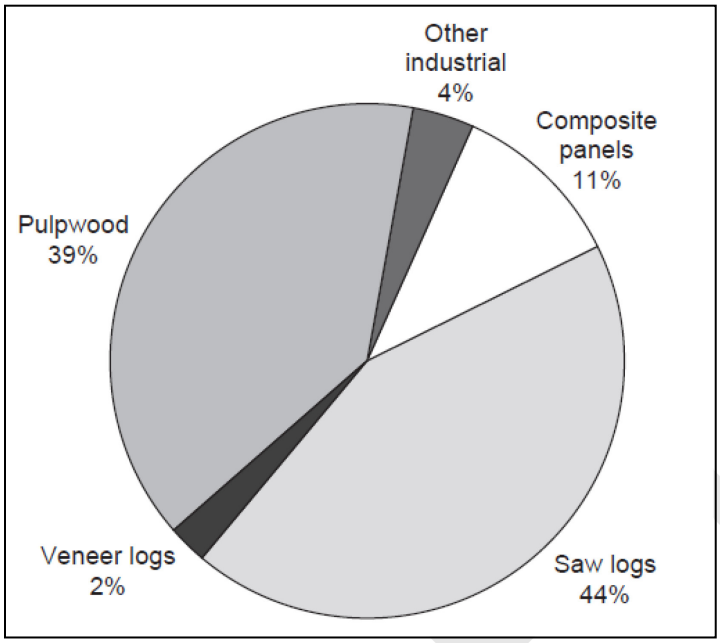
Figure 8 : Roundwood production for all products by species group and year (Virginia – 1984-2009)



Source: USDA – Forest Service (Assessment of TPO and Use, 2009)

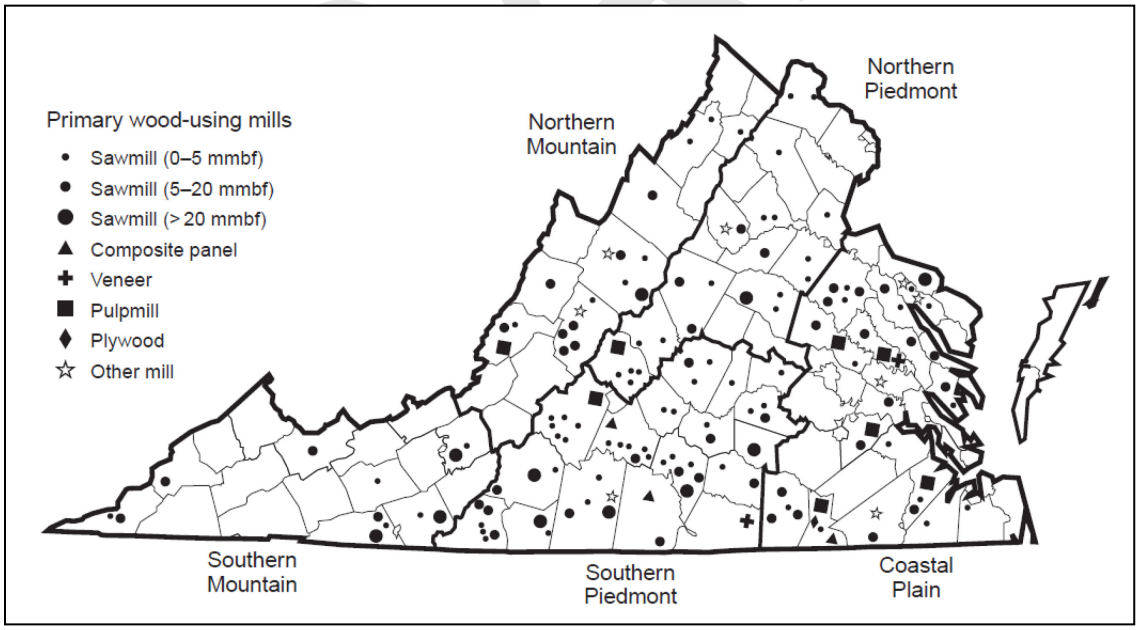
Across all products, 78% of roundwood harvested was retained for processing at Virginia mills. Exports of roundwood to other States amounted to 2.4 million m³, while imports of roundwood amounted to 2.3 million m³ making the State a net exporter of roundwood.

Figure 9 : Roundwood production by type of product (Virginia, 2009)



Source: USDA – Forest Service (Assessment of TPO and Use, 2009)

Figure 10 : Primary wood-using mills by region (Virignia, 2009)



mmbf = million board feet

Source: USDA – Forest Service (Assessment of TPO and Use, 2009)

3. Sustainability of Virginia forest

3.1. Evolution of forest area an risk of conversion

The Table 4 and related Figure 11 hereafter consider the detailed information available (2012) in the US Forest service database[11] and the evolution mainly during the last decade. Forest area appears slightly fluctuating between 2001 and 2011, and eventually the total forestland area in 2012 is nearly the same as in 2001.

The earliest available data regarding timberland show a significant decrease between 1977 and 1985 (with a loss of about 3.4%).

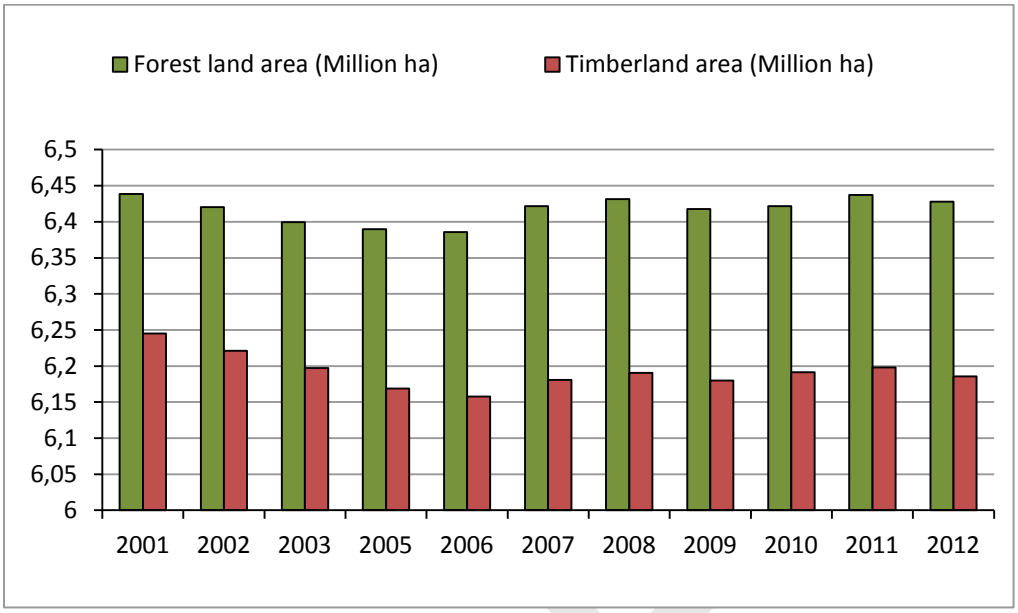
Table 3 : Evolution of forested area (2001-2012) and timberland (1977-2012) in Virginia

Year	Forestland (ha)	Change (ha)	Change %	Timberland (ha)	Change (ha)	Change %
1977	-	-	-	6463966	-	-
1985	-	-	-	6246913	-217053	-3.36%
1992	-	-	-	6251776	4863	0.08%
2001	6438343	-	-	6244964	-6812	-0.11%
2002	6420307	-18036	-0.28%	6221316	-23648	-0.38%
2003	6399661	-20646	-0.32%	6197070	-24246	-0.39%
2005	6389890	-9771	-0.15%	6168786	-28284	-0.46%
2006	6385866	-4024	-0.06%	6157776	-11010	-0.18%
2007	6421761	35895	0.56%	6180792	23016	0.37%
2008	6431531	9770	0.15%	6190356	9564	0.15%
2009	6417731	-13800	-0.21%	6179870	-10486	-0.17%
2010	6421523	3792	0.06%	6191281	11411	0.18%
2011	6437357	15834	0.25%	6198071	6790	0.11%
2012	6427724	-9633	-0.15%	6185819	-12252	-0.20%

Source: adapted from US Forest service, FIA Program (http://apps.fs.fed.us/fido/standardrpt.html)

[11] http://apps.fs.fed.us/fido/standardrpt.html

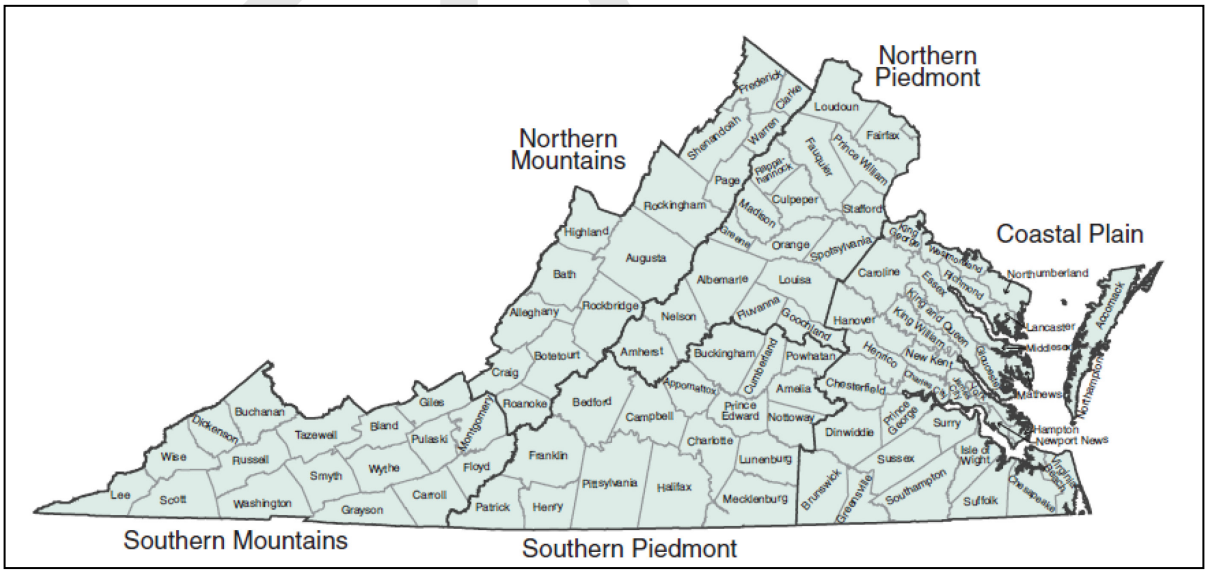
Figure 11 : Change in forest land and timberland area over time – Virginia



Source: adapted from US Forest service, FIA Program (http://apps.fs.fed.us/fido/standardrpt.html)

Figure 13 shows the distribution[12] of the forestland area (between 2001 and 2011) by FIA survey units (Forest Inventory and Analysis Units – US Forest Service - Figure 12). At the survey unit level, the Coastal Plain saw the biggest decrease of forest land (-2.1%), compensated by an increase in other regions, mainly in the Northern Mountains (+1.8%).

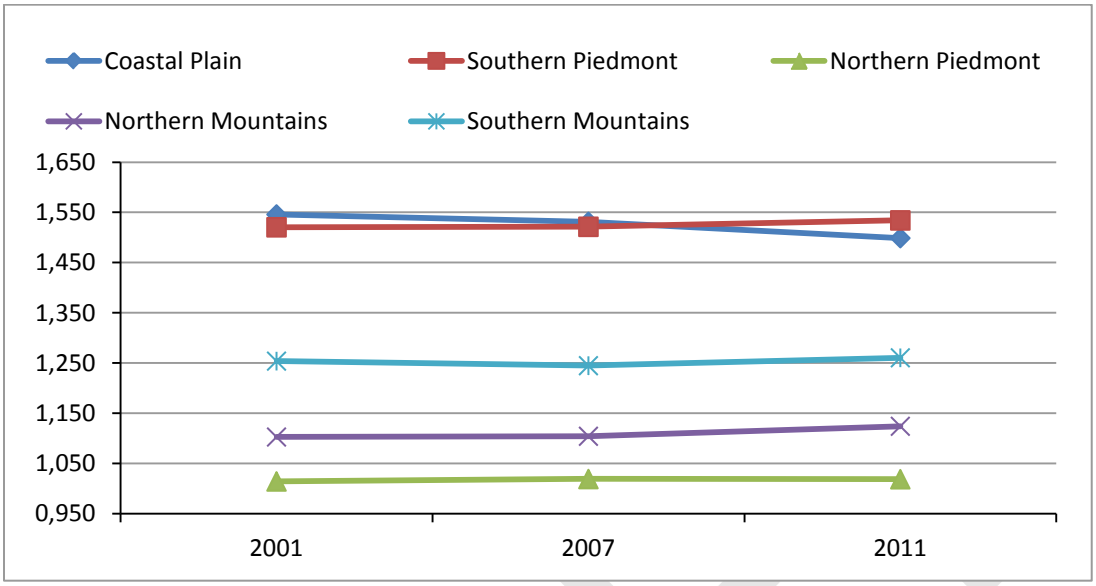
Figure 12 : Forest Inventory and Analysis Survey Units in Virginia



Source: Virginia Department of Forestry

[12] Forest inventory & Analysis Factsheet 2011 – USDA, Forest Service - http://www.srs.fs.usda.gov/pubs/45264

Figure 13 : Forest land area (in million ha) change by FIA survey unit



Source: adapted from Forest Inventory & Analysis Factsheet – Virginia , 2011 – USDA, Forest Service

The yearly data of the Forestry Inventory and Analysis (FIA) makes possible to further investigate the recent decrease of the forest areas in Virginia, through the evolution of forest area by county (see annex 1)[13].

The FSC risk assessment platform www.globalforestregistry.org considers the USA are at unspecified risk in terms of conversion of forest to other land uses, because the following criterion is not verified in the country:

- There is no net loss AND no significant rate of loss (> 0.5% per year) of natural forests and other naturally wooded ecosystems such as savannahs taking place in the eco-region in question.

Indeed, even though at the national level, forested area in the USA increase by 0.1% yearly on average, there are important regional variations and forest extent is are known to be decreasing in different parts of the country. Hence the Global Forest Registry recommends performing an analysis at the state level.

As we have seen above that the most recent trend in North Carolina was the gain of 0.1% of the forested area between 2007 and 2012, we can't exclude a risk of conversion and recommend an analysis at a finer level. The risk can be seen as unspecified at the state level.

At the county level annex 2 makes possible to identify counties where the average annual losses of forest were in excess of 0.5% (which is the threshold the Global Forest Registry refers to in its risk assessment). There are 24 counties and 4 independent cities where the 0.5% threshold was

[13] http://apps.fs.fed.us/fido/standardrpt.html

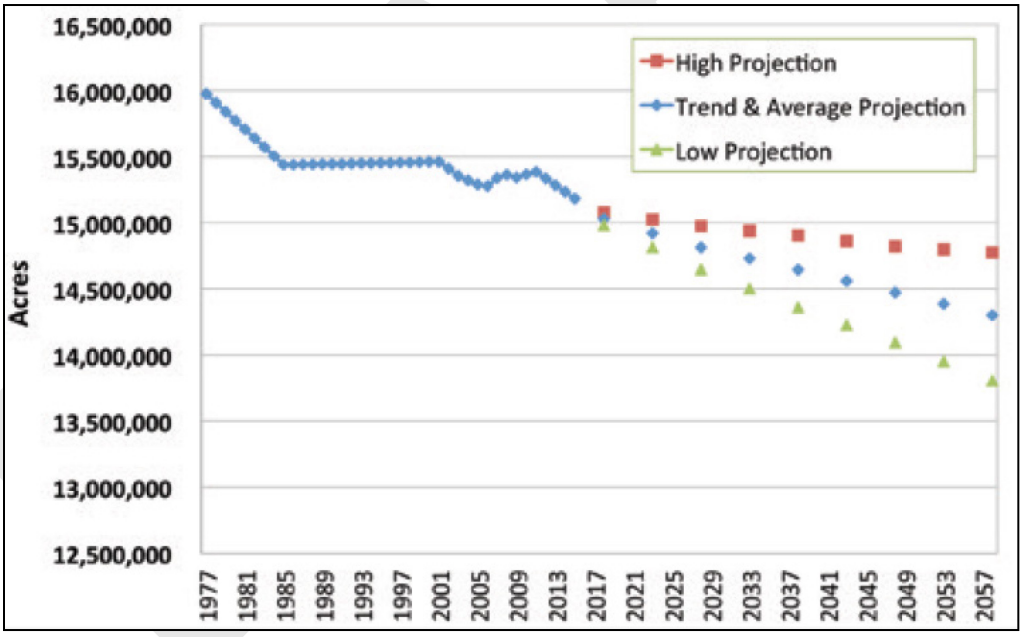
exceeded as yearly average in the period 2007-2012 (out of 94 counties and 5 independent cities which are relevant to consider in terms of forestry[14]).

Unsurprisingly most of those counties where the forest land has been decreasing are located in the coastal plain area. The influence of Washington DC and Richmond, associated with high population densities, leads to urbanisation pressure.

In late 2012, the Southern Forest Futures Project (SFFP) summary report was released, which will be followed by subregional summaries. The goal of this project is to model and project the tentative impact of urbanization/ population growth; climate change; non-native invasive and timber markets/demand on the extent and composition of the forests of the South. The study uses six scenarios or "cornerstones" to project future trends in forestland area, forest type and timber volume production among other parameters.

For Virginia[15], the SFFP study estimates an annual loss of about 8400 ha of timberland through the year 2058 (Figure 14). The loss of forest area is distributed among the various forest types, with the exception of pine plantations, which are expected to increase (Figure 15).

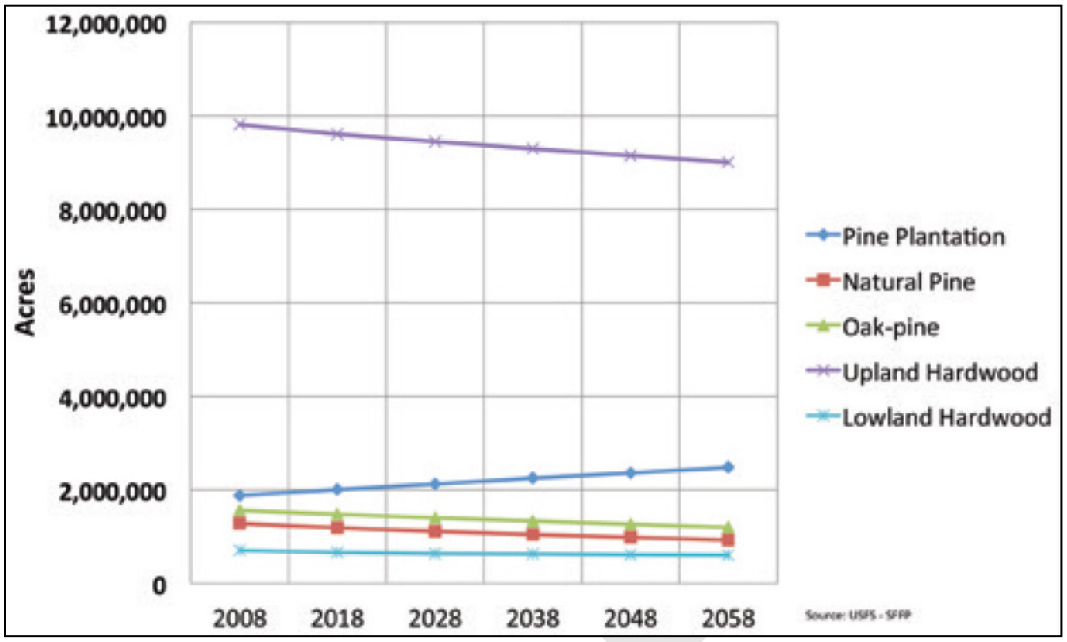
Figure 14 : Trend and projection of timberland area for Virginia



Source:' Southern Forest Futures Project & FIA' and '2013 State of the forest–VDOF')

[14] more independant cities exist but are not liste in USDA inventory because they don't have any forest land.
[15] 2013 State of the forest–VDOF' - http://www.dof.virginia.gov/print/index.htm - from 'The Southern Forest Futures Project'

Figure 15 : Projection of forest types 2008-2058 in Virginia

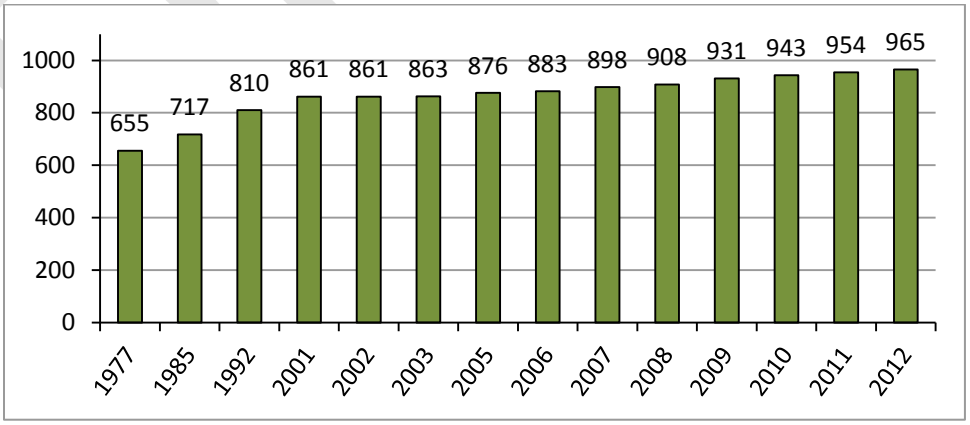


Source:' Southern Forest Futures Project & FIA' and '2013 State of the forest–VDOF')

3.2. Living wood volumes and removals

Figure 16 shows the evolution of net volume of live trees in timberland between 1977 and 2012. For all species combined, the net volume of live trees on timberland in Virginia has increased by 47% since 1977. A slight but permanent increase is recorded during the last decade (evolution of about 12% between 2002 and 2012).

Figure 16 : Evolution of net volume of live trees (at least 5 inch d.b.h./d.r.c.) in million m³ on timberland (Virginia, 1977-2012)



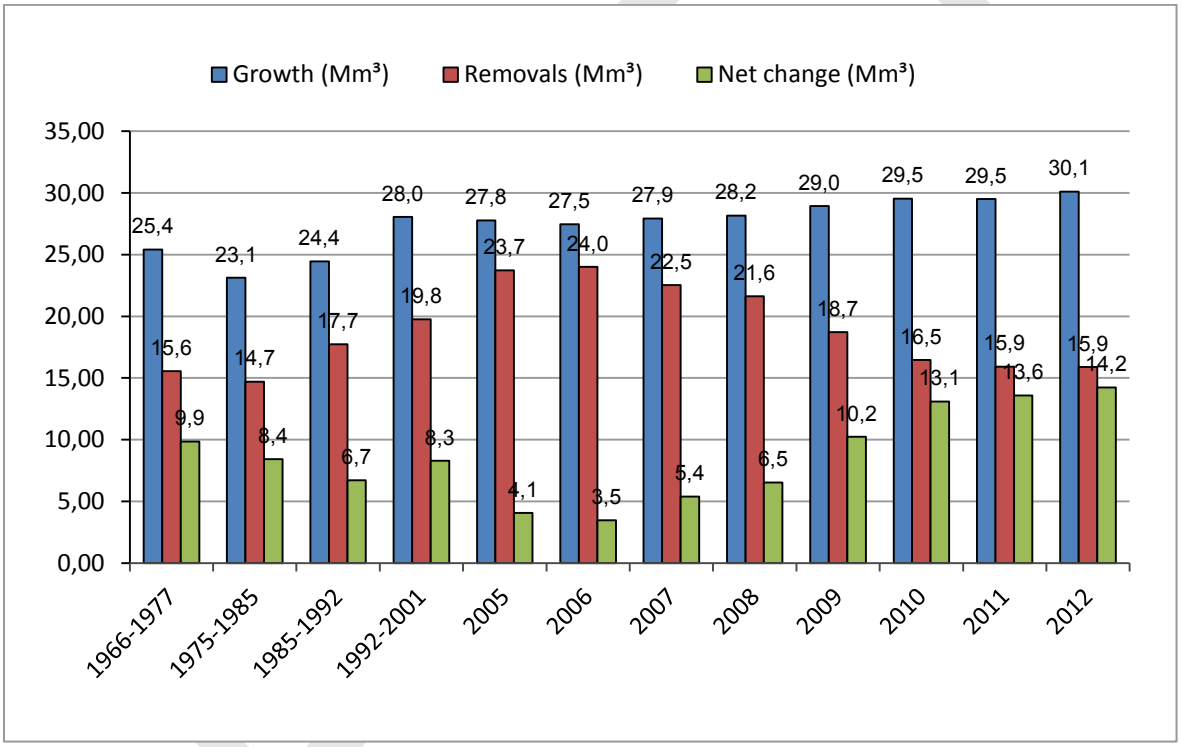
Source: adapted from USDA – Forest Service (http://apps.fs.fed.us/fido/standardrpt.html)

According to the USDA – Forest Service, in 2012, the net annual growth of live trees volume on timberland averaged 30.1 million m³, annual mortality 7.9 million m³ and annual removals 15.9 million

m³. The growth, removals (harvesting and mortality) and net change between the mid 1960s and 2012 is presented on the Figure 19.

As we can see, the net growth of live trees exceeds removals since at least the mid 1960s, meaning that Virginia has been growing more wood volume than its harvesting since this moment. The average annual net growth has been rather stable between the early 1990s and 2008, before showing a slight and constant increase till 2012. Average annual removals peaked in 2006 before decreasing constantly till 2011. In these recent years, decreased harvests attributable to declining domestic timber demand have contributed to this situation, according to a report released by the University of Virginia[16]. Because the gap between annual growth and annual removals has been growing since 2005, the net increase in forest living woody biomass has been increasing as well.

Figure 17 : Average net annual growth VS removals of live trees on timberland (at least 5 inch d.b.h./d.r.c.), in million m³



Net change = net growth - removals

Source: adapted from USDA – Forest Service (http://apps.fs.fed.us/fido/standardrpt.html)

[16] The Economic Impacts of Agriculture and Forest Industries in Virginia

3.3. Protection of ecosystems and biodiversity

As shown on Table 6, the conservation land in Virginia covers 1121129 ha, which is about 10.1% of the state area. It is a rarther high percentage compared to other states in the South East. This includes both public and private land, under various conservation status. Figure 20 shows an overview of all protected areas in Virginia. Those protected areas are either public (federal, state, county or local) and private lands.

Table 4 : Land under protection status in Virginia (as of 2011)

	Status 1	Status 2	Status 3	Total
Acres	542039	544385	1683946	2770370
Ha	219355	220305	681469	1121129
Percentage of state area	1.98%	1.99%	6.15%	10.12%

Source: USGS Gap analysis http://gapanalysis.usgs.gov/

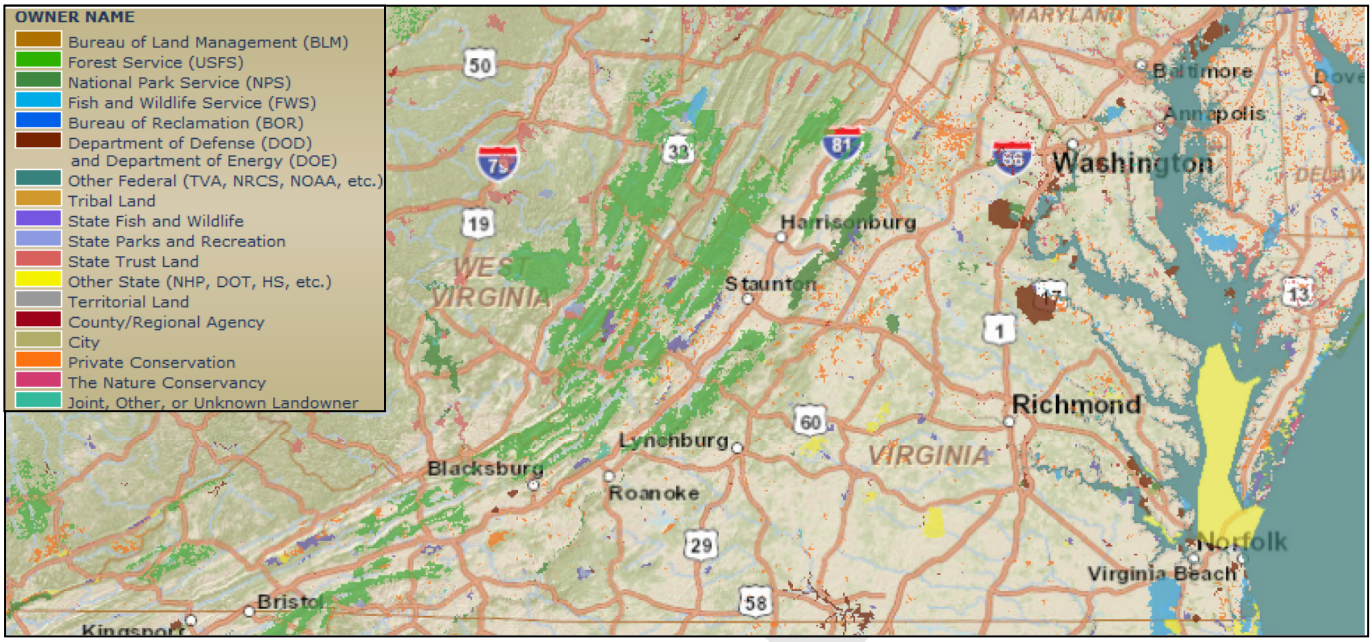
Status 1: An area having permanent protection from conversion of natural land cover and a mandated management plan in operation to maintain a natural state within which disturbance events (of natural type, frequency, intensity, and legacy) are allowed to proceed without interference or are mimicked through management.

Status 2: An area having permanent protection from conversion of natural land cover and a mandated management plan in operation to maintain a primarily natural state, but which may receive uses or management practices that degrade the quality of existing natural communities, including suppression of natural disturbance.

Status 3: Area having permanent protection from conversion of natural land cover for the majority of area. Subject to extractive uses of either broad, low-intensity type (eg. Logging) or localized intense type (eg. Mining). Confers protection to federally listed endangered and threatened species throughout the area.

Note that different figures exist in terms of total conservation area in the State, depending on the categories of protection that are taken into account (particularly in the status 3 as defined above). For example, Figure 20 includes military zones, which are not designated for the purpose of biodiversity and ecosystems protection, even though they might be of considerable interest because the areas are very large and continuous, with most of the time very little human disturbance.

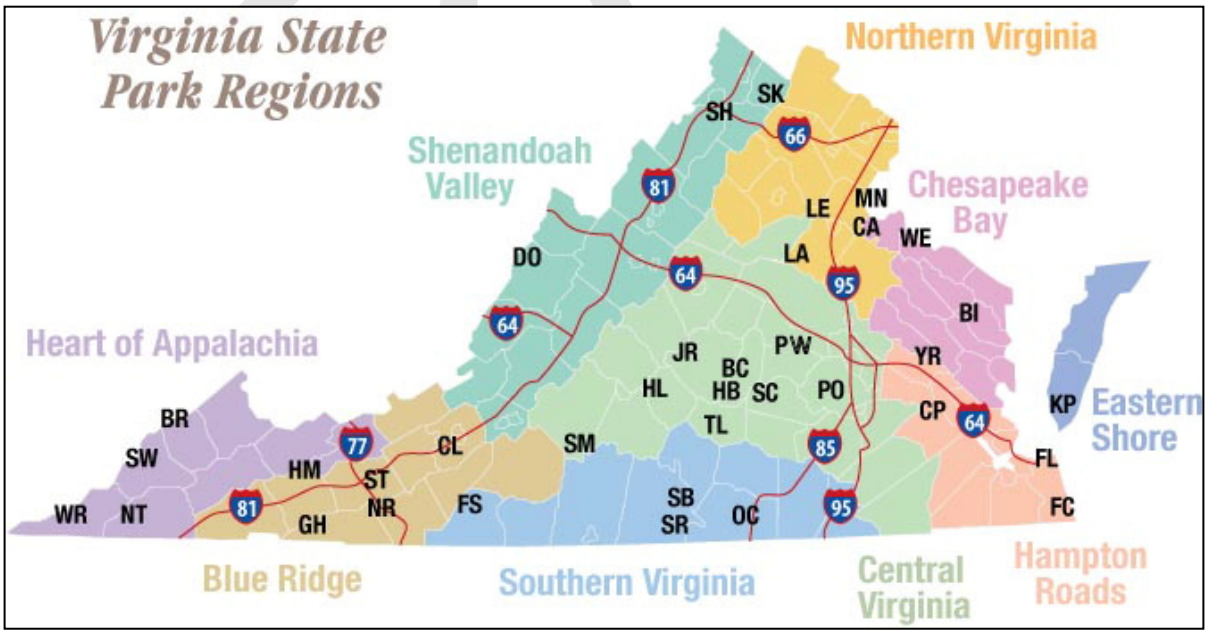
Figure 18 : Protected areas in Virginia



Source: National Gap Analysis Program (GAP) – Protected areas data viewer (http://gis1.usgs.gov/csas/gap/viewer/padus/Map.aspx)

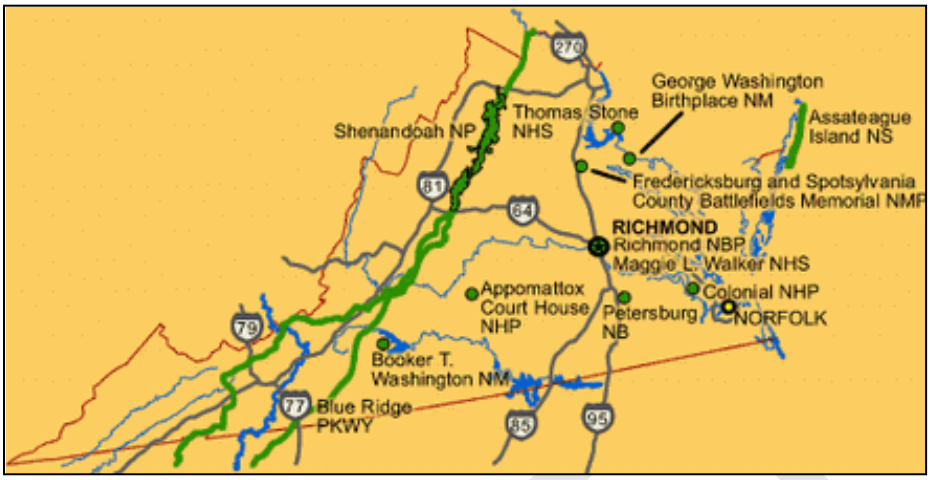
Figure 21 gives an overview of the locations (by two-letter groupings) and distribution of State parks in Virginia. Figure 22 shows the location of national parks in Virginia.

Figure 19 : State Parks in Virginia



Source: http://www.dcr.virginia.gov/state_parks/amenity-search.shtml

Figure 20 : National parks in Virginia



Source: http://usparks.about.com/cs/usparklocator/l/blpkva.htm

There have been recent efforts to improve the situation. Table 7 and related Figure 23 show the new surfaces put into conservation between 1998 and 2005 (unfortunately, no more recent data are available yet for Virginia in the source mentioned). We can see that the extent of new land turned to conservation yearly has significantly increased each year since 1998.

Table 5 : New land under conservation status per year in Virginia (1998-2005)

Year	1998	1999	2000	2001	2002	2003	2004	2005	Total
Acres	1741	3785	21309	26553	44037	39830	57990	66659	261903
ha	705	1532	8623	10746	17821	16119	23468	26976	105988

http://www.conservationalmanac.org

A number of conservation schemes have been introduced recently to increase the conservation land in Virginia, including initiatives to encourage conservation on private land (which is particularly important given the proportion of private forests within the State).

The most important programs are described hereunder:

- **Department of Conservation and Recreation**[17]: The Department of Conservation and Recreation acquires land for state park's and state Natural Area Preserve lands. Funding is made available through annual legislative appropriations.

- **Department of Game and Inland Fisheries**[18]: Beginning on the mid 2000, legislation passed by Virginia's General Assembly allocated the state's two percent share of the sales tax revenue generated from the sale of hunting, fishing, and wildlife watching equipment to the Game Protection Fund.

[17] http://www.conservationalmanac.org/secure/almanac/midatlantic/va/programs.html
[18] http://www.conservationalmanac.org/secure/almanac/midatlantic/va/programs.html

- **Virginia Land Conservation Foundation (VLCF)**[19]: A major building block of Virginia's conservation efforts is the VLCF. VLCF manages the Virginia Land Conservation Fund. The Fund provides grants to state agencies, including the Virginia Outdoors Foundation, and matching grants to local governments and nonprofit organizations for land acquisition and purchase of development rights to protect open spaces and parks, natural areas, historic areas, farmlands, and forests.

- **Virginia Outdoors Foundation (VOF) Open Space Lands Preservation Trust Fund**[20]: Created in 1966, the VOF has the mission "to promote the preservation of open-space lands and to encourage private gifts of money, securities, land or other property to preserve the natural, scenic, historic, scientific, open-space and recreational areas of the Commonwealth." A portion of VOF's operating expenses are funded by annual appropriations from the General Assembly. Donations, interest income, and recordation fees fund the rest of the Foundation's work in localities where VOF has an open-space easement fund. The 1997 Virginia General Assembly created the Open Space Lands Preservation Trust Fund, to assist landowners with the costs of conveying open-space easements and the purchase of all or part of the value of the easements. VOF holds most of the easements obtained under the Land Conservation Tax Incentives Program.

- **Land Conservation Tax Incentives**[21]: The Virginia Land Conservation Incentives Act of 1999 significantly enhanced the tax benefits available to private landowners who donate land or conservation easements to the state. Under the tax credit program, a landowner can receive an income tax credit equal to 40 percent of the fair market value of the donated land or easement. If the total tax credit exceeds the maximum annual allotment, the excess value can be carried over for a total of ten years. The law changed in 2007 by reducing the credit from 50 percent to 40 percent and implementing a statewide cap of $100 million in the tax credits available.

- **Virginia Clean Water Revolving Loan Fund – Land Conservation Loan Program**[22]: During the 2003 session, the Virginia General Assembly amended a part of the Code of Virginia. The new code section further expanded the activities of the Virginia Water Facilities Revolving Fund (the Fund) by allowing the State Water Control Board to authorize low interest loans from the fund for acquisition of title or other rights to real property, provided that the State Water Control Board is satisfied that the acquisition would protect or improve water quality and prevent pollution of state waters.

- **The Forest Legacy Program (FLP)**[23]: The FLP, a program of the USDA Forest Service in partnership with States, supports State efforts to protect environmentally important forestlands. The program is designed to purchase land, or conservation easements, in an

[19] http://www.conservationalmanac.org/secure/almanac/midatlantic/va/programs.html
[20] http://www.conservationalmanac.org/secure/almanac/midatlantic/va/programs.html
[21] http://www.conservationalmanac.org/secure/almanac/midatlantic/va/programs.html
[22] http://www.conservationalmanac.org/secure/almanac/midatlantic/va/programs.html
[23] http://www.dof.virginia.gov/land/legacy/index.htm

effort to protect private land that is threatened by conversion to non-forest uses. FLP is an entirely voluntary program that utilizes Federal grant funds to assist states in conserving lands that provide public benefits including sustainable forest resources, clean water, clean air, wildlife habitat, and forested scenic views, as well as protecting sensitive sites and habitats utilized by threatened and endangered species.

- **The Conservation Reserve Enhancement Program (CREP)**[24]: The CREP is a state/federal conservation program administered by the USDA Farm Service Agency. The primary goal is to improve water quality (by establishing vegetative buffers along streams, intermittent streams, other water bodies and around sinkholes), provide livestock with limited access to streams or alternate watering facilities outside of riparian areas and increase wildlife habitat in riparian areas and restore wetlands. In Virginia, this program is applicable in the entire Chesapeake Bay and certain watersheds in Southern Rivers region.

- **The Conservation Reserve Program (CRP)**[25]: The CRP is also administered by the USDA Farm Service Agency and is applicable in all counties. Its primary goal is to establish long-term resource conserving covers and implement certain high-priority conservation practices on eligible land.

- **The Conservation Stewardship Program (CSP)**[26]: The CSP is a voluntary program that encourages agricultural and forestry producers to address resource concerns by undertaking additional conservation activities and improving and maintaining existing conservation systems. CSP provides financial and technical assistance to help land stewards conserve and enhance soil, water, air, and related natural resources on their land.

3.4. Protection of water

In the US, the Clean Water Act (CWA) was introduced in 1972 to regulate the discharge of pollutants in water. In this framework, forestry operations are considered as nonpoint sources and, hence, are generally exempted for permit under CWA as long as Best Management Practices (BMP) are developed and implemented. It is the responsibility of states to develop, implement and assess the Best Management Practices, under the control and funding of the federal Environmental Protection Agency (EPA). Even though the impact on water is the core of the BMP, many states have gone further and used the BMP as a tool for other management purpose (soil, landscape, wildlife etc...).

The 'Virginia's Forestry Best Management Practices for Water Quality' was released in 2011[27]. The administration in charge of the BMP is the Virginia Department of Forestry (VDOF) which inspects logging jobs to ensure that best management practices are being followed by loggers. VDOF also has a major role in protecting watersheds through riparian forest buffers. Riparian forest buffers

[24] http://www.dof.virginia.gov/financing/costshare/index.htm
[25] http://www.dof.virginia.gov/financing/costshare/crp-cont.htm
[26] http://www.dof.virginia.gov/financing/costshare/csp.htm
[27] http://www.dof.virginia.gov/water/index-BMP-Guide.htm

reduce erosion and cleanse water entering streams. These activities are allowed under the Code of Virginia (Water Quality Law).

The topics covered by the BMP:

- Planning for forestry operations
- Forest roads
- Timber harvesting
- Site preparation and reforestation
- Silvicultural chemical treatment
- Fire management
- Wetland management

In Southeast USA, there are specific arrangements for the site preparation before establishing pine plantations on wetlands[28]. Such operations are no exempt of permitting on wetlands and a specific permit under CWA section 404 has to be obtained. This makes possible for the administration to better control the mechanical works in sensitive environment.

Additionally, according to the BMP in Virginia, canals and ditches providing minor drainage to temporarily lower the water level on a wetland site during road construction, timber harvesting and site preparation are considered normal and exempt from Section 404 permitting if it does not result in the immediate or gradual conversion of a wetland to an upland or other land use.

Under the CWA, it is required to regularly evaluate to what extent the BMP are actually implemented in the practice. The last assessments[29] in the state of Virginia were completed in 2012 and concerned 240 harvested tracts across the State.

The 2012 assessments show good results. It was estimated that just less than 90% of the relevant BMP were implemented. While Table 8 shows statewide results, Table 9 shows the BMP average values by VDOF administrative region (Figure 7). These averages are the result of combining questions in the categories across all 240 audits as a single complete set and averaging those questions by category.

[28] http://water.epa.gov/lawsregs/guidance/wetlands/silv2.cfm
[29] http://www.dof.virginia.gov/water/index.htm

Table 6 : Statewide data for the 2012 BMP audit by BMP category

BMP Category	Number of Tracts	Yes (%)	Margin of Error (%)
Roads	196	85.2	+/- 5.1
Decks	240	94.1	+/- 3.1
Crossings	106	91.5	+/- 5.4
SMZs	175	91.5	+/- 4.2
Wetlands	11	92.3	+/- 16.1
Planning	240	85.4	+/- 4.6
Skidding	237	89.6	+/- 4.0
Mechanical	4	74.2	+/- 43.8
Fire	4	89.5	+/- 30.7
Chemicals	2	100.0	–
All	240	89.7	+/- 3.9
Logging	240	89.8	+/- 3.8

Source: Silvicultural BMP Implementation Monitoring for Virginia - VDOF

Table 7 : Regional data for the 2012 BMP audit by BMP category

BMP Category	Eastern (% Yes)	Central (% Yes)	Western (% Yes)
Roads	83.0	84.0	88.2
Decks	93.9	93.7	94.9
Crossings	90.5	93.3	87.8
SMZs	97.9	90.2	83.9
Wetlands	96.6	N/A	50.0
Planning	94.5	83.6	75.9
Skidding	95.6	88.5	86.4
Mechanical	N/A	95.2	30.0
Fire	N/A	93.0	78.6
Chemicals	100.0	N/A	N/A
All	93.1	89.1	87.3

Source: Silvicultural BMP Implementation Monitoring for Virginia - VDOF

Statewide, according the 2012 Southern Region[30] Report (Implementation of Forestry BMP), overall BMP implementation rate was 75%, 82% and 86 % respectively for the year 2007, 2009 and 2011.

[30] http://www.southernforests.org/resources/publications/SGSF%20BMP%20Report%202012.pdf/view

3.5. Protection of soils

The protection of soil, including soil erosion, soil compaction, soil fertility, pollution control/prevention is addressed in the Best Management Practice applicable to forestry in Virginia. It includes considerations of soil in all the topics mentioned in the section 3.4, with a special focus regarding the soil erosion.

As described under section 3.4, it appears from the BMP Implementation and Compliance Survey that the BMP are generally well implemented in the State of Virginia.

In Virginia, the Soil and Water Conservation Districts[31] (Virginia Department of Conservation and Recreation) were established in the 1930s to develop comprehensive programs and plans to conserve soil resources, control and prevent soil erosion, prevent floods and conserve, develop, utilize and dispose water. Since the mid-1980s, the Department of Conservation has relied heavily on districts to help deliver many programs aimed at controlling and preventing nonpoint source pollution, often on a hydrologic unit basis.

Despite some search about this topic, we are not aware of any monitoring programme at the State level exists in order to assess the soils condition (erosion, compaction, fertility, pollution) as well as their evolution over time.

3.6. Protection of carbon stocks

In forest land the carbon stocks mainly includes:

- living above ground and below ground woody biomass,
- soil organic carbon,
- carbon in litter.

We have seen in section 3.2 that the volume of live trees has been increasing in Virginia since at least the mid 1970s. In this context, the sequestrated carbon stock in living biomass has increased.

As shown in the Table 10 : and related Figure 24 (data from the US Forest service (FIA Program)), we can see a constant increase of carbon stocks regarding the living above/below ground woody biomass and the litter over the last decade. The estimated soil organic carbon is rather stable, with some fluctuation (slight decrease between 2001 and 2005 and an overall increase since 2006 till 2012).

Despite the slight fluctuations in the estimated amounts of soil organic carbon, we can consider that the sum of the main carbon stocks in forest land has constantly increased since 2001 totalling an increase with 6% between 2001 and 2011.

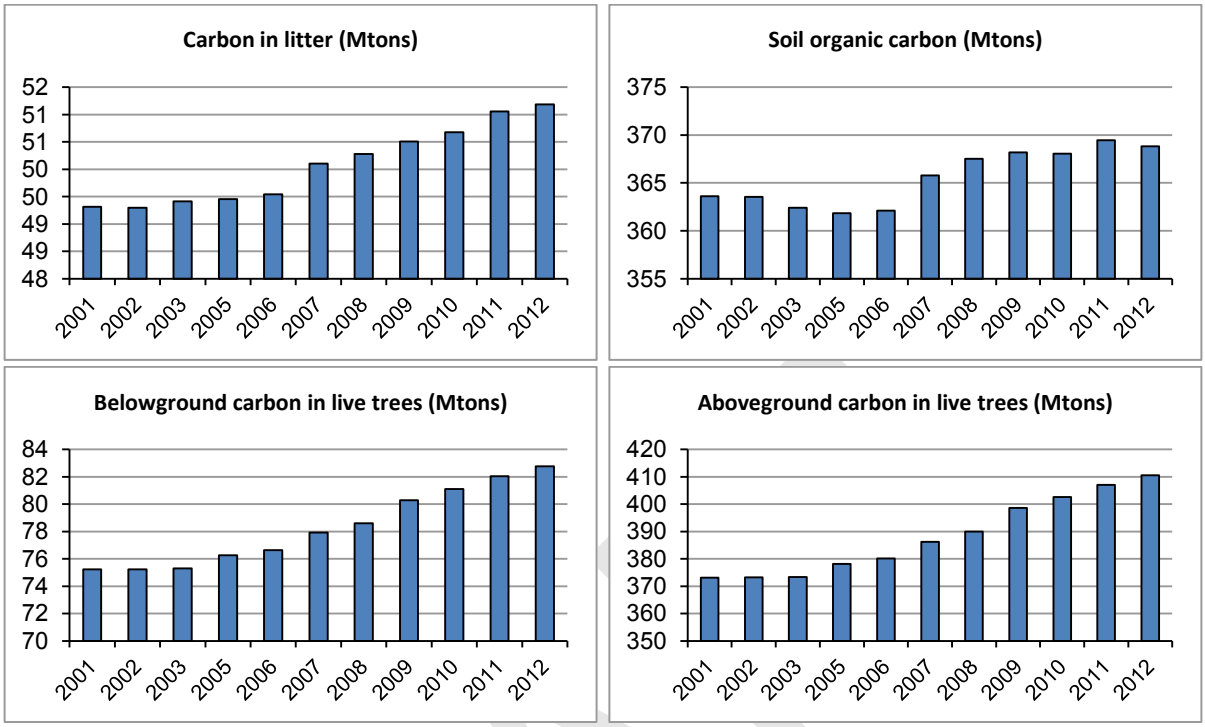
[31] http://www.dcr.virginia.gov/water_quality/swcds.shtml#npsroles

Table 8 : Carbon stocks evolution in forestland – (Virginia 2001-2012)

Year	Carbon in litter (million tons)	Soil organic carbon (million tons)	Belowground carbon in live trees (at least 1 inch d.b.h./d.r.c.) (million tons)	Aboveground carbon in live trees (at least 1 inch d.b.h./d.r.c.) (million tons)
2001	49.32	363.60	75.22	373.09
2002	49.29	363.54	75.23	373.24
2003	49.41	362.42	75.30	373.36
2005	49.45	361.83	76.27	378.16
2006	49.54	362.10	76.64	380.13
2007	50.11	365.78	77.92	386.27
2008	50.28	367.52	78.60	389.93
2009	50.51	368.18	80.29	398.62
2010	50.67	368.06	81.10	402.56
2011	51.06	369.46	82.03	407.00
2012	51.19	368.81	82.77	410.55

Source: adapted from US Forest service, FIA Program (http://apps.fs.fed.us/fido/standardrpt.html

Figure 21 : Carbon stocks evolution in forestland – Virginia, 2001-2012



Source: adapted from US Forest service, FIA Program (http://apps.fs.fed.us/fido/standardrpt.html

3.7. Protection of air quality

The main impact of forestry on air quality relates to the use of fire. Using fire under controlled conditions is a common practice in Virginia ("prescribed burning"). Prescribed burning is an important and useful silvicultural tool which can have different objectives:

- Prepare sites before seeding and planting
- Reduce hazardous fuels under tree stands to prevent wildfires
- Improve wildlife habitat
- Improve forage for grazing (through changes in underbush vegetation)
- Manage competing vegetation
- Control insects and disease
- Enhance appearance (refresh forest appearance, improve flowering....)
- Improve access (clear underbush before harvesting or other operations)

The BMP describes appropriate use of fire and prevention of wildfires, including appropriate implementation of firebreaks.

In order to assist in achieving the objectives of "prescribed burning", as well as to minimize its related problems, the Virginia Department of Forestry has established a Certified Prescribed Burn Managers Program. This program includes training on fire behaviour, environmental effects of fire and smoke management.

Additionally, The Virginia Department of Forestry has developed voluntary smoke management guidelines to minimize concentrations of smoke in sensitive areas and assist in maintaining air quality standards.

Open burning is subject to permit in Virginia and is regulated by the State Air Pollution Control Board and the Virginia Department of Forestry. As burning vegetation has an impact on air quality, open fires are banned from sensitive areas and during some periods of the years to avoid disturbance related to air pollution.

3.8. Illegal logging

The FSC risk assessment platform www.globalforestregistry.org considers the USA are at low risk in terms of illegal logging, because the following criteria are all verified:

1.1 Evidence of enforcement of logging related laws in the district [32]
1.2 There is evidence in the district demonstrating the legality of harvests and wood purchases that includes robust and effective system for granting licenses and harvest permits [33]
1.3 There is little or no evidence or reporting of illegal harvesting in the district of origin[34]
1.4 There is a low perception of corruption related to the granting or issuing of harvesting permits and other areas of law enforcement related to harvesting and wood trade[35]

[32] www.illegal-logging.info ; www.eia-international.org ; http://www.ahec-europe.org/
[33] www.illegal-logging.info ; www.eia-international.org ; http://www.ahec-europe.org/
[34] www.illegal-logging.info ; www.eia-international.org ; http://www.ahec-europe.org/
[35] http://www.transparency.org/cpi2012/results

3.9. Civil rights and traditional rights

The FSC risk assessment platform www.globalforestregistry.org considers the USA are at low risk in terms of violation of civil and traditional rights, because the following criteria are all verified:

- There is no UN Security Council ban on timber exports from the country concerned
- The country or district is not designated a source of conflict timber (e.g. USAID Type 1 conflict)
- There is no evidence of child labor or violation of ILO Fundamental Principles and Rights at work taking place in forest areas in the district concerned
- There are recognized and equitable processes in place to resolve conflicts of substantial magnitude pertaining to traditional rights including use rights, cultural interests or traditional cultural identity in the district concerned
- There is no evidence of violation of the ILO Convention 169 on Indigenous and Tribal Peoples taking place in the forest areas in the district concerned

3.10. Forest certification

The main forest certification schemes used in Virginia are:

- SFI (Sustainable Forestry Initiative[36]), which is endorsed by PEFC (Programme for the Endorsement of Forest Certification)
- ATFS (American Tree Farm System[37]), which is specifically suitable for small private owners
- FSC (Forest Stewardship Council[38]), which is represented in more than 50 countries.

The certified forest area under each of those schemes as for 2011 is presented in the table hereunder:

Table 9 : Certified forest land in Virginia (2011)

	SFI	FSC	ATFS	Total certified
Acres certified	406552	209683	903356	1519591
Ha certified	164526	84856	365575	614957
Percentage forests	2.58 %	1.33 %	5.73%	9.64%

Source: http://www.southernforests.org/resources/publications/SGSF%20Forest%20Certification%20Report%20r1.pdf

[36] http://www.sfiprogram.org
[37] https://www.treefarmsystem.org
[38] https://us.fsc.org

4. Conclusions

Virginia has an important forest that covers about 62% of the State's land area. Most of this forest is privately owned (82%).

The Oak-hickory forest type group occupies the largest proportion of forest land in Virginia with 60.8%. The loblolly-shortleaf pine group is second with 18.6%, followed by the oak-pine group (10.8%). It is expected that pine (particularly in intensively managed plantation) will take more importance in the future.

The earliest available data regarding timberland show a significant decrease between 1977 and 1985 (with a loss of about 3.4%), then the total forested surface in Virginia has become fairly stable. Despite this stabilization (with minor fluctuations) some counties (and independent cities) did experience a significant loss of forest between 2007 and 2012 (losses higher than 0.5% per year in 28 cases out of 99). Most of those losses occur in the coastal plain area, which is the most populated part of the states, particularly in the surroundings of Richmond and Washington DC. Those losses have been compensated in other parts of the state. As a result timberland surfaces in 2001 and 2012 and nearly identical (increase by 0.02% yearly).

While the forested areas were rather stable or slightly fluctuating, the estimated net volume of live trees on timberland (for all species combined) has been consistently increasing between 2001 and 2012, reflecting smaller removals (mortality and harvesting) and presumably more intensive forest management in some places (in particular, plantation of pines).

Because of the increase of the volume of standing trees, the carbon stock associated to living woody biomass has been growing as well. As a result the total carbon stocks (living above-ground and underground biomass, as well as litter and soil organic matter) are estimated to have increased by 6% between 2001 and 2011 .

Virginia has various types of conservation lands dedicated to the protection of biodiversity and ecosystems, including State parks, National parks, private reserves... The extent of the protected areas is rather good (10.1%), compared to other southern states. There have been recent efforts to improve the situation and various schemes have been introduced to promote conservation land, in particular on private grounds through tax incentives mechanisms. New land turned to conservation each year has been consistently increasing between 1998 and 2005.

Virginia has developed Best Management Practices (BMP) for forestry to comply with the Clean Water Act. Those BMP address both water and soil conservation. The most recent survey (2012) shows a rather good level (89.7%) of compliance and implementation of the BMP in the forestry operations.

Even though controlled fires are regularly used in forest management practices in Virginia, the use of fire is strongly regulated and fire is banned from sensitive areas and during some periods of the years to avoid disturbance related to air pollution.

The FSC risk assessment platform www.globalforestregistry.org considers the USA are at low risk in terms of violation of illegal logging and in terms of violation of traditional and civil rights.

The forest certification systems are little developed in North Carolina, with about 9.6% of forest certified under 3 systems SFI, ATFS and FSC.

ANNEX 1:

Forest area in Virginia by county (forest area in ha) from 2007 to 2012

County	2007	2008	2009	2010	2011	2012
Accomack (1)	44484	44484	43466	42292	43137	42274
Albemarle (3)	114584	114648	114780	115966	117389	118692
Alleghany (5)	99855	100373	102702	102468	102194	102118
Amelia (7)	62539	62334	63605	63727	63473	63687
Amherst (9)	94856	97401	96803	96936	96936	97614
Appomattox (11)	51015	51131	50844	50967	50803	50356
Arlington (13)	-	-	-	-	-	-
Augusta (15)	130165	133999	136140	137731	137504	139245
Bath (17)	130871	131633	128659	127845	127953	127780
Bedford (19)	117796	117722	118537	118740	118379	117332
Bland (21)	70459	70459	69517	71883	72650	72238
Botetourt (23)	95324	95859	96028	99315	99427	99740
Brunswick (25)	110885	110885	111698	106396	107677	106821
Buchanan (27)	116054	115978	118025	117422	117555	117159
Buckingham (29)	130364	126900	125535	125764	127075	128347
Campbell (31)	85702	85703	86742	91333	93440	93045
Caroline (33)	103237	103309	100880	100050	97753	98141
Carroll (35)	75262	74701	77768	77928	77902	78743
Charles City (36)	38585	38522	37773	36774	36740	36542
Charlotte (37)	88089	89408	89231	89276	88842	88546
Chesterfield (41)	67568	65183	62129	61379	62202	61806
Clarke (43)	9885	12205	12212	12194	12193	11814
Craig (45)	66187	64094	63366	63216	62629	63087
Culpeper (47)	44842	42208	42183	40850	40850	41197
Cumberland (49)	46698	46638	46325	46418	46234	45747
Dickenson (51)	79982	80169	80290	81568	81508	80730
Dinwiddie (53)	93680	93758	92459	91251	91839	92318
Essex (57)	33421	33537	35487	35148	35778	35183
Fairfax (59)	39361	38619	37792	35195	34143	35005
Fauquier (61)	82965	85855	87501	88326	88326	87199
Floyd (63)	48693	48693	49360	49400	49512	48742
Fluvanna (65)	40909	40909	40500	39957	40522	40717
Franklin (67)	108434	108414	107347	106478	106601	103769
Frederick (69)	61892	63070	62665	62580	62993	64832
Giles (71)	76608	76608	79169	79302	78868	76599
Gloucester (73)	37597	37597	35784	35581	35635	35761
Goochland (75)	44577	44806	44673	44886	44886	44495
Grayson (77)	64924	65458	64677	66127	65633	66610
Greene (79)	30026	30026	29973	30139	30139	30846
Greensville (81)	51663	51592	50286	49869	50752	49953
Halifax (83)	147473	145909	145819	150057	150105	150575
Hanover (85)	76829	77104	75058	74922	75554	74808
Henrico (87)	24093	24093	22350	21774	21950	21787
Henry (89)	78581	78561	78264	79405	79159	78342
Highland (91)	89091	89539	89438	89235	89320	89778
Isle Of Wight (93)	44515	44515	44428	43851	44705	44485
James City (95)	25938	25938	24071	23534	23858	23771
King And Queen (97)	56519	58975	58399	57047	57121	54974
King George (99)	30590	30590	29181	30718	30749	30857

County	2007	2008	2009	2010	2011	2012
King William (101)	43235	43687	42870	43191	43346	44228
Lancaster (103)	18507	18507	18242	18229	18482	18183
Lee (105)	72212	72212	74521	75334	74969	76106
Loudoun (107)	49439	50091	49830	46114	46114	45710
Louisa (109)	78727	79330	81444	81379	80409	78902
Lunenburg (111)	94796	94688	94591	99422	98560	98661
Madison (113)	38594	38594	39995	38207	38207	38481
Mathews (115)	10418	10500	10256	10190	10205	10261
Mecklenburg (117)	119221	117965	117922	118197	117737	120242
Middlesex (119)	21988	21988	20399	20162	20119	20165
Montgomery (121)	65354	65020	65950	65952	66104	66559
Nelson (125)	105681	103411	103021	103033	103033	103743
New Kent (127)	35628	35628	34088	34360	34322	34319
Northampton (131)	10228	10228	10512	10008	10376	10105
Northumberland (133)	24441	24313	23091	23442	23573	23545
Nottoway (135)	56365	60400	59161	59445	59319	58764
Orange (137)	55698	55698	56200	56137	58030	57687
Page (139)	40067	40275	40251	40154	40199	40391
Patrick (141)	81811	81685	81450	82087	81828	81262
Pittsylvania (143)	153533	152939	150896	152057	152502	152779
Powhatan (145)	39467	39455	41028	41090	41228	40869
Prince Edward (147)	59622	60079	59075	59138	58997	58898
Prince George (149)	43887	43887	42771	42383	42139	42693
Prince William (153)	35039	35698	34535	35168	35168	34365
Pulaski (155)	49145	49314	49959	49980	53207	52865
Rappahannock (157)	54827	54880	55019	54993	54993	53769
Richmond (159)	32276	32276	32385	31701	32182	31966
Roanoke (161)	34191	34208	34157	33789	34375	34263
Rockbridge (163)	102167	102763	102696	104944	105058	105197
Rockingham (165)	136578	135148	140390	142548	142664	142546
Russell (167)	59192	56730	56402	57804	57671	57712
Scott (169)	100071	102532	102688	99609	99807	99592
Shenandoah (171)	77048	75548	75544	76681	76829	76439
Smyth (173)	79182	79182	78704	76907	77314	76730
Southampton (175)	99822	99882	100541	99089	99198	99502
Spotsylvania (177)	57885	57315	57237	58911	60273	60821
Stafford (179)	51350	51350	49533	49579	49579	50760
Surry (181)	60396	59825	58397	58439	58922	58747
Sussex (183)	106283	108425	108681	105396	107183	106708
Tazewell (185)	92152	92152	91734	91115	91046	91061
Warren (187)	31141	31349	31380	31321	31059	30908
Washington (191)	84285	84285	84729	84764	84948	84744
Westmoreland (193)	36937	36937	36470	36106	36619	36223
Wise (195)	66003	66003	66059	66605	66341	68207
Wythe (197)	45491	45491	45548	45575	45673	45340
York (199)	19255	19255	17982	19979	17794	17858
Chesapeake (550)	37631	37631	38085	38153	38773	35738
Hampton (650)	522	522	485	521	521	498
Newport News (700)	2412	2412	2416	2304	2308	2345
Suffolk (800)	72792	72214	72110	70420	71096	70567
Virginia Beach (810)	15103	17515	16385	16196	16365	15491
Total	6421761	6431531	6417731	6421523	6437357	6427724

ANNEX 2:

Loss and gain of forestland (in %) by county between 2007 and 2012

County	Total change (ha) 2007-2012	Total change (%) 2007-2012	Yearly average (%) 2007-2012
Fairfax (59)	-4356	-11.07%	-2.21%
Henrico (87)	-2306	-9.57%	-1.91%
Chesterfield (41)	-5762	-8.53%	-1.71%
James City (95)	-2167	-8.35%	-1.67%
Middlesex (119)	-1823	-8.29%	-1.66%
Culpeper (47)	-3645	-8.13%	-1.63%
Loudoun (107)	-3729	-7.54%	-1.51%
York (199)	-1397	-7.26%	-1.45%
Charles City (36)	-2043	-5.29%	-1.06%
Chesapeake (550)	-1893	-5.03%	-1.01%
Accomack (1)	-2210	-4.97%	-0.99%
Caroline (33)	-5096	-4.94%	-0.99%
Gloucester (73)	-1836	-4.88%	-0.98%
Craig (45)	-3100	-4.68%	-0.94%
Hampton (650)	-24	-4.60%	-0.92%
Franklin (67)	-4665	-4.30%	-0.86%
New Kent (127)	-1309	-3.67%	-0.73%
Northumberland (133)	-896	-3.67%	-0.73%
Brunswick (25)	-4064	-3.67%	-0.73%
Greensville (81)	-1710	-3.31%	-0.66%
Smyth (173)	-2452	-3.10%	-0.62%
Suffolk (800)	-2225	-3.06%	-0.61%
Newport News (700)	-67	-2.78%	-0.56%
King And Queen (97)	-1545	-2.73%	-0.55%
Surry (181)	-1649	-2.73%	-0.55%
Prince George (149)	-1194	-2.72%	-0.54%
Hanover (85)	-2021	-2.63%	-0.53%
Russell (167)	-1480	-2.50%	-0.50%
Bath (17)	-3091	-2.36%	-0.47%
Cumberland (49)	-951	-2.04%	-0.41%
Westmoreland (193)	-714	-1.93%	-0.39%
Rappahannock (157)	-1058	-1.93%	-0.39%
Prince William (153)	-674	-1.92%	-0.38%
Nelson (125)	-1938	-1.83%	-0.37%
Lancaster (103)	-324	-1.75%	-0.35%
Buckingham (29)	-2017	-1.55%	-0.31%
Mathews (115)	-157	-1.51%	-0.30%
Dinwiddie (53)	-1362	-1.45%	-0.29%
Appomattox (11)	-659	-1.29%	-0.26%
Prince Edward (147)	-724	-1.21%	-0.24%
Northampton (131)	-123	-1.20%	-0.24%
Tazewell (185)	-1091	-1.18%	-0.24%
Stafford (179)	-590	-1.15%	-0.23%
Richmond (159)	-310	-0.96%	-0.19%
Shenandoah (171)	-609	-0.79%	-0.16%
Warren (187)	-233	-0.75%	-0.15%
Patrick (141)	-549	-0.67%	-0.13%
Pittsylvania (143)	-754	-0.49%	-0.10%
Scott (169)	-479	-0.48%	-0.10%
Fluvanna (65)	-192	-0.47%	-0.09%
Bedford (19)	-464	-0.39%	-0.08%
Wythe (197)	-151	-0.33%	-0.07%
Southampton (175)	-320	-0.32%	-0.06%
Henry (89)	-239	-0.30%	-0.06%

County	Total change (ha) 2007-2012	Total change (%) 2007-2012	Yearly average (%) 2007-2012
Madison (113)	-113	-0.29%	-0.06%
Goochland (75)	-82	-0.18%	-0.04%
Isle Of Wight (93)	-30	-0.07%	-0.01%
Giles (71)	-9	-0.01%	0.00%
Floyd (63)	49	0.10%	0.02%
Roanoke (161)	72	0.21%	0.04%
Louisa (109)	175	0.22%	0.04%
Sussex (183)	425	0.40%	0.08%
Charlotte (37)	457	0.52%	0.10%
Washington (191)	459	0.54%	0.11%
Highland (91)	687	0.77%	0.15%
Page (139)	324	0.81%	0.16%
Mecklenburg (117)	1021	0.86%	0.17%
King George (99)	267	0.87%	0.17%
Dickenson (51)	748	0.94%	0.19%
Buchanan (27)	1105	0.95%	0.19%
Amelia (7)	1148	1.84%	0.37%
Montgomery (121)	1205	1.84%	0.37%
Halifax (83)	3102	2.10%	0.42%
Alleghany (5)	2263	2.27%	0.45%
King William (101)	993	2.30%	0.46%
Bland (21)	1779	2.52%	0.50%
Virginia Beach (810)	388	2.57%	0.51%
Grayson (77)	1686	2.60%	0.52%
Greene (79)	820	2.73%	0.55%
Amherst (9)	2758	2.91%	0.58%
Rockbridge (163)	3030	2.97%	0.59%
Wise (195)	2204	3.34%	0.67%
Powhatan (145)	1402	3.55%	0.71%
Orange (137)	1989	3.57%	0.71%
Albemarle (3)	4108	3.59%	0.72%
Lunenburg (111)	3865	4.08%	0.82%
Nottoway (135)	2399	4.26%	0.85%
Rockingham (165)	5968	4.37%	0.87%
Carroll (35)	3481	4.63%	0.93%
Botetourt (23)	4416	4.63%	0.93%
Frederick (69)	2940	4.75%	0.95%
Spotsylvania (177)	2936	5.07%	1.01%
Fauquier (61)	4234	5.10%	1.02%
Essex (57)	1762	5.27%	1.05%
Lee (105)	3894	5.39%	1.08%
Augusta (15)	9080	6.98%	1.40%
Pulaski (155)	3720	7.57%	1.51%
Campbell (31)	7343	8.57%	1.71%
Clarke (43)	1929	19.51%	3.90%
Arlington (13)	-	-	-
Total	5963	0.09%	0.02%

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