

# Hickory

Shagbark hickory, *Carya ovata*  
Bitternut hickory, *Carya cordiformis*

The volume in hickory has increased steadily since 1968 and is aging. The number of sawtimber-sized trees has increased by over 50% and the volume in large trees has more than tripled.

Growth rates haven't changed since 1983 but mortality has increased sevenfold. Hickory accounts for about 1.4% of volume and growth but only 0.8% of mortality and removals. The volume of bitternut hickory is expected to decrease in the next 40 years while the volume of shagbark hickory should increase substantially.

Hickory is not a prominent timber species, accounting for only 0.2% of roundwood production in 2009. Although removals have quadrupled since 1983, we harvest much less hickory compared to other species. Hickory wood has the highest density of all species in Wisconsin and therefore may be a valuable source of woody biomass.



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Modelling future volumes

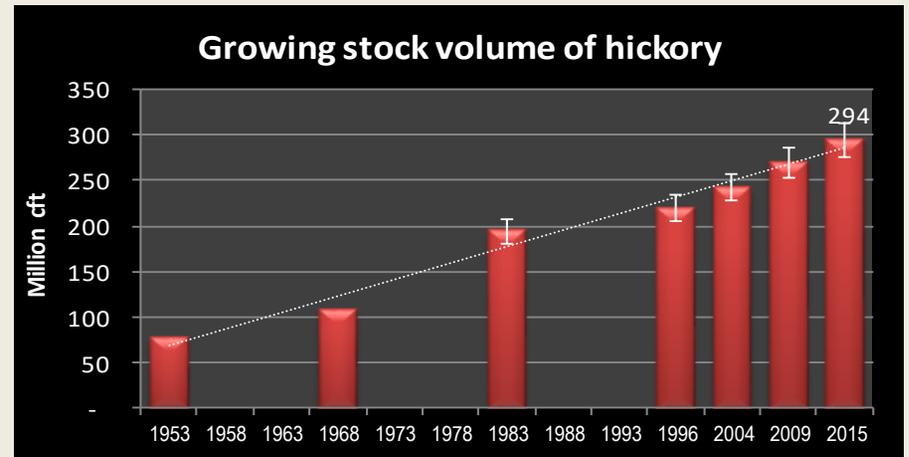


*“How has the hickory resource changed?”*  
**Growing stock volume and diameter class distribution by year**

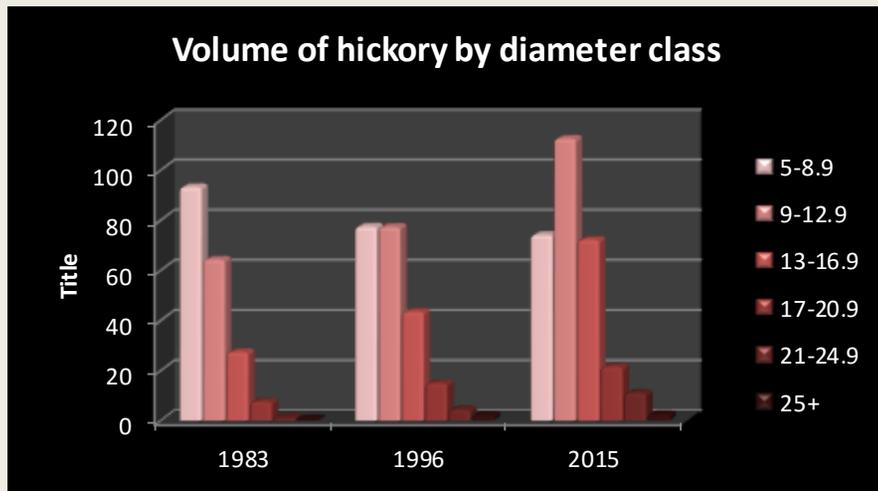
The [growing stock volume](#) of hickory in 2015 was about 294 million cubic feet or 1.4% of total statewide volume (chart on right). The volume of hickory has increased steadily since 1953, 52% since 1983 and 34% since 1996.

The hickory resource is maturing; the total volume in small growing stock (5-12.9 inches dbh) has increased by 18% since 1983 while the volume in large trees (13+ inches dbh) has more than tripled (chart below left).

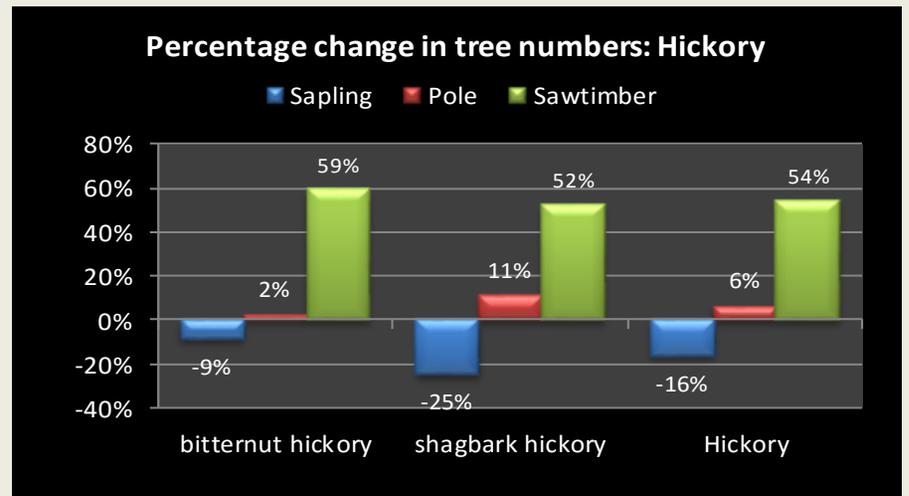
The number of sawtimber hickory has increased by 54% while the number of saplings has decreased by 16% (chart below right). Lack of regeneration may affect long term sustainability of both species.



Growing stock volume (million cubic feet) by inventory year.  
 Source: USDA Forest Inventory and Analysis data



Growing stock volume (million cubic feet) by diameter class (inches).  
 Source: USDA Forest Inventory and Analysis data.



Percentage change in the number of live trees by size class between 1996 and 2015.  
 Source: USDA Forest Inventory and Analysis data 1996 and 2015.

*"Where is hickory found in Wisconsin?"*

**Growing stock volume by region with map**



About 60% of hickory volume is bitternut hickory (Table 1). Most hickory occurs in southwest Wisconsin with only 4% in the northern part of the state.

Shagbark hickory is found almost exclusively on the oak / hickory forest type whereas bitternut hickory is also an important component of the maple / beech / birch type.

Table 1. Growing stock volume (million cft) by species and region of the state.

Species	Central	North east	North west	South east	South west	Total	Percent of total
<b>Shagbark hickory</b>	28	6	5	14	63	<b>117</b>	<b>40%</b>
<b>Bitternut hickory</b>	17	-	-	48	112	<b>177</b>	<b>60%</b>
<b>Total</b>	<b>45</b>	<b>6</b>	<b>5</b>	<b>62</b>	<b>175</b>	<b>294</b>	<b>100%</b>
<b>Percent of total</b>	<b>15%</b>	<b>2%</b>	<b>2%</b>	<b>21%</b>	<b>60%</b>	<b>100%</b>	

Source: USDA Forest Service, Forest Inventory and Analysis 2015

For a table on **Volume by County** go to:

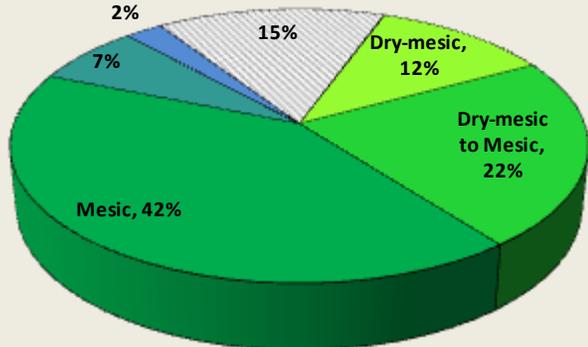
<http://dnr.wi.gov/topic/ForestBusinesses/documents/tables/VolumeCountySpecies.pdf>



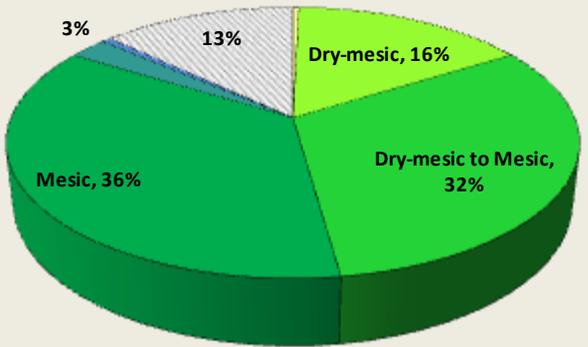
*“What kind of sites does hickory grow on?”*  
**Habitat type and site index distribution**

About two-thirds of both bitternut and shagbark hickory growing stock volume is found on dry- mesic to mesic and mesic habitat types (chart below). About half of bitternut hickory volume occurs on more mesic sites whereas almost half of shagbark hickory volume occurs on dry-mesic and dry-mesic to mesic sites.

**Bitternut Hickory**



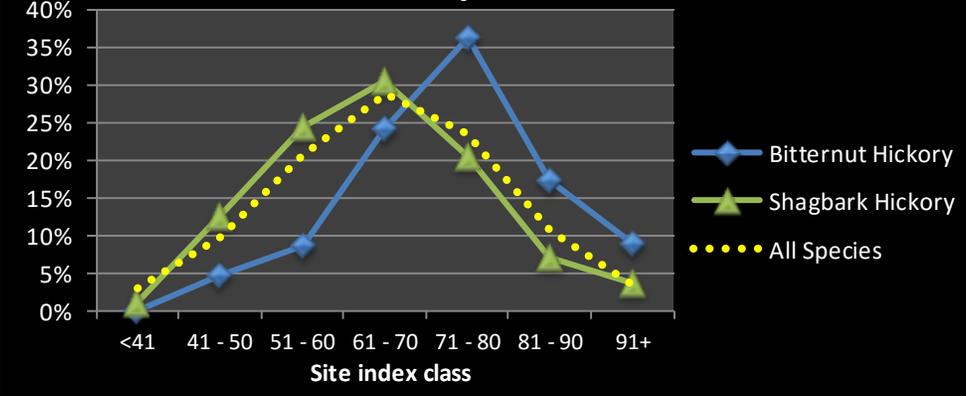
**Shagbark Hickory**



- Habitat type group<sup>1</sup>**
- Very Dry to Dry
  - Dry to Dry-mesic
  - Dry-mesic
  - Dry-mesic to Mesic
  - Mesic
  - Mesic to Wet-mesic
  - Wet
  - Undefined

Percent distribution of growing stock volume by habitat type group (USDA Forest Inventory & Analysis data).

**Percent of volume by site index**



Again bitternut hickory growing stock volume is found on slightly richer sites (chart on left). Over 85% of bitternut hickory volume is located on sites with a site index greater than 60. Only 62% of shagbark hickory volume is on sites with a site index greater than 60.

The average site index by volume for bitternut hickory is 74 much higher than the average for all species, 66. The average for shagbark hickory is 65.

Percent distribution of growing stock volume by site index class (USDA Forest Inventory & Analysis data).

<sup>1</sup> For more information on habitat types see Schmidt, Thomas L. 1997. Wisconsin forest statistics, 1996. Resource Bulletin NC-183. St. Paul, MN: U.S. Dept. of Agriculture, Forest Service, North Central



*“How fast is hickory growing?”*

**Average annual net growth: trends and ratio of growth to volume**

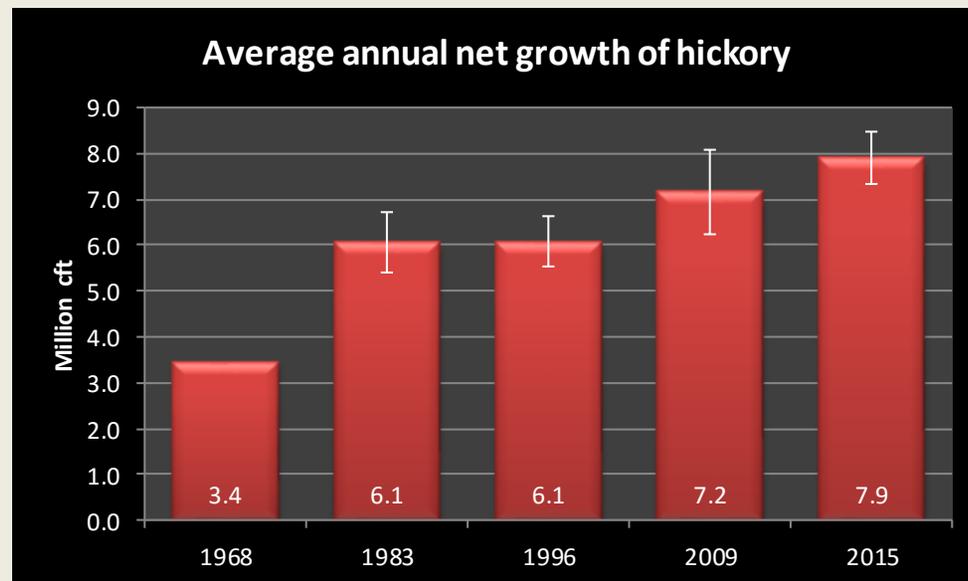
The [average annual net growth](#) of hickory is about 7.9 million cubic feet per year, representing 1.4% of statewide volume growth (chart on right). Volume growth has increased significantly since 1983.

Almost all volume growth for hickory occurs in southern Wisconsin (Table 2) as does the highest growth to volume ratio.

Table 2. Average annual net growth (million cft/year) of growing stock and the ratio of growth to volume by region of the state.

Region	Net growth	Percent of Total	Ratio of growth to volume
Northeast	0.2	2%	2.8%
Northwest	0.1	1%	2.3%
Central	1.1	14%	2.5%
Southwest	4.9	60%	2.8%
Southeast	1.8	22%	2.9%
<b>Statewide</b>	<b>8.2</b>	100%	<b>2.8%</b>

Source: USDA Forest Inventory and Analysis 2015



Average annual net growth (million cubic feet).  
Source: USDA Forest Inventory & Analysis data

The ratio of growth to volume for hickory is 2.8%, almost equal to the statewide average of 2.7% for all species.

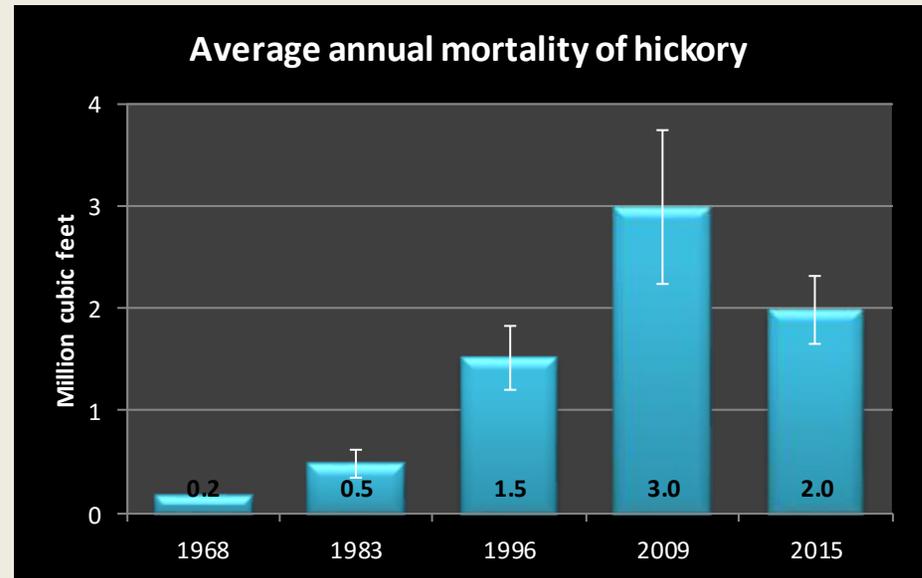
For a table of **Average annual growth, mortality and removals by region** go to:  
<http://dnr.wi.gov/topic/ForestBusinesses/documents/tables/GrowthMortalityRemovals.pdf>



*“How healthy is hickory in Wisconsin?”*  
**Average annual mortality: trends and ratio of mortality to growth**

The [average annual mortality](#) of hickory, about 2.0 million cubic feet per year from 2010 to 2015, has increased four fold since 1983 (chart on right). The percent of statewide mortality, 0.8%, is much less than the percent of total volume in the state, 1.4%.

The ratio of mortality to volume is 0.7% for hickory species and is four times higher for bitternut hickory compared to shagbark hickory (Table 3). This rate is much lower than the statewide average of 1.1% for all species.



Average annual mortality (million cubic feet) by inventory year. Error bars represent the 67% confidence interval.

Source: USDA Forest Inventory & Analysis data

Table 3. Mortality, volume and the ratio of mortality to volume.

Species	Average annual mortality (cft)	Volume of growing stock (cft)	Mortality / volume
<b>Bitternut hickory</b>	1,383,605	116,966,576	<b>1.2%</b>
<b>Shagbark hickory</b>	607,162	177,450,581	<b>0.3%</b>
<b>Total hickory</b>	<b>1,990,767</b>	<b>294,417,157</b>	<b>0.7%</b>

Source: USDA Forest Inventory & Analysis data

For a table of **Average annual growth, mortality and removals by region** go to:  
<http://dnr.wi.gov/topic/ForestBusinesses/documents/tables/GrowthMortalityRemovals.pdf>

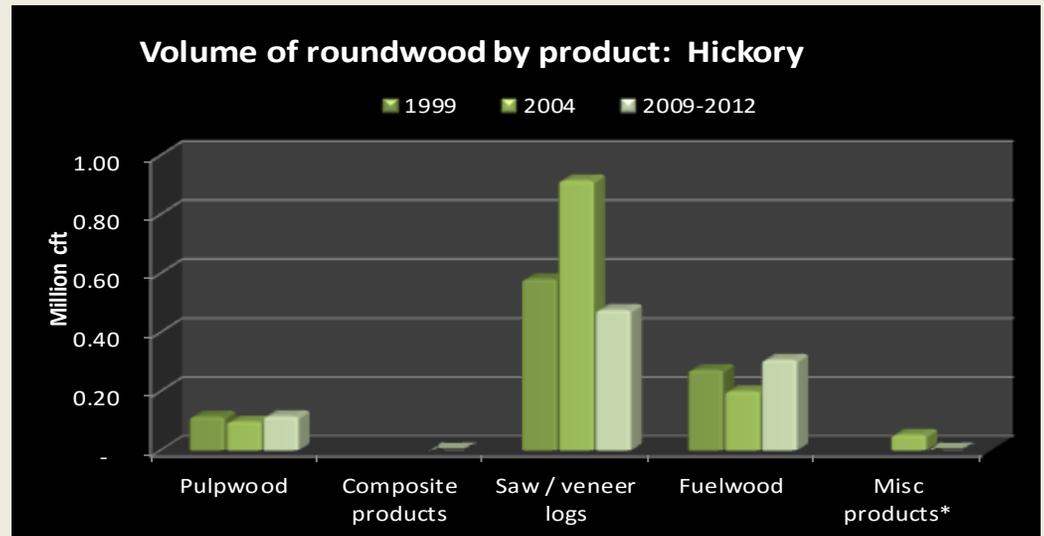


*"How much hickory do we harvest?"*

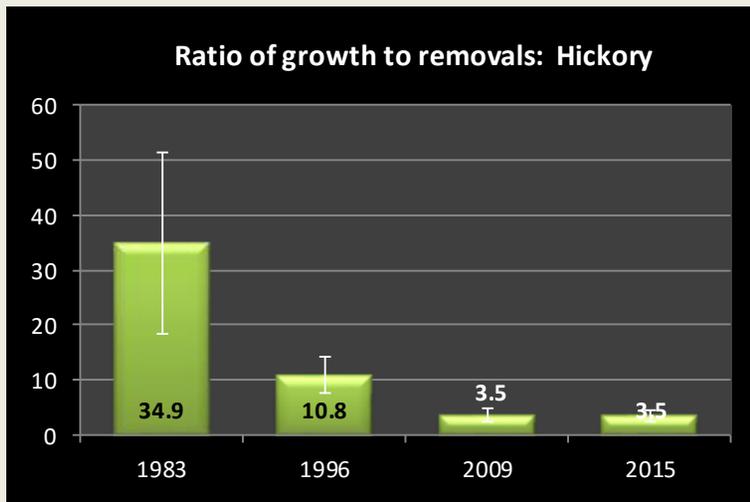
**Roundwood production by product: trends and ratio of removals to growth**

In 2009-2011, Wisconsin produced 898,000 cubic feet of hickory [roundwood](#) or about 0.2% of the state's total volume (chart on right ). Over half of this was in sawlogs and veneer with 34% used for fuelwood and 13% for pulpwood.

Between 2004 and 2009, sawlog/veneer production decreased by 50% while fuelwood production increased.



Volume of roundwood. Most recent figures for pulpwood and composite products are from 2011 while other product volumes are from 2009. \* Miscellaneous products include poles, posts and pilings. Source: Ronald Piva, USDA Forest Service, Northern Research Station, St. Paul MN



Source: USDA Forest Inventory & Analysis data

Removals of hickory were 2.3 million cubic feet per year from 2010 to 2015. Over 70% of this was bitternut hickory.

The ratio of average annual net growth to removals decreased from 34.9 in 1983 to 3.5 in 2015 (chart on left), mostly due to a more than quadrupling of harvest levels. The ratio of growth to removals for hickory is twice as high as the average of 1.7 for all species in the state.

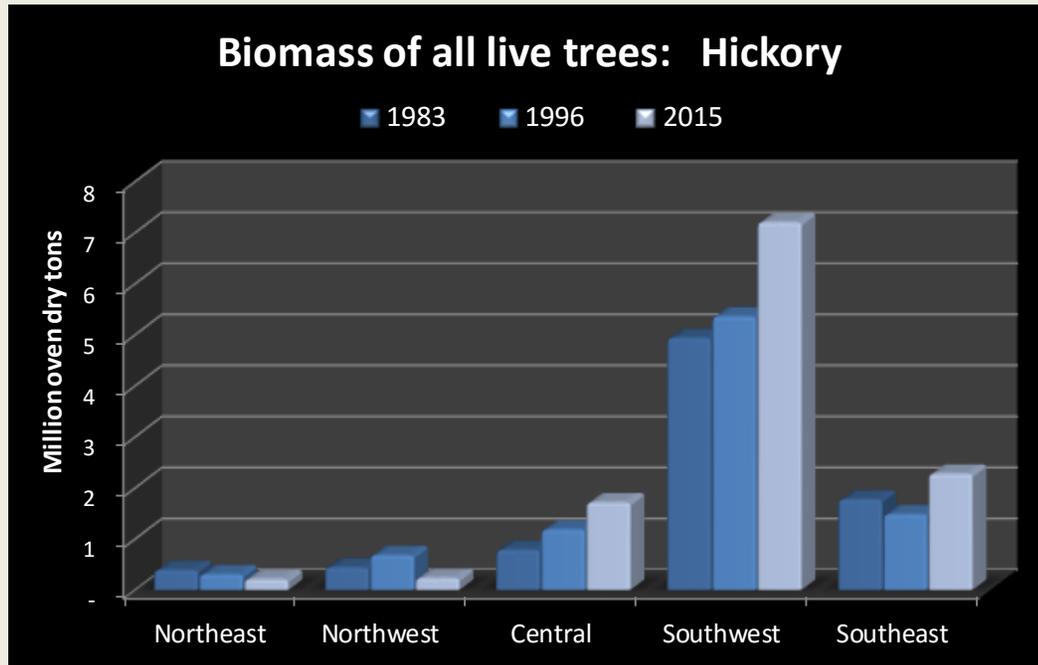
For a table of **Average annual growth, mortality and removals by region** go to:

<http://dnr.wi.gov/topic/ForestBusinesses/documents/tables/GrowthMortalityRemovals.pdf>



*“How much hickory biomass do we have?”*  
**Aboveground biomass by region of the state**

There were 11.3 million short tons of aboveground biomass in live trees in the hickory group in 2015, an increase of 36% from 1983. This is equivalent to approximately 5.7 million tons of carbon and represents 1.8% of all aboveground carbon statewide. As with volume, most hickory is located in southern Wisconsin (chart below).



Biomass (above ground dry weight of live trees >1 in dbh, short tons) by year and region of the state.  
 Source: USDA Forest Inventory & Analysis data.

The density of hickory wood is the highest of all species with a ratio of biomass to volume of 45 oven-dry lbs. per cubic foot (ODP/cft). The average for all hardwoods is about 37 ODP/cubic feet and for all species is 33 ODP/cubic feet.

Approximately, 68% of all hickory biomass is located in the main stem and 19% in the top branches.

The high density of hickory wood may make it a valuable species for biomass production.

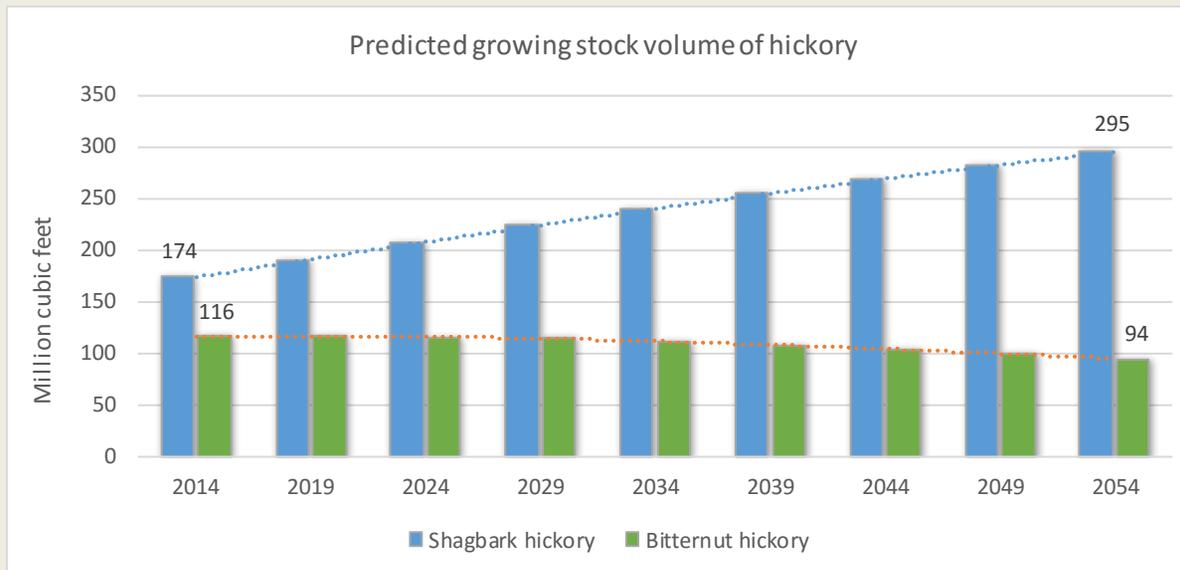
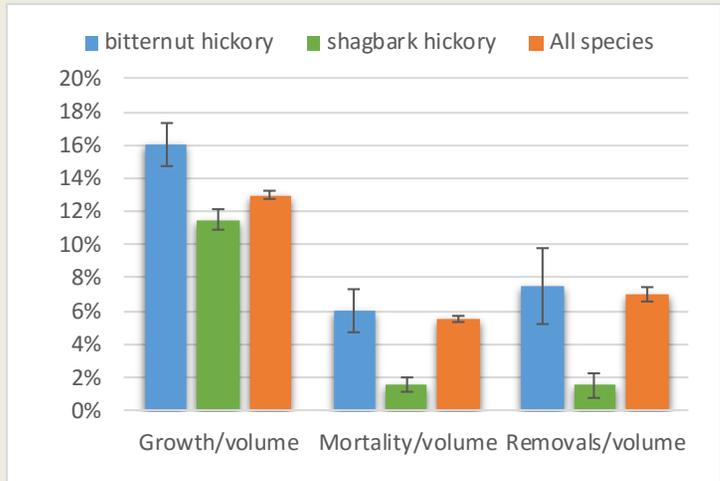
For a table of **Biomass by County** go to:  
<http://dnr.wi.gov/topic/ForestBusinesses/documents/tables/BiomassByCounty.pdf>

*"Can we predict the future of hickory?"*

**Predicted volumes based on current rates of mortality and harvest**

The 5-year ratios of mortality to volume, removals to volume and growth to volume are significantly lower for basswood compared to all species in the state (chart on right).

The Forest Vegetation Simulator (FVS<sup>1</sup>) was used to predict future volumes of bitternut and shagbark hickory through 2054 (chart below). Bitternut hickory volume decreases by 18% in the next 40 years whereas shagbark hickory volume increases by 69%. The decrease in bitternut hickory may very well be due to high sawtimber removals. For instance, the 5-year ratio of sawtimber removals to volume is almost eight times higher for bitternut hickory (11.5%) compared to shagbark hickory (1.5%) and is one of the highest ratios of all species.



The Forest Vegetation Simulator is a forest growth and yield simulation model created by the USDA Forest Service, see <http://www.fs.fed.us/fmcs/fvs/>.