Forest sustainability in the state of North Carolina, 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 North Carolina, including general condition, management and sustainability assessment.

2. North Carolina forests overview

2.1. Location and distribution

North Carolina is located in the East of the USA and covers a total surface area of 139 390 km². The State of North Carolina is divided into 100 counties and is bordered by Tennessee on the west, Virginia on the north and by Georgia and South Carolina on the south. In the east, North Carolina is bordered by the Atlantic Ocean.

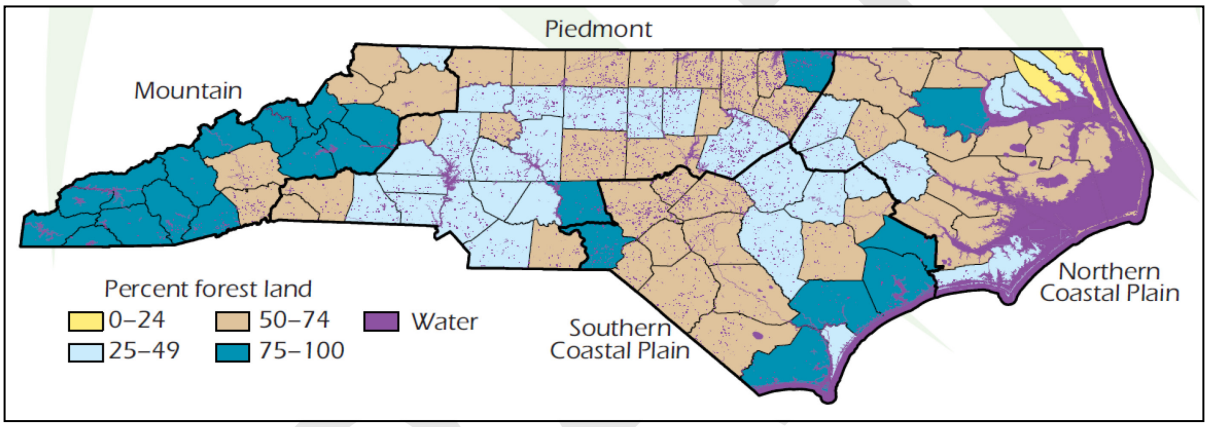
Figure 1: General maps of North Carolina

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

North Carolina's forest is part of the large forest area of the East coast of the USA. Nowadays, North Carolina's forest covers about 60% of the State's land area with 7.53 million ha[1]. Nearly all of the forest land (97%) is considered available for timber production.

As seen on the figure below and according to the inventory[2] conducted by the US Department of Agriculture – Forest Service, 68 of North Carolina's 100 counties were more than 50% forested in 2011. Twenty-three of these were more than 75% forested. Fifteen of the most heavily forested counties were located in the Mountain region of the State (one of the four surveys units considered for the USDA-Forest Service's inventory). There were two counties less than 25% forested both in the Northern Coastal Plain region of the State.

Figure 2 : Surveys units and percentage of land in forest by county (North Carolina, 2011)



Source: Forest Inventory & Analysis factsheet (2011) - USDA – Forest Service

The Table 1 shows the distribution of the timberland area by survey unit in 2011.

Table 1 : Area of timberland by survey unit in 2011 (North Carolina)

Survey unit	Area (ha)	% of total timberland area
Southern Coastal Plain	2067755	28%
Northern Coastal Plain	1501964	21%
Piedmont	2155447	29%
Mountains	1590469	22%
Total	7315636	100%

Source: adapted from Forest Inventory & Analysis factsheet (2011) - USDA – Forest Service

[1] Source: situation as per 2012 Forest Inventory and Analysis, USDA – Forest service
[2] Forest inventory & Analysis Factsheet 2011 – USDA, Forest Service-http://srsfia2.fs.fed.us/states/north_carolina.shtml

2.1. Ecological zones

North Carolina has a wide range of elevations. From sea level on the east, the land rises to a high point of 2037m above sea level in the west (Mount Mitchell which is the highest point in the Eastern US). About ½ of North Carolina is less than 150 above sea level.

The climate of the coastal plains is strongly influenced by the Atlantic Ocean, which keeps temperatures mild in winter and moderate in summer. Most of the state falls in the humid subtropical climate zone. More than 500 km from the coast, the western, mountainous part of the state has a subtropical highland climate.

Depending on the place, the typical high temperatures recorded in July are in the range 28°C to 32°C while the typical low temperatures recorded in January are in the range -3°C to 4°C[3].

Depending on the place, the average precipitations range generally from 1 050 to 2 250 mm per year[4].

North Carolina is divided by the 4 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. **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

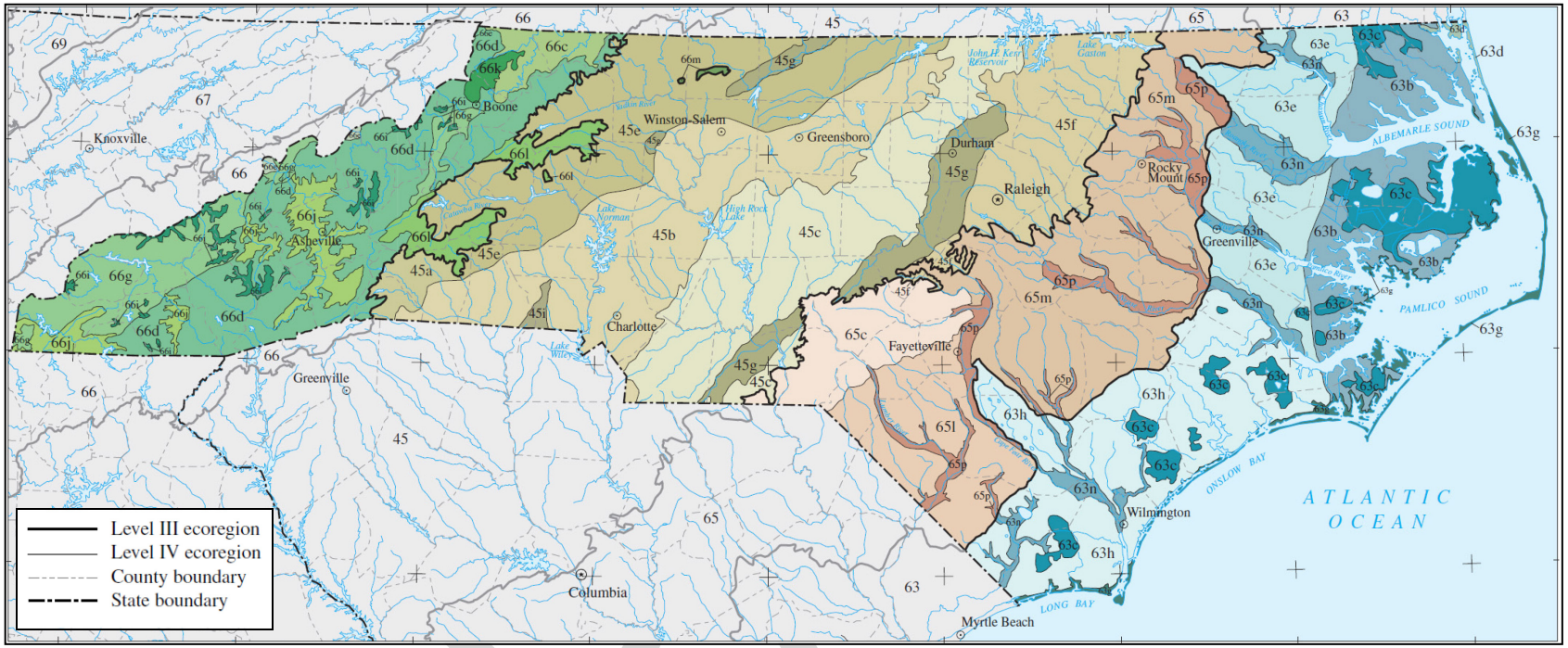
[3]Source : http://www.ustravelweather.com/north-carolina/
[4]Source : http://average-rainfall.weatherdb.com/
[5]Source: Primary Distinguishing Characteristics of Level III Ecoregions of the Continental United States (http://www.hort.purdue.edu/newcrop/cropmap/ecoreg/descript.html)

Piedmont, and the older limestone, chert, and shale found in the Interior Plateau. Streams in this area are relatively low-gradient and sandy-bottomed.

D. 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 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.

Figure 3: Ecoregions of North Carolina (Levels III & IV)



45 Piedmont
- 45a Southern Inner Piedmont
- 45b Southern Outer Piedmont
- 45c Carolina Slate Belt
- 45e Northern Inner Piedmont
- 45f Northern Outer Piedmont
- 45g Triassic Basins
- 45i Kings Mountain

63 Middle Atlantic Coastal Plain
- 63b Chesapeake-Pamlico Lowlands and Tidal Marshes
- 63c Nonriverine Swamps and Peatlands
- 63d Virginian Barrier Islands and Coastal Marshes
- 63e Mid-Atlantic Flatwoods
- 63g Carolinian Barrier Islands and Coastal Marshes
- 63h Carolina Flatwoods
- 63n Mid-Atlantic Floodplains and Low Terraces

65 Southeastern Plains
- 65c Sand Hills
- 65l Atlantic Southern Loam Plains
- 65m Rolling Coastal Plain
- 65p Southeastern Floodplains and Low Terraces

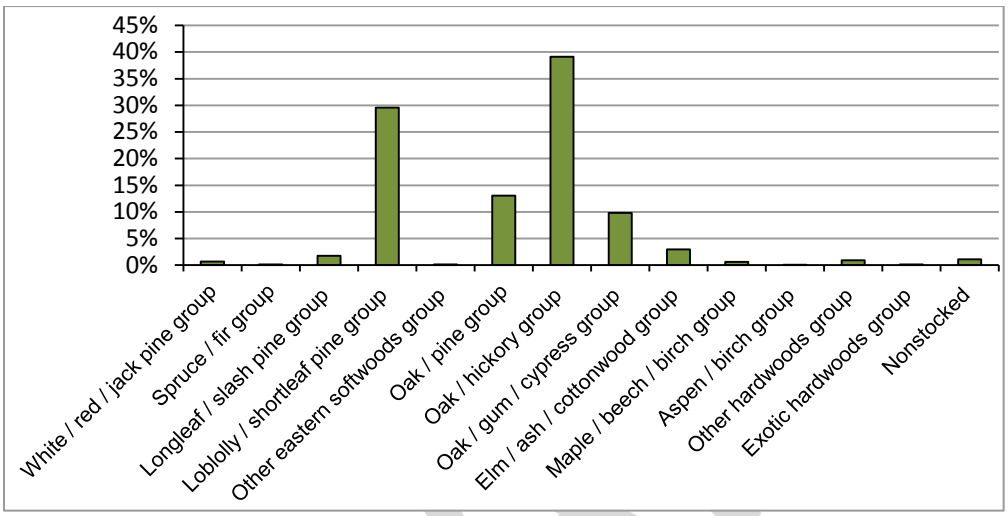
66 Blue Ridge
- 66c New River Plateau
- 66d Southern Crystalline Ridges and Mountains
- 66e Southern Sedimentary Ridges
- 66g Southern Metasedimentary Mountains
- 66i High Mountains
- 66j Broad Basins
- 66k Amphibolite Mountains
- 66l Eastern Blue Ridge Foothills
- 66m Sauratown Mountains

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 North Carolina with 39.1%. The loblolly-shortleaf pine group is second with 29.5%, followed by the oak-pine group (13%). 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 2 : Area of forest land by forest-type group (2012)

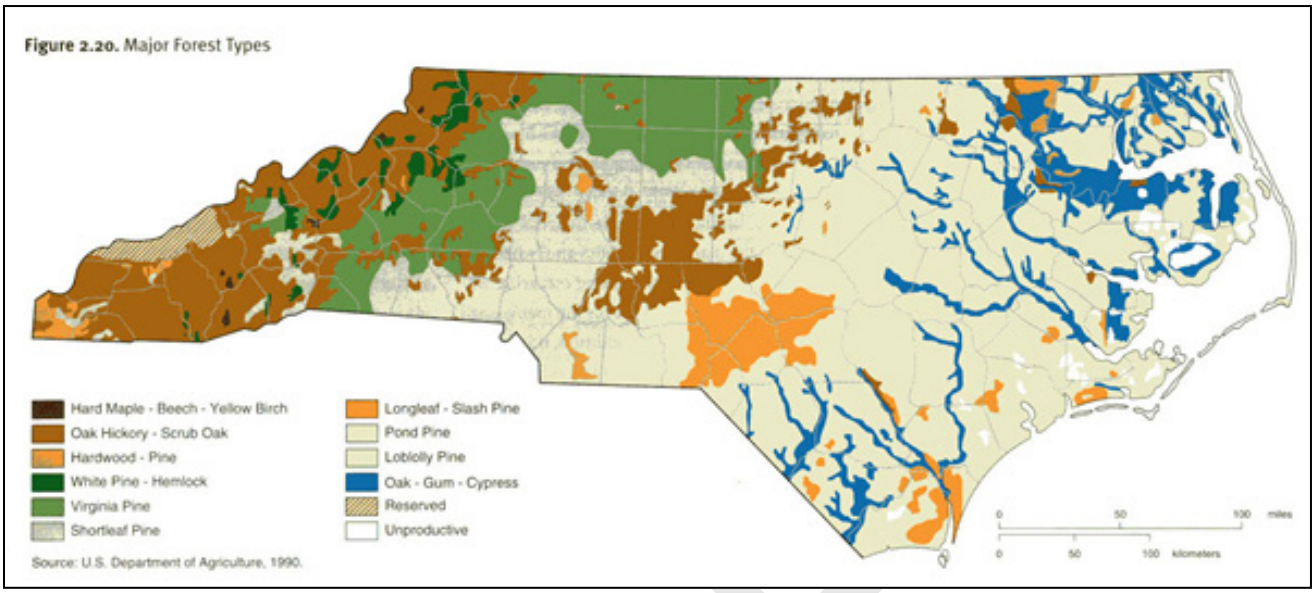
Forest type group	Area (ha)	% of total forestland area
Oak / hickory group	2948639	39.1%
Loblolly / shortleaf pine group	2226320	29.5%
Oak / pine group	982133	13.0%
Oak / gum / cypress group	740396	9.8%
Elm / ash / cottonwood group	223261	3.0%
Longleaf / slash pine group	130971	1.7%
Nonstocked	82455	1.1%
Other hardwoods group	71548	0.9%
White / red / jack pine group	50384	0.7%
Maple / beech / birch group	45407	0.6%
Other eastern softwoods group	10660	0.1%
Spruce / fir group	10205	0.1%
Exotic hardwoods group	8294	0.1%
Aspen / birch group	4898	0.1%
Total	**7535569**	

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

Altogether, hardwood forest types comprise about 67% of the forest land in North Carolina. Softwood forest types occupy 32% and non-stocked areas makeup the remaining 1%.

The Figure 5 hereafter shows the major forest types in North Carolina.

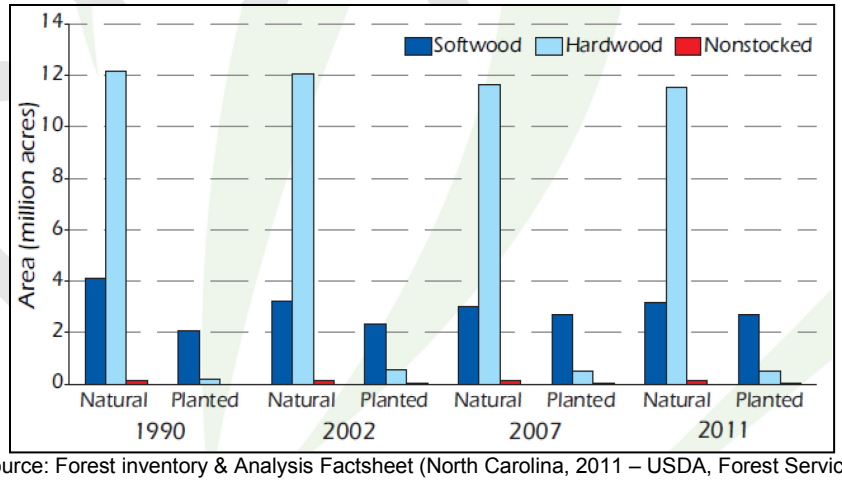
2.2.1.1. Figure 5 : Major forest types of North Carolina



Source: https://web.duke.edu/nicholas/bio217/ked13/freshwater.html

According to the USDA - Forest Service[6], 18% of the State's timberland showed evidence of artificial regeneration in 2011 (Figure 6). This is about 50% of the softwood stands. This proportion has increased over the last couple of decades. Back in 1990, planted softwood was only a third of the softwood stands.

Figure 6: Timberland area by major forest-type group, stand origin and survey year (North Carolina, 2011)



Source: Forest inventory & Analysis Factsheet (North Carolina, 2011 – USDA, Forest Service)

[6] Forest Inventory & Analysis factsheet (2011) - USDA – Forest Service

2.3. Forest ownership

Approximately 83% of North Carolina's forestland area is privately-owned and the 17% remaining is publicly-owned (federal, state and local public owners). Of the privately-owned land, about 92% is owned by non-industrial private sector and the remaining is owned by forest industries.

North Carolina's timberland and forestland ownership patterns are given in the following table.

Table 3 : Area of forest land and timberland by ownership groups

Forest land / Ownership groups		Area (ha)		% of total forestland area
Forest Service	National forest	520636	520636	7%
Other federal	National Park Service	116329	347089	5%
	Fish and Wildlife Service	106215		
	Department of Defense or Energy	122230		
	Other federal	2315		
State and local gov't	State	293852	403415	5%
	Local (county, municipal, etc.)	109563		
Private	Undifferentiated private	6264428	6264428	83%
Total			7535569	
Timberland / Owner ship groups		**Area (ha)**		**% of total timberland area**
Forest Service	National forest	478494	478494	7%
Other federal	Fish and Wildlife Service	91545	213620	3%
	Department of Defense or Energy	119760		
	Other federal	2315		
State and local gov't	State	282113	391676	5%
	Local (county, municipal, etc.)	109563		
Private	Undifferentiated private	6249712	6249712	85%
Total			7333502	

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

2.4. Competent authorities

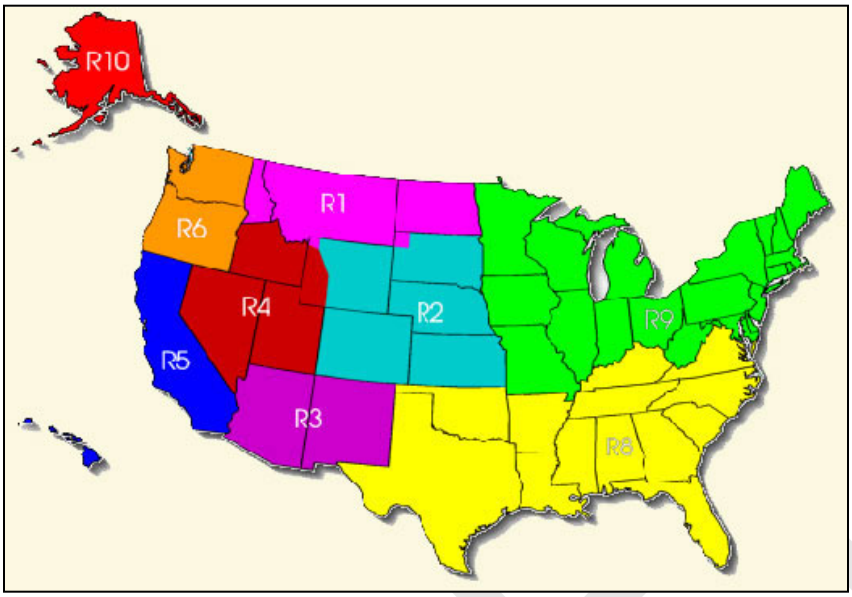
Forest management in the United States of America, at the federal level is under the authority of the US Department of Agriculture and more specifically it's agency of the US Forest Service whose mission is to:

"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, North Carolina and other States like Alabama and Georgia belongs to the R8 region: Southern Region.

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

Figure 7 : 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 North Carolina Forest Service (NCFS) of the North Carolina Department of Agriculture & Consumer Services is in charge of forest resources management, development and protection.

The programs under these objectives are directed at the thousands of private landowners who collectively own just over 5.5 million ha of forest land in North Carolina. Programs include reforestation services, forest fire prevention and suppression, and insect and disease control. The agency is also involved in the genetic improvement of forest trees, seedling production at state nurseries, long range forestry planning and technical development, water quality controls, urban forestry assistance, training and support to volunteer fire departments and forestry education.

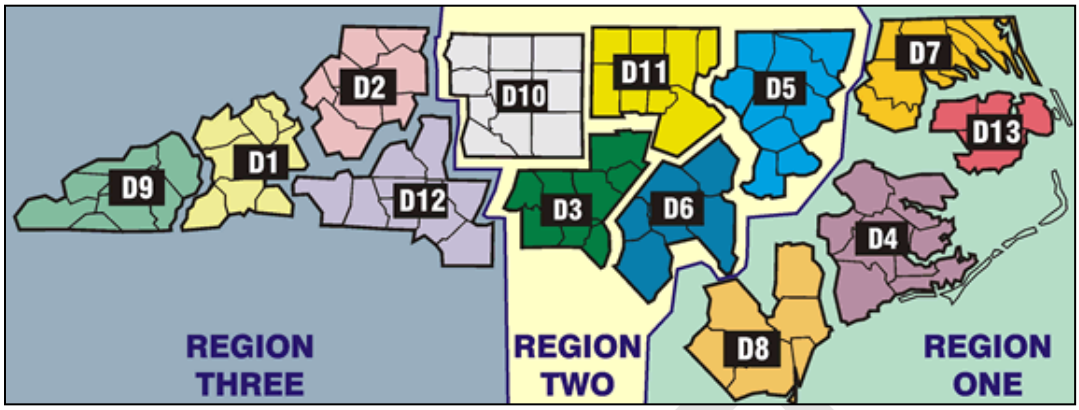
The NCFS is organized as follows[8]:

- Assistant Commissioner's Office – State Forester, Aviation & Engineering;
- 4 Sections – Administrative Services, Forest Protection, Safety, Planning and Analysis, and Forest Management/Development;
- 3 Regional Offices – Coastal, Piedmont and Mountain;
- 13 Districts headquartered;
- County Forest Ranger or Forester and staff (if any) in each county.

The NCFS management areas of Regional and District offices are shown on the figure hereafter.

[8] North Carolina Forest Service - http://www.ncforestservice.gov/about_ncfs.htm

Figure 8 : North Carolina District/Region map



Source: North Carolina Forest Service

2.5. *Overview of wood-related industry*

The wood products industry is a major contributor to North Carolina's manufacturing economy. In 2011, the industry had about 2300 companies involving approximately 67500 jobs with a payroll of $2.7 billion[9]. The majority of these companies are small, employing less than 100 people. The forestry sector contributes more than $4.5 billion to the state's gross product.

The forest products industry is the largest manufacturing business sector in North Carolina, contributing approximately $24 billion annually to the state's economy and providing around 180 000 jobs for North Carolinians.

The primary forest products industry consists of mills that process logs or whole trees (roundwood) into variety of products and include facilities processing lumber, pulp and paper, veneer, plywood, composite panels, posts, logs for logs homes, biomass for energy and other products. The number of roundwood processing facilities has declined steadily since 1990 and total roundwood production in 2009 was at historical lows for virtually all product classes. North Carolina is a net exporter of roundwood for pulp, panels, veneer and other industrial uses, while it is a net importer of saw logs.

The information below presents a few highlights about North Carolina's timber product output (TPO)[10] and the main available figures related to the period 2007-2009. Between 2007 and 2009, TPO from roundwood was down 4.06 million m³, or 20%, to 16.57 million m³. Output of softwood roundwood products declined 13%, and output of hardwood roundwood products declined 32% (Figure 9).

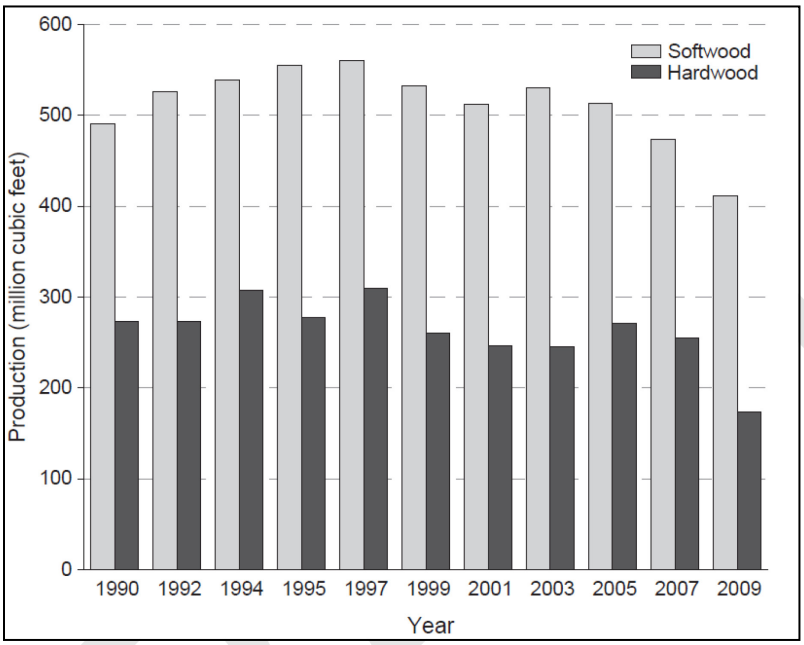
Saw logs and pulpwood were the principal roundwood products in 2009. Combined output of these products accounted for 87% (14.5 million m³) of North Carolina's total roundwood output (Figure 10).

We can see on Figure 11 that the primary wood-using mills are rather homogeneously distributed throughout the state.

[9] North Carolina Forest Service - http://www.ncforestservice.gov/about_ncfs.htm
[10] North Carolina's Timber Industry - An Assessment of Timber Product Output and Use, 2009 http://www.treesearch.fs.fed.us/pubs/38695

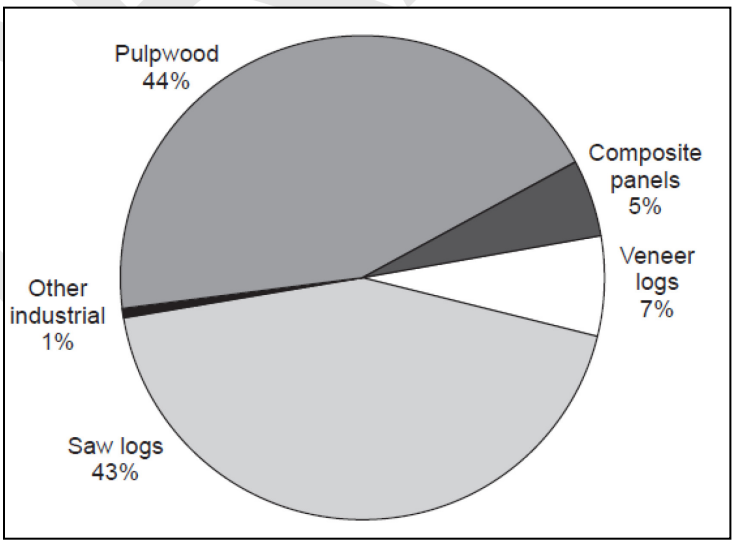
Across all products, 81% of roundwood harvested was retained for processing at North Carolina mills. Exports of roundwood to other States amounted to 3.2 million m³, while imports of roundwood amounted to 2.5 million m³ making the State a net exporter of roundwood.

Figure 9 : Roundwood production for all products by species group and year (North Carolina – 1960-2009)



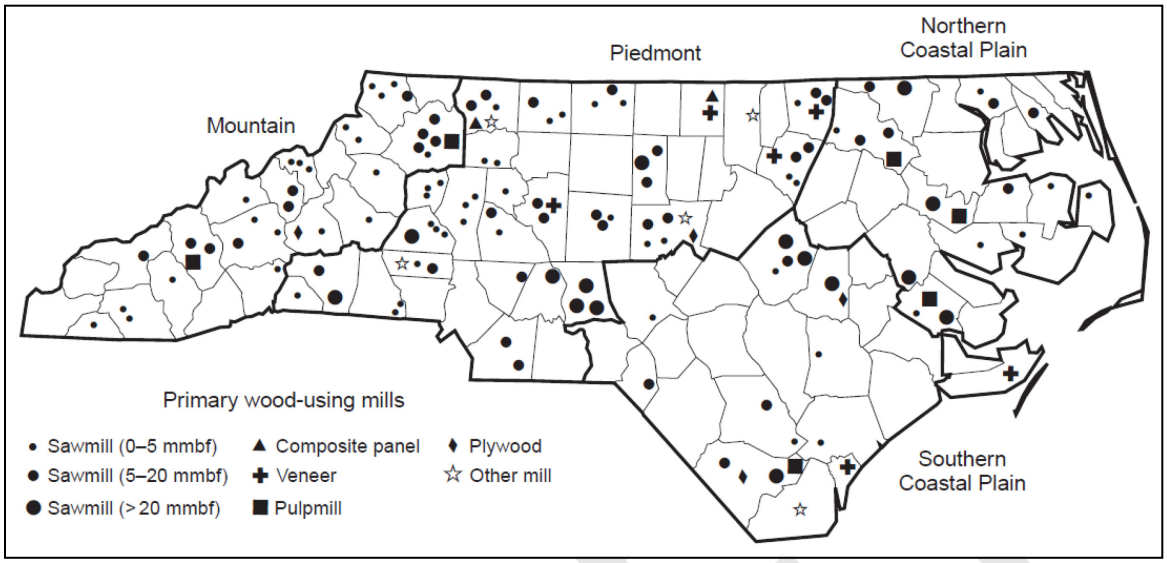
Source: USDA – Forest Service (Assessment of TPO and Use, 2009)

Figure 10 : Roundwood production by type of product (North Carolina, 2009)



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

Figure 11 : Primary wood-using mills by region (North Carolina 2009)



mmbf = million board feet

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

3. Sustainability of North Carolina forest

3.1. Evolution of forest area an risk of conversion

Table 4 and related Figure 12 hereafter consider the detailed information available (2012) in the US Forest service database[11] and the evolution since 1974. Forestland and timberland appear rather stable or trending slightly downwards since 2002, after showing a constant overall decline since the 1990s.

If we analyse more precisely the evolution of timberland during the period of relative stability in the last decade (2002 to 2012), a slight decrease of about 1.1% is recorded (i.e. about 0.11% decrease yearly on average). If we consider the last 5 years' trend (period between 2007 and 2012), we can observe a slight increase of 0.21% (i.e. about 0.04% increase yearly on average).

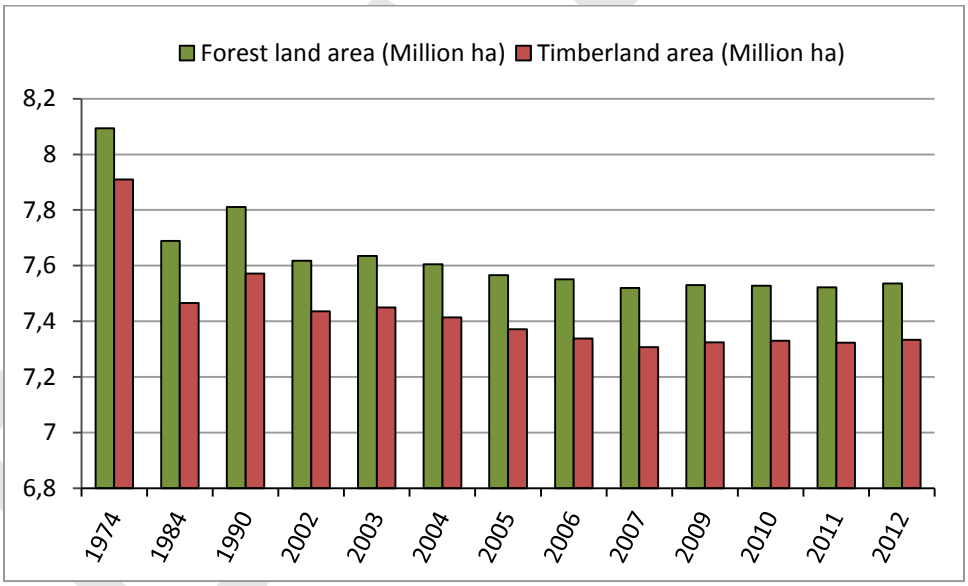
[11] http://apps.fs.fed.us/fido/standardrpt.html

Table 4 : Evolution of forested area (2002-2012) and timberland (1974-2012) in North Carolina

Year	Forestland (ha)	Change (ha)	Change %	Timberland (ha)	Change (ha)	Change %
1974	-	-	-	7909521	-	-
1984	-	-	-	7466032	-443489	-5.61%
1990	-	-	-	7571850	105818	1.42%
2002	7617139	-	-	7435903	-135947	-1.80%
2003	7635383	18244	0.24%	7449232	13329	0.18%
2004	7604608	-30775	-0.40%	7414079	-35153	-0.47%
2005	7566176	-38432	-0.51%	7371829	-42250	-0.57%
2006	7550733	-15443	-0.20%	7338231	-33598	-0.46%
2007	7519939	-30794	-0.41%	7306787	-31444	-0.43%
2009	7530255	10316	0.14%	7324611	17824	0.24%
2010	7527655	-2600	-0.03%	7329961	5350	0.07%
2011	7522117	-5538	-0.07%	7322564	-7397	-0.10%
2012	7535569	13452	0.18%	7333502	10938	0.15%

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

Figure 12 : Change in forest land and timberland area over time – North Carolina

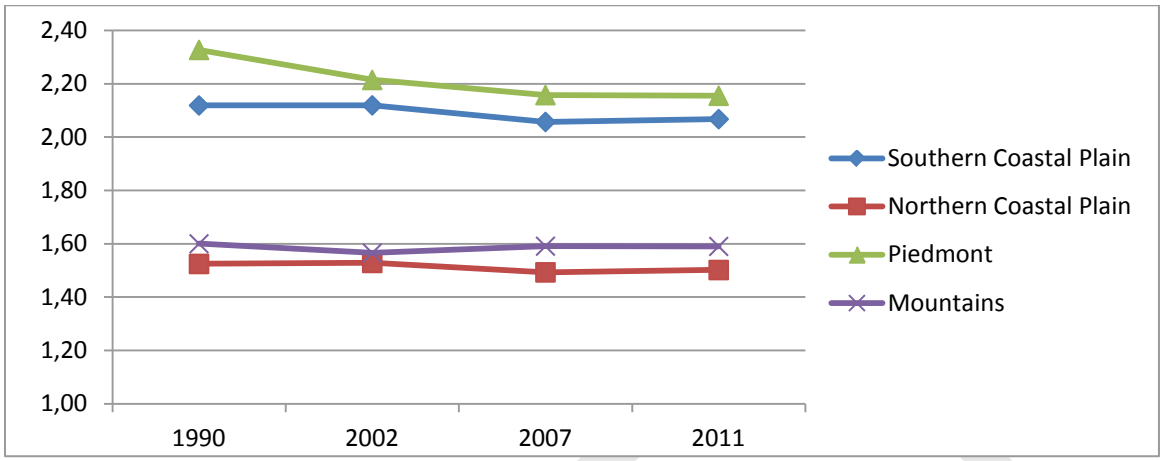


Source: adapted from US Forest service, FIA Program (http://apps.fs.fed.us/fido/standardrpt.html) and completed with the FIA factsheet (2007) for forest land area between 1974 and 2002.

Figure 13 shows the distribution[12] of the timberland area (between 1990 and 2011) by FIA survey units (Forest Inventory and Analysis Units – US Forest Service - Figure 2). The timberland extent in the Mountain survey units appears to be very stable since 1990, while decreases are recorded mainly in Piedmont and, to a lesser extent, in coastal plains.

[12] Forest inventory & Analysis Factsheet 2011 – USDA, Forest Service-http://srsfia2.fs.fed.us/states/north_carolina.shtml

Figure 13 : Timberland area (in million ha) change by year and Forest Inventory and Analysis survey unit



Source: adapted from Forest Inventory & Analysis Factsheet – North Carolina, 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 North Carolina, 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 0.21% 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 16 counties where the 0.5% threshold was exceeded as yearly average in the period 2007-2012 (out of the 100 counties in North Carolina):

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

- Alexander
- Iredell
- Union
- Alleghany
- Lincoln
- Wilson
- Greene
- Jones
- Yadkin
- Durham
- Granville
- Guilford
- Sampson
- Lee
- Onslow
- Swain

Unsurprisingly, most of those counties are in the Piemont region, where the loss of forest surfaces has been the most obvious over the last decade and where the pressure of urbanization is important (highest population densities in this part of the state, under the influence of the two most important cities Charlotte and Raleigh).

3.2. *Living wood volumes and removals*

Table 5 shows the net volume, by species group, of live trees in forest land in 2012, according to the more recent available data in the Forestry Inventory and Analysis (FIA) of the USDA – Forest Service[14]. We can see that the Oak/hickory forest-type group accounted for 45% of live-tree volume in North Carolina in 2012, with a total of about 506 million m³.

Table 5: Net volume of live trees in forest land (at least 5 inch d.b.h./d.r.c.), in million m³, by forest-type group (North Carolina, 2012)

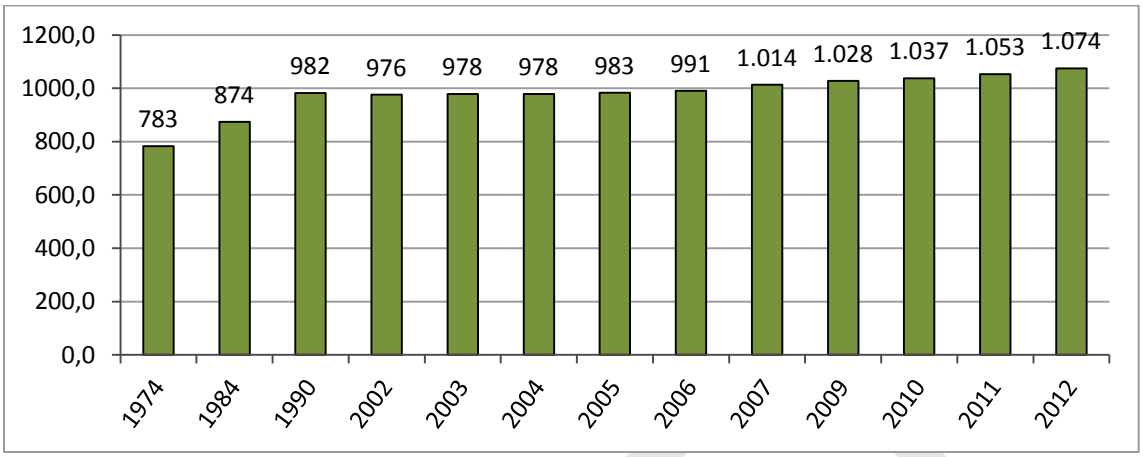
Forest-type group	Net volume (million m³)	% of total net volume
White / red / jack pine group	14.86	1.33%
Spruce / fir group	2.33	0.21%
Longleaf / slash pine group	14.71	1.32%
Loblolly / shortleaf pine group	282.31	25.35%
Other eastern softwoods group	0.55	0.05%
Oak / pine group	119.35	10.72%
Oak / hickory group	505.99	45.43%
Oak / gum / cypress group	119.34	10.72%
Elm / ash / cottonwood group	31.76	2.85%
Maple / beech / birch group	9.46	0.85%
Aspen / birch group	0.09	0.01%
Other hardwoods group	12.34	1.11%
Exotic hardwoods group	0.50	0.05%
Nonstocked	0.18	0.02%
Total	**1113.78**	

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

Figure 14 shows the evolution of net volume of live trees in timberland between 1974 and 2012. For all species combined, the net volume of live trees on timberland in North Carolina has increased by 37% since 1974. A slight but constant increase is recorded since 2002 (evolution of about 10% since 2002).

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

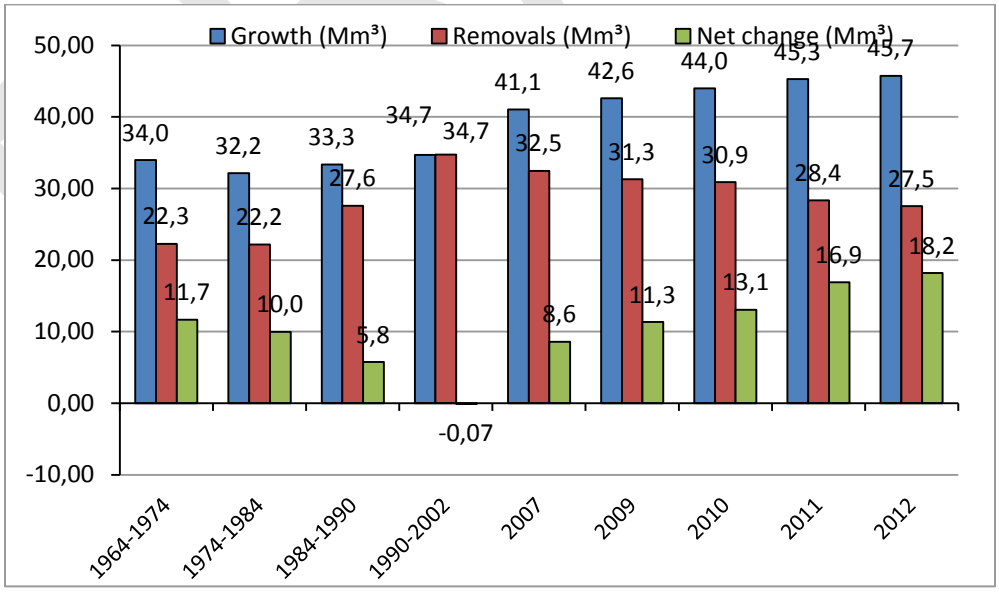
Figure 14 : Evolution of net volume of live trees (at least 5 inch d.b.h./d.r.c.) in million m³ on timberland (North Carolina, 1974-2012)



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

We can see on the Figure 16 that the net growth of live trees exceeds removals since at aftert 2002, meaning that North Carolina has been growing more wood volume than its harvesting since this moment. We can notice that the net gain has been declining since the mid-sixties until the survey period '1990-2002', where the lowest balance is recorded (negative balance of about 0.1 million cubic meters), before increasing steadily until 2012. The negative balance between 1990-2002 is due to the combination of the reduction of timberland area during this period (as described above) and a peak in timber harvesting. After 2002, the harvested volumes have decreased, and this decrease was accelerated with the subprime crisis, while the forested areas remained rather stable.

Figure 15 : Average net annual growth VS removals of live trees on timberland (at least 5 inch d.b.h./d.r.c.), in million m³



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

3.3. Protection of ecosystems and biodiversity

As shown on Table 6, the conservation land in North Carolina covers 1154434 ha, which is about 8.3% of the state area. This includes both public and private land, under various conservation status. Figure 17 shows an overview of all protected areas in North Carolina. Those protected areas are either public (federal, state, county or local) and private lands.

Table 6 : Land under protection status in North Carolina (as of 2011)

	Status 1	Status 2	Status 3	Total
Acres	362489	863827	1626353	2852669
Ha	146694	349578	658162	1154434
Percentage of state area	1.1%	2.5%	4.7%	8.3%

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.

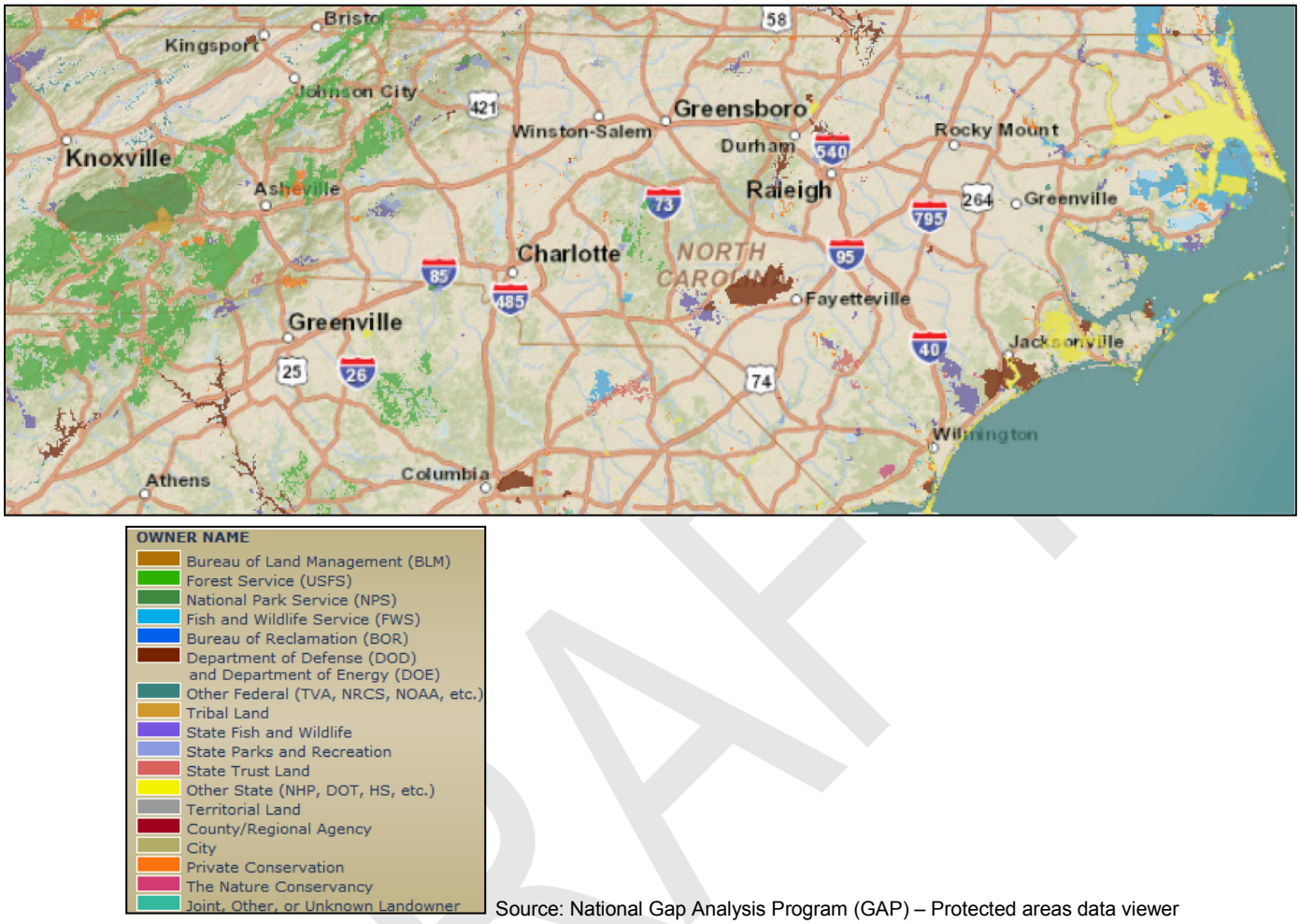
Status 2: An area having permanent protection from conversion of natural land cover and a mandated management plan in operation to maintain a primarily natural state, but which may receive uses or management practices that degrade the quality of existing natural communities, including suppression of 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 17 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.

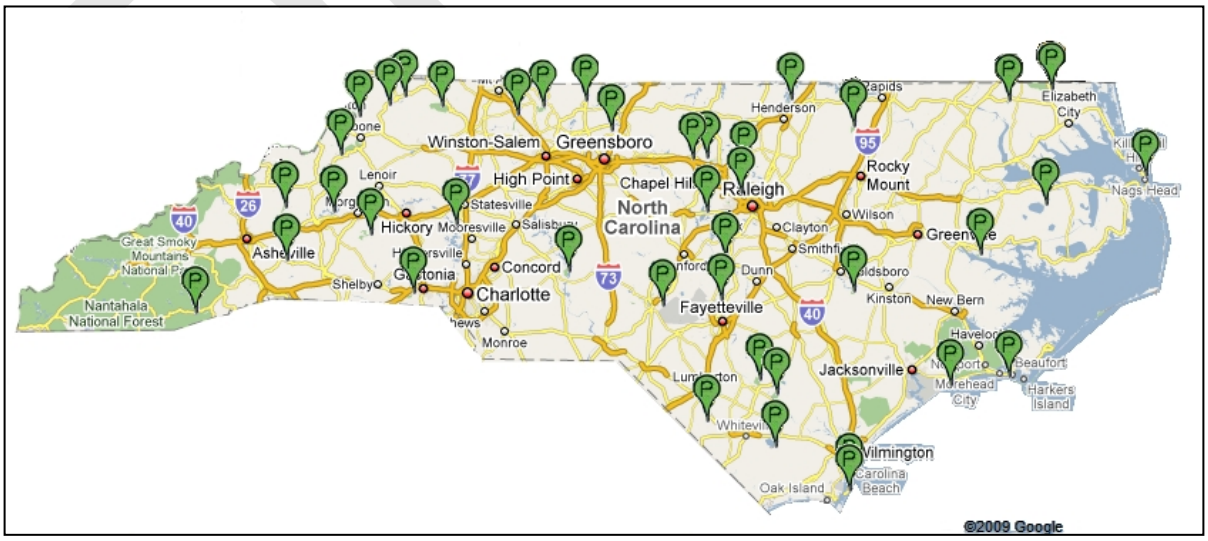
Figure 18 shows the location of State parks in North Carolina. Figure 19 shows the location of national parks in North Carolina.

Figure 16 : Protected areas in North Carolina



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

Figure 17 : State Parks in North Carolina



Source: http://ncfsp.org/Projects/Park%20Tours/ParkTours.html - from Google maps

Figure 18 : National parks in North Carolina

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

Even though the protected areas in North Carolina are rather limited, there have been recent efforts to improve the situation. Table 7 and Figure 21 show the new surfaces put into conservation between 1998 and 2008. We can observe that the yearly average of new areas put into conservation and the total of new land between 1998 and 2008 are relatively good, compared to some other nearby states. The increase is about 2% in 10 years (i.e. about 0.2 % yearly).

Table 7 : New land under conservation status per year in North Carolina (1998-2008)

Year	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	Total
Acres	60792	85642	71277	65143	71633	104263	74327	89335	110021	106126	65210	903767
ha	24602	34658	28845	26362	28989	42194	30079	36153	44524	42948	26389	365741

http://www.conservationalmanac.org

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

The most important programs are described hereunder:

- **Ecosystem Enhancement Program (EEP)**[15]: The mission of the EEP is to "restore, enhance, preserve and protect the functions associated with wetlands, streams and riparian areas, including but not limited to those necessary for the restoration, maintenance and protection of water quality and riparian habitats throughout North Carolina." Revenue for EEP is derived from the Department of Transportation for offsetting impacts of transportation-infrastructure projects. In addition, EEP also leverages other funding sources for the initiative.

[15] http://www.conservationalmanac.org/secure/almanac/southeast/nc/programs.html

- **Clean Water Management Trust Fund (CWMTF)**[16]: The CWMTF was established in 1996 to help finance projects that specifically address water pollution problems including the protection and conservation of watersheds through land acquisition.

- **Natural Heritage Trust Fund**[17]: This program was established in 1987 and provides funding to select state agencies for the acquisition of important natural areas to conserve the state's ecological diversity and cultural heritage, and to inventory the state's natural heritage resources.

- **North Carolina Tax Credit Program**[18]: The state offers an income tax credit of 25% of the fair market value of land donated to public or private non-profit conservation entities. Eligible properties contribute to the goals of protecting water supply and quality, retaining working farms and forests, and development of greenways for trails and wildlife corridors. Approximately 20% of donations are made by conservation easement.

- **The Forest Legacy Program (FLP)**[19]: The purpose of the FLP is to help landowners, state and local governments, and private land trusts identify and protect environmentally important forest lands that are threatened by present and future conversion to non-forest uses. The Forest Legacy Program is designed to assure that both traditional uses of private lands and the public values of America's forest resources are protected for future generations.

- **The Conservation Reserve Program (CRP)**[20]: By reducing water runoff and sedimentation CRP protects groundwater and improves the condition of lakes, rivers, ponds, and streams. Landowners may use the cropland converted under the program to grow trees, wildlife habitat, grasses and legumes, or combinations of permanent covers.

- **The Conservation Reserve Enhancement Program (CREP)**[21]: The CREP is a state/federal conservation program administered by the USDA Farm Service Agency, targeted to address water quality, soil erosion, and wildlife habitat concerns in North Carolina. Currently, the program involves 76 counties in North Carolina.

- **The Wildlife Habitat Incentives Program (WHIP)**[22]: The WHIP is a voluntary program for people who want to develop and improve wildlife habitat primarily on private land. Through WHIP USDA's Natural Resources Conservation Service provides both technical assistance and up to 75% cost-share assistance to establish and improve fish and wildlife habitat.

[16] http://www.conservationalmanac.org/secure/almanac/southeast/nc/programs.html
[17] http://www.conservationalmanac.org/secure/almanac/southeast/nc/programs.html
[18] http://www.conservationalmanac.org/secure/almanac/southeast/nc/programs.html
[19] http://ncforestservice.gov/fsandfl/what_is_forest_legacy.htm
[20] http://ncforestservice.gov/Managing_your_forest/crp.htm
[21] http://ncforestservice.gov/Managing_your_forest/crep.htm
[22] http://www.nrcs.usda.gov/wps/portal/nrcs/main/nc/programs/financial/whip/

- **The healthy Forests Reserve Program (HFRP)**[23]: The purpose of the HFRP is to assist landowners, on a voluntary basis, in restoring, enhancing and protecting forestland resources on private lands through easements, 30-year contracts and 10-year cost-share agreements.

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...).

In the State of North Carolina, the latest version of BMP was released in 2006[24]. The administration in charge of the BMP is the North Carolina Forest Service (Department of Agriculture and Customers Services). For forestry activities in North Carolina, the term 'best management practice' is actually defined by state administrative code rule '15A NCAC 01I .0102 (4)', found within the Forest Practices Guidelines (FPG – see below) Related to Water Quality :

> "Best Management Practice (BMP) means a practice, or combination of practices, that is determined to be an effective and practicable (including technological, economic, and institutional considerations) means of preventing or reducing the amount of pollution generated by nonpoint sources to a level compatible with water quality goals."

In North Carolina, the FPG are mandatory, statewide requirements defined by North Carolina Administrative Code '15A NCAC 01I .0100 - .0209'. All forestry-related, site-disturbing activities must comply with the FPG if that activity is to remain exempt from permitting and other requirements specified in the North Carolina Sedimentation Pollution Control Act. The North Carolina Forest Service inspects thousands of job sites each year to assess compliance with these regulations. The FPG are goal-oriented performance standards, and there are nine of them:

- Streamside Management Zone (SMZ)
- Prohibition of Debris Entering Streams and Waterbodies
- Access Road and Skid Trail Stream Crossings
- Access Road Entrances
- Prohibition of Waste Entering Streams, Waterbodies, and Groundwater
- Pesticide Application
- Fertilizer Application
- Stream Temperature
- Rehabilitation of Project Site

[23] http://www.nrcs.usda.gov/wps/portal/nrcs/main/nc/programs/easements/forests/
[24] http://ncforestservice.gov/water_quality/bmp_manual.htm

All forestry work must comply with the FPG, as well as other regulations that are related to water quality protection. The bottom line for FPG is to keep sediment and other pollution out of the water no matter what method is used. Usually, BMP can be the best and lowest cost solution to comply with the FPG, and other water quality regulations.

While the law does not require the use of BMPs on forestry sites in North Carolina, the emergence of market-demand driven forest certification programs has elevated the awareness and implementation of forestry BMPs to a new level. These certification programs require that participants meet or exceed the recommended BMPs for each state in which they own timberland or have manufacturing operations.

The topics covered by the BMP:

- Planning forestry operations
- Streamside management zones and riparian buffers
- Runoff control and forestland access
- Silvicultural activities in forested wetlands
- Forest management chemicals
- Equipment fluids and solid waste
- Fire management
- Site preparation and reforestation
- Site rehabilitation and stabilization

In Southeast USA, there are specific arrangements for the site preparation before establishing pine plantations on wetlands[25]. 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.

Under the CWA, it is required to regularly evaluate to what extent the BMP are actually implemented in the practice. The last assessments[26] in the state of North Carolina were completed in 2008 and concerned 212 sites across the State. The previous assessments were completed in 2003.

Additionally, an assessment of compliance with North Carolina's Forest Practices Guidelines Related to Water Quality (FPG) was completed to determine the influence of BMP implementation on FPG compliance.

Statewide, BMP implementation was 85% in the 2008 survey. Implementation during this Survey period (2006-2008) increased slightly from the 2000-2003 period, which had an overall implementation rate of 82%.

[25] http://water.epa.gov/lawsregs/guidance/wetlands/silv2.cfm
[26] http://ncforestservice.gov/water_quality/wq_bmp_studies.htm

On average statewide, when BMP were properly implemented, there was no risk to water quality nearly 100% of the time. Conversely, when BMPs were not implemented, it resulted in a risk to water quality 54% of the time.

On average statewide, BMP for 'streamside management zones', 'stream crossings', 'debris entering streams', 'rehabilitation of the project site' and 'skid trails' represent 73% of the non-implemented BMPs and 94% of the observed risk to water quality.

FPG compliance was more common on harvest sites with higher BMP implementation. Conversely, as BMP implementation decreased, the number of compliant FPG standards also decreased (more non-compliant standards). These data indicate that implementation of BMP can yield higher FPG compliance on forestry sites and lower implementation of BMP can yield a larger number of non-compliant FPG standards.

3.5. Protection of soils

The protection of soil, including soil erosion, soil compaction and soil fertility, is addressed in the Best Management Practice applicable to forestry in North Carolina. It includes considerations of soil in the following topics:

- Planning forestry operations
- Stream side management zones and riparian buffers
- Runoff control and forestland access
- Silvicultural activities in forested wetlands
- Forest management chemicals
- Fire management
- Site preparation and reforestation
- Site Rehabilitation and stabilization

In the majority of subjects mentioned above and covered by the BMP, the most commonly discussed aspect regarding the protection of soil is the soil erosion.

As described under section 3.4, it appears from the BMP Implementation and Compliance Survey (latest report dated 2008) that the BMP are generally well implemented in the State of North Carolina. 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) 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 North Carolina over the last three decades, and this despite a slight decrease in the forest area if we consider the last ten years (-1.1% between 2002 and 2012). In this context, the sequestrated carbon stock in living biomass has increased.

As shown in the Table 8 and related Figure 21 (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 since 2002. Regarding the soil organic carbon, we can see the opposite trend and an overall decrease (by 0.8%) since 2002.

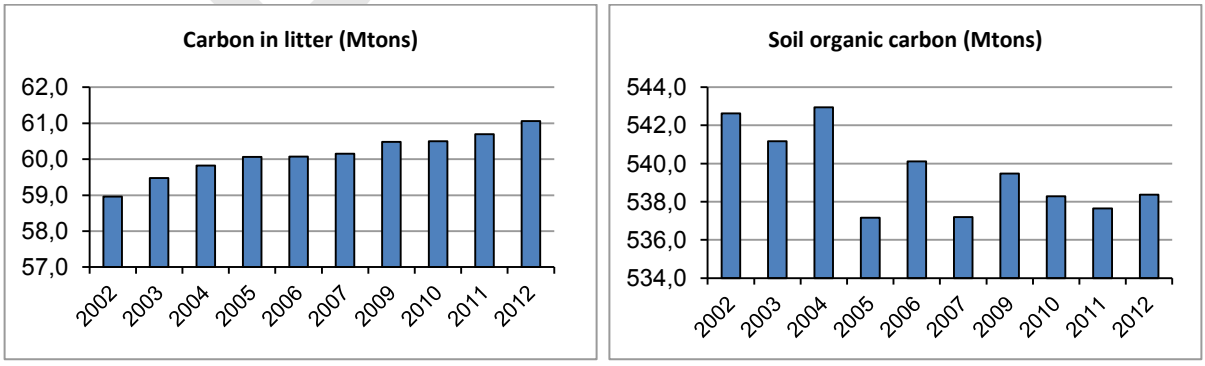
Despite this decrease of the soil organic carbon between 2002 and 2012, we can see that the sum of the main carbon stocks in forest land has constantly increased since 2005 (increase by 3.7% in ten years).

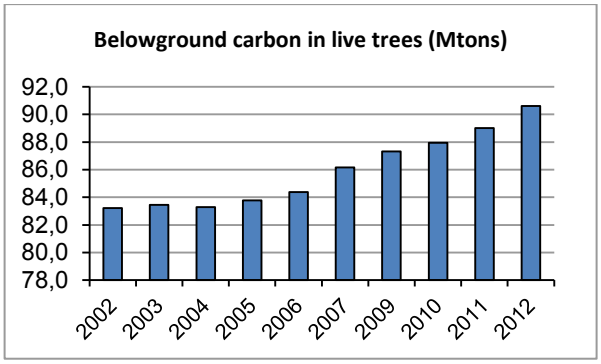
Table 8 : Carbon stocks evolution in forestland – (North Carolina 2002-2012)

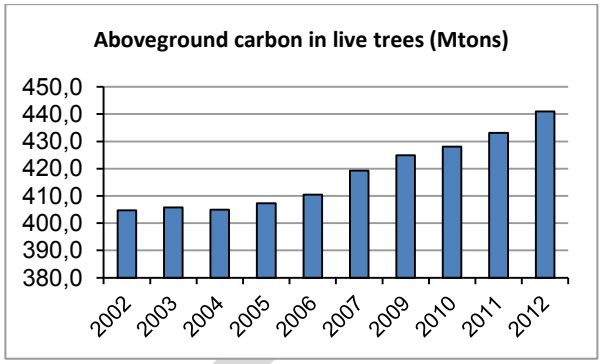
Year	Carbon in litter (million tons)	Soil organic carbon (million tons)	Belowground carbon in live trees (at least 1 inch d.b.h./d.r.c.) (million tons)	Aboveground carbon in live trees (at least 1 inch d.b.h./d.r.c.) (million tons)
2002	58.96	542.63	83.22	404.72
2003	59.47	541.17	83.45	405.74
2004	59.82	542.94	83.28	404.90
2005	60.07	537.16	83.78	407.30
2006	60.07	540.11	84.38	410.46
2007	60.15	537.19	86.17	419.25
2009	60.48	539.47	87.32	424.95
2010	60.50	538.29	87.95	428.09
2011	60.69	537.65	89.00	433.10
2012	61.06	538.37	90.61	440.96

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

Figure 19 : Carbon stocks evolution in forestland – North Carolina, 2002-2012







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 North Carolina forestry ("prescribed burning"). Prescribed burning is a critical management tool that benefits North Carolina's forests[27]: wildlife and environment, and also helps reduce the impact of wildfire hazards. Prescribed fire is especially important in North Carolina due to the large amount of land lying in the Wildland/Urban Interface.

North Carolina Forest Service trains, plans and coordinates with local fire services before a prescribed fire is started, and ensure that all burning regulations are complied with. The BMP describes appropriate use of fire and prevention of wildfires, including appropriate implementation of firelines and planning for prescribed burning.

The use of fire is subject to permit issued by the North Carolina Forest Service and that burning must be in compliance with North Carolina Air Quality regulations related to outdoor burning. 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.

Additionally, The North Carolina Forest Service established some smoke management guidelines[28] and burning categories mainly based on the ventilation rate, burning type (open/understory), distance to smoke sensitive areas and timeframe.

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 [29]

[27] http://ncforestservice.gov/fire_control/fc_prescribedfire.htm
[28] http://ncforestservice.gov/fire_control/fc_smoke_management_guidelines.htm

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 [30]
1.3 There is little or no evidence or reporting of illegal harvesting in the district of origin[31]
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[32]

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 North Carolina are:

- SFI (Sustainable Forestry Initiative[33]), which is endorsed by PEFC (Programme for the Endorsement of Forest Certification)
- ATFS (American Tree Farm System[34]), which is specifically suitable for small private owners
- FSC (Forest Stewardship Council[35]), 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:

[29] www.illegal-logging.info ; www.eia-international.org ; http://www.ahec-europe.org/
[30] www.illegal-logging.info ; www.eia-international.org ; http://www.ahec-europe.org/
[31] www.illegal-logging.info ; www.eia-international.org ; http://www.ahec-europe.org/
[32] http://www.transparency.org/cpi2012/results
[33] http://www.sfiprogram.org
[34] https://www.treefarmsystem.org
[35] https://us.fsc.org

Table 9 : Certified forest land in North Carolina (2011)

	SFI	FSC	ATFS	Total certified
Acres certified	1 065 980	10 455	330 577	1 407 012
Ha certified	431 387	4 231	133 780	569 398
Percentage forests	5.78 %	0.06 %	1.79%	7.63%

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

4. Conclusions

North Carolina has an important forest that covers about 60% of the State's land area. Most of this forest is privately owned (83%).

The Oak-hickory forest type group occupies the largest proportion of forest land in North Carolina (39.1%). The next most common forest-type groups are the loblolly-shortleaf pine (29.5%), and the oak-pine (13%).

Forestland and timberland area appears stable or trending slightly downwards since 2002, after showing a constant overall decline since the 1990s. If we consider the evolution during the last decade, a slight decrease of about 1.1% is recorded for timberland. If we consider the period between 2007 and 2012, a slight increase of 0.21% is noticed.

For all species combined, the net volume of live trees on timberland in North Carolina has increased by 37% since 1974. A slight but constant increase is recorded since 2002 (augmentation by about 10% since 2002).

Because of the increase of the volume of standing trees, the carbon stock associated to living woody biomass is growing. The total carbon stock in forests is estimated to have increased by 3.7 % between 2002 and 2012, despite an estimated decrease in the component of of carbon stock present in soil organic matter.

North Carolina 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 limited (8.3%). Even though these areas are rather limited, 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.

North Carolina 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 (completed in 2008) shows a rather good level (85%) of compliance and implementation of the BMP in the forestry operations.

Even though controlled fires are regularly used in forest management practices in North Carolina, 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 7.6% of forest certified under 3 systems SFI, ATFS and FSC.

ANNEX 1:

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

County	2007	2009	2010	2011	2012
Alamance (1)	52982	53817	54271	54176	54185
Alexander (3)	45350	45341	43014	39267	39052
Alleghany (5)	31613	30789	29577	29577	29339
Anson (7)	89783	89639	89680	91680	90978
Ashe (9)	69387	70001	70554	70607	70559
Avery (11)	52221	52221	52183	51939	54459
Beaufort (13)	143010	143182	142413	141386	143416
Bertie (15)	133566	133438	133076	132966	133516
Bladen (17)	161677	161293	160652	160732	162130
Brunswick (19)	170610	169429	169973	169773	170167
Buncombe (21)	87921	88576	86841	86881	88975
Burke (23)	101833	100801	101504	101347	100259
Cabarrus (25)	32159	32700	35040	35019	35457
Caldwell (27)	92328	92856	91787	91171	90855
Camden (29)	29947	29921	29205	29199	29499
Carteret (31)	69304	68165	67823	67827	69056
Caswell (33)	73450	73461	73666	72906	72619
Catawba (35)	39931	40165	40689	40005	39364
Chatham (37)	105972	105814	107772	106062	104497
Cherokee (39)	107767	107767	107736	107685	106730
Chowan (41)	20879	20903	20787	20718	20561
Clay (43)	40192	40192	40182	40163	40132
Cleveland (45)	49846	51513	50969	49674	49869
Columbus (47)	155532	154300	153594	153672	152120
Craven (49)	110843	110492	109953	110285	111962
Cumberland (51)	90089	90069	90208	91446	94776
Currituck (53)	15649	16235	16149	16147	16313
Dare (55)	65119	67355	67080	67182	66857
Davidson (57)	75633	75477	73846	74406	73733
Davie (59)	36925	36908	36743	36764	36248
Duplin (61)	113809	113634	113538	113594	112044
Durham (63)	39010	38797	38856	38860	37620
Edgecombe (65)	66923	66819	66237	66233	66914
Forsyth (67)	43349	43010	43483	43585	43401
Franklin (69)	78292	78205	78209	78200	77722
Gaston (71)	42066	42148	41507	41187	41050
Gates (73)	58800	58602	58327	58373	58790
Graham (75)	68750	68750	68331	68372	68432
Granville (77)	90300	89918	87340	87343	87122

County	2007	2009	2010	2011	2012
Greene (79)	25887	24882	24827	24750	24826
Guilford (81)	73454	73913	72903	73350	70872
Halifax (83)	117234	117357	116741	115765	116478
Harnett (85)	78575	78520	78167	80648	83398
Haywood (87)	104325	111162	111599	109143	108404
Henderson (89)	62920	62920	62895	62923	64769
Hertford (91)	67009	67088	66852	66770	66334
Hoke (93)	66809	66664	68819	68818	68070
Hyde (95)	88562	88367	88134	88119	95347
Iredell (97)	47508	47393	45165	43423	43072
Jackson (99)	110653	110653	110561	110955	108671
Johnston (101)	87777	88945	91862	89496	91647
Jones (103)	94846	94474	91958	91961	91009
Lee (105)	43515	43451	41829	41851	42183
Lenoir (107)	54297	54936	54887	54885	54511
Lincoln (109)	34191	34134	31574	31558	31894
McDowell (111)	100443	100488	99698	99719	99627
Macon (113)	115128	116217	118521	118558	121359
Madison (115)	88203	88795	88716	88696	89104
Martin (117)	86133	85982	85532	85702	84774
Mecklenburg (119)	39363	39182	39687	39076	39987
Mitchell (121)	39557	39345	38984	38987	39139
Montgomery (123)	93840	93620	93366	93877	93625
Moore (125)	130458	132575	132130	130333	132275
Nash (127)	71373	71325	73067	73022	73086
New Hanover (129)	15634	15628	17361	17960	18218
Northampton (131)	92816	92667	94609	92218	93720
Onslow (133)	147222	147095	147133	146567	142908
Orange (135)	52044	52014	52099	51446	52375
Pamlico (137)	59465	58345	57921	57837	58136
Pasquotank (139)	12798	12759	12695	12704	12610
Pender (141)	173464	176267	176953	179965	177222
Perquimans (143)	26594	26577	26490	26344	28988
Person (145)	54071	54026	54191	54228	53759
Pitt (147)	69362	69277	68812	68627	68420
Polk (149)	42572	42594	43320	43309	43395
Randolph (151)	110247	109631	112841	114164	113449
Richmond (153)	99632	99482	99387	99994	99827
Robeson (155)	136019	135609	136683	138152	134501
Rockingham (157)	98954	99007	99229	98959	97802
Rowan (159)	48635	49057	48861	48840	52396
Rutherford (161)	85474	84777	84693	86984	86710

County	2007	2009	2010	2011	2012
Sampson (163)	110451	110544	110415	108007	107033
Scotland (165)	54799	54718	56800	56625	55927
Stanly (167)	47558	47947	47921	47325	46933
Stokes (169)	81524	81729	82838	84068	84493
Surry (171)	79626	81763	82653	82587	82064
Swain (173)	131389	124758	124373	126572	128032
Transylvania (175)	88317	88137	88116	88169	88021
Tyrrell (177)	53312	55583	57354	60295	60873
Union (179)	68425	68417	68864	67650	63416
Vance (181)	38759	38720	38869	38859	40210
Wake (183)	57560	59355	57832	58180	61293
Warren (185)	85408	85163	85047	84329	84033
Washington (187)	44651	44256	44064	44067	44241
Watauga (189)	47064	46390	48211	48233	48214
Wayne (191)	63144	63124	63099	64947	67769
Wilkes (193)	135142	136847	136150	134147	133858
Wilson (195)	36376	36346	33737	33686	33987
Yadkin (197)	33902	33902	34172	34255	32626
Yancey (199)	62651	62651	62594	63022	62863
Total	7519939	7530255	7527655	7522117	7535569

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
Alexander (3)	-6298	-13.89%	-2.78%
Iredell (97)	-4436	-9.34%	-1.87%
Union (179)	-5009	-7.32%	-1.46%
Alleghany (5)	-2274	-7.19%	-1.44%
Lincoln (109)	-2297	-6.72%	-1.34%
Wilson (195)	-2389	-6.57%	-1.31%
Greene (79)	-1061	-4.10%	-0.82%
Jones (103)	-3837	-4.05%	-0.81%
Yadkin (197)	-1276	-3.76%	-0.75%
Durham (63)	-1390	-3.56%	-0.71%
Granville (77)	-3178	-3.52%	-0.70%
Guilford (81)	-2582	-3.52%	-0.70%
Sampson (163)	-3418	-3.09%	-0.62%
Lee (105)	-1332	-3.06%	-0.61%
Onslow (133)	-4314	-2.93%	-0.59%
Swain (173)	-3357	-2.56%	-0.51%
Davidson (57)	-1900	-2.51%	-0.50%
Gaston (71)	-1016	-2.42%	-0.48%
Pamlico (137)	-1329	-2.23%	-0.45%
Columbus (47)	-3412	-2.19%	-0.44%
Davie (59)	-677	-1.83%	-0.37%
Jackson (99)	-1982	-1.79%	-0.36%
Warren (185)	-1375	-1.61%	-0.32%
Caldwell (27)	-1473	-1.60%	-0.32%
Martin (117)	-1359	-1.58%	-0.32%
Duplin (61)	-1765	-1.55%	-0.31%
Burke (23)	-1574	-1.55%	-0.31%
Chowan (41)	-318	-1.52%	-0.30%
Camden (29)	-448	-1.50%	-0.30%
Pasquotank (139)	-188	-1.47%	-0.29%
Catawba (35)	-567	-1.42%	-0.28%
Chatham (37)	-1475	-1.39%	-0.28%
Pitt (147)	-942	-1.36%	-0.27%
Stanly (167)	-625	-1.31%	-0.26%
Rockingham (157)	-1152	-1.16%	-0.23%
Caswell (33)	-831	-1.13%	-0.23%
Robeson (155)	-1518	-1.12%	-0.22%
Mitchell (121)	-418	-1.06%	-0.21%
Hertford (91)	-675	-1.01%	-0.20%
Cherokee (39)	-1037	-0.96%	-0.19%
Wilkes (193)	-1284	-0.95%	-0.19%
Washington (187)	-410	-0.92%	-0.18%
McDowell (111)	-816	-0.81%	-0.16%
Franklin (69)	-570	-0.73%	-0.15%
Halifax (83)	-756	-0.64%	-0.13%
Person (145)	-312	-0.58%	-0.12%

County	Total change (ha) 2007-2012	Total change (%) 2007-2012	Yearly average (%) 2007-2012
Graham (75)	-318	-0.46%	-0.09%
Carteret (31)	-248	-0.36%	-0.07%
Transylvania (175)	-296	-0.34%	-0.07%
Brunswick (19)	-443	-0.26%	-0.05%
Montgomery (123)	-215	-0.23%	-0.05%
Clay (43)	-60	-0.15%	-0.03%
Bertie (15)	-50	-0.04%	-0.01%
Gates (73)	-10	-0.02%	0.00%
Edgecombe (65)	-9	-0.01%	0.00%
Cleveland (45)	23	0.05%	0.01%
Forsyth (67)	52	0.12%	0.02%
Richmond (153)	195	0.20%	0.04%
Bladen (17)	453	0.28%	0.06%
Beaufort (13)	406	0.28%	0.06%
Yancey (199)	212	0.34%	0.07%
Lenoir (107)	214	0.39%	0.08%
Orange (135)	331	0.64%	0.13%
Northampton (131)	904	0.97%	0.19%
Craven (49)	1119	1.01%	0.20%
Madison (115)	901	1.02%	0.20%
Buncombe (21)	1054	1.20%	0.24%
Anson (7)	1195	1.33%	0.27%
Moore (125)	1817	1.39%	0.28%
Rutherford (161)	1236	1.45%	0.29%
Mecklenburg (119)	624	1.59%	0.32%
Ashe (9)	1172	1.69%	0.34%
Hoke (93)	1261	1.89%	0.38%
Polk (149)	823	1.93%	0.39%
Scotland (165)	1128	2.06%	0.41%
Pender (141)	3758	2.17%	0.43%
Alamance (1)	1203	2.27%	0.45%
Nash (127)	1713	2.40%	0.48%
Watauga (189)	1150	2.44%	0.49%
Dare (55)	1738	2.67%	0.53%
Randolph (151)	3202	2.90%	0.58%
Henderson (89)	1849	2.94%	0.59%
Surry (171)	2438	3.06%	0.61%
Stokes (169)	2969	3.64%	0.73%
Vance (181)	1451	3.74%	0.75%
Haywood (87)	4079	3.91%	0.78%
Currituck (53)	664	4.24%	0.85%
Avery (11)	2238	4.29%	0.86%
Johnston (101)	3870	4.41%	0.88%
Cumberland (51)	4687	5.20%	1.04%
Macon (113)	6231	5.41%	1.08%
Harnett (85)	4823	6.14%	1.23%
Wake (183)	3733	6.49%	1.30%
Wayne (191)	4625	7.32%	1.46%
Hyde (95)	6785	7.66%	1.53%

County	Total change (ha) 2007-2012	Total change (%) 2007-2012	Yearly average (%) 2007-2012
Rowan (159)	3761	7.73%	1.55%
Perquimans (143)	2394	9.00%	1.80%
Cabarrus (25)	3298	10.26%	2.05%
Tyrrell (177)	7561	14.18%	2.84%
New Hanover (129)	2584	16.53%	3.31%
Total	**15630**	**0.21%**	**0.04%**

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