Black oak and Northern pin oak

Black oak, *Querqus velutina*
Northern pin oak, *Querqus ellipsoidalis*

The volume in black and northern pin oaks has increased especially in larger size classes. However, there are significant differences between the species. Since 1996, the number of black oak trees has declined in all size classes while the number of northern pin oak has increased. Models suggest that volumes will continue to decrease especially for black oak.

Since 2009,growth rates have decreased and mortality has increased especially for black oak. Whereas black and northern pin oak species make up about 3.7% of all volume of trees in Wisconsin, they account for only 1.6% of net growth and 7.3% of mortality.

Black and northern pin oaks are important timber species, comprising over 6.3% of removals. The ratio of growth to removals is 0.5 indicating we remove twice as much wood as is being replaced by new growth. Due to the high density of black and northern pin oak wood, it may be a valuable source of woody biomass for biofuel production.

- *How has the black and northern pin oak resource changed?*
  Volume and diameter class distribution:
- *Where is black and northern pin oak found in Wisconsin?*
  Growing stock volume by region with map
- *What kind of sites do black and northern pin oak grow on?*
  Habitat type and site index distribution
- *How fast is black and northern pin oak growing?*
  Average annual net growth: trends and ratio of growth to volume
- *How healthy is black and northern pin oak in Wisconsin?*
  Average annual mortality: trends and ratio of mortality to volume
- *How much black and northern pin oak do we harvest?*
  Roundwood production by product and ratio of growth to removals
- *How much black and northern pin oak biomass do we have?*
  Tons of aboveground biomass by region of the state
- *Can we predict the future of black and northern pin oak?*
  Modelling future volumes

Division of Forestry
WI Dept of Natural Resources 2016

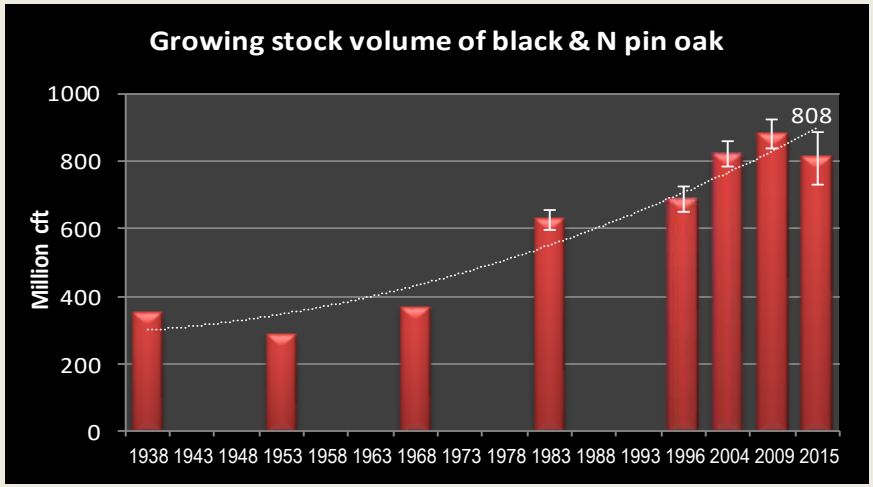
"How has the black and northern pin oak resource changed?"

Growing stock volume and diameter class distribution

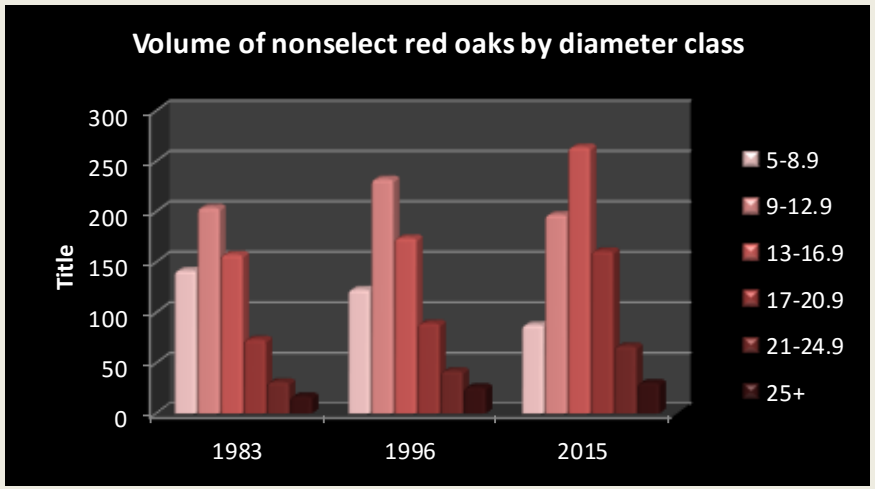
The growing stock volume of black and northern pin oaks is about 808 million cubic feet or 3.7% of total statewide volume (chart on right). The volume of black and northern pin oaks rose between 1938 and 2009. The decline after 2009 is not significant due to sampling error.

The red oak resource is maturing; the total volume in small growing stock (5-12.9 inches dbh) has decreased by 11% since 1983 while the volume in large trees (13+ inches dbh) has increased by 82% (chart below left).

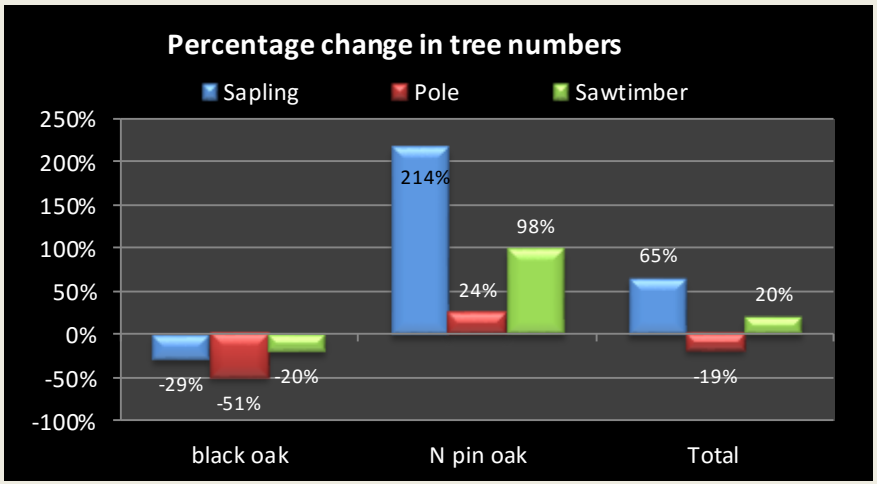
There is a significant difference in the change in tree numbers between the two species (chart below right). The number of N pin oak trees has increased in all size classes while the number of black oak has decreased.



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



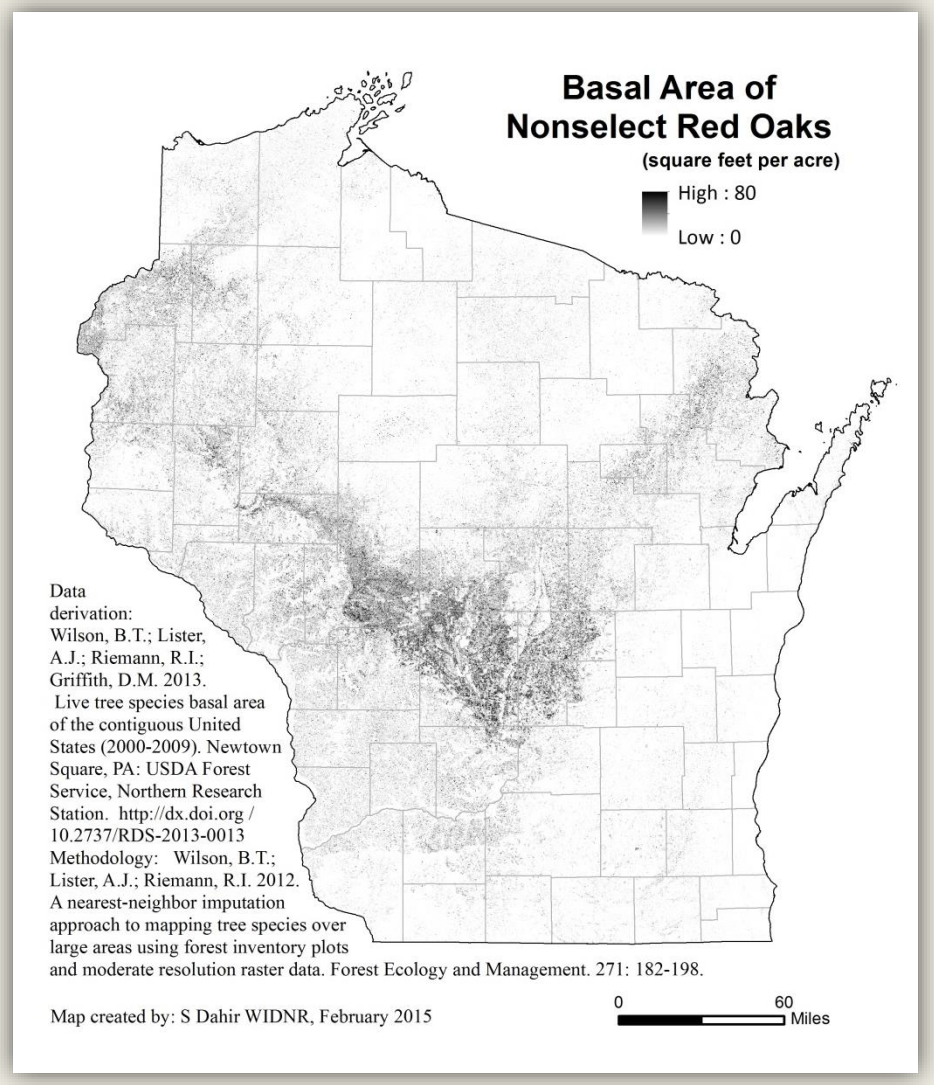
Growing stock volume (million cubic feet) by diameter class (inches).
Source: USDA Forest Inventory and Analysis data



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 black and northern pin oaks found in Wisconsin?"

Growing stock volume by region with map



Over half of black and northern pin oak volume occurs in central Wisconsin with another one quarter in the north (Table 1).

The majority of volume is found on the white oak / red oak / hickory forest type with lesser amounts on aspen and red pine types.

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

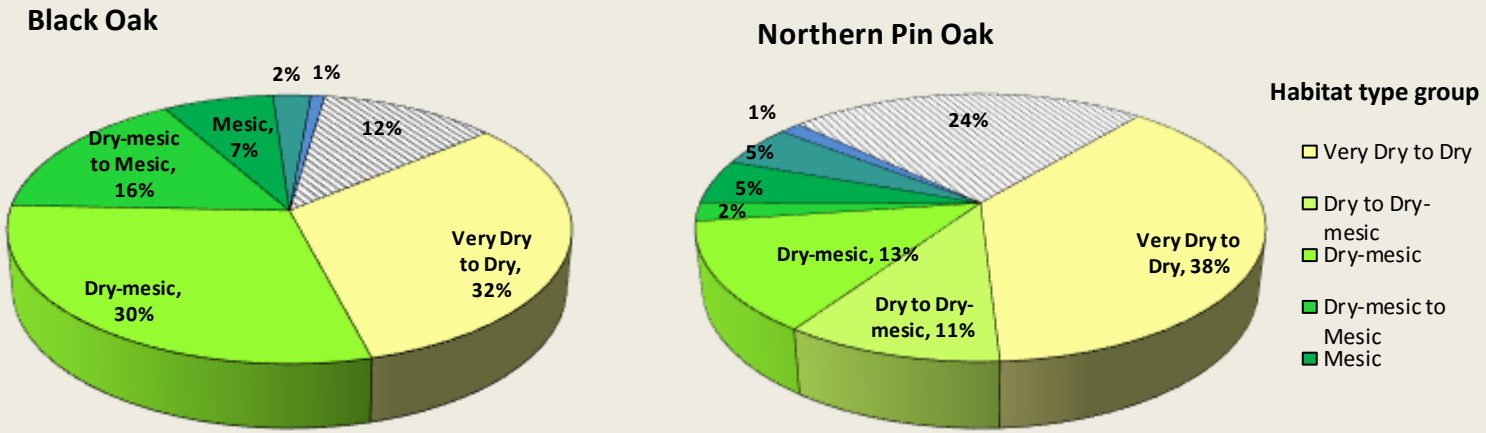
Species	Central	North east	North west	South east	South west	Total	Percent of total
Black oak	226	-	-	38	85	**349**	**43%**
N pin oak	189	101	106	18	46	**460**	**57%**
Total	**414**	**101**	**106**	**56**	**131**	**808**	**100%**
Percent of total	**51%**	**12%**	**13%**	**7%**	**16%**	**100%**	

Source: USDA Forest Service, Forest Inventory and Analysis 2013

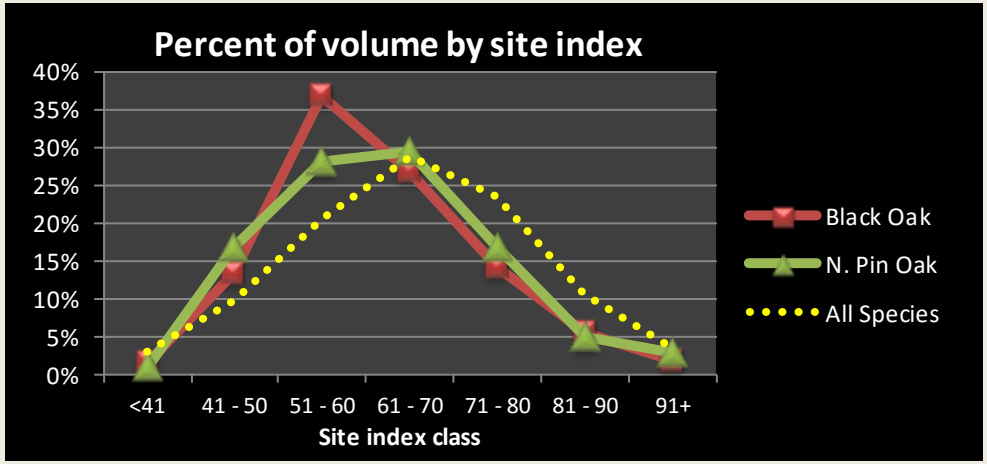
For a table on **Volume by County** go to:
http://dnr.wi.gov/topic/ForestBusinesses/documents/tables/VolumeCountySpecies.pdf

"What kind of sites does black and northern pin oak grow on?"

Black and northern pin oaks grow mostly on dry habitat types. Northern pin oak occurs on somewhat drier sites compared to black oak. For instance, half of pin oak volume is found on very dry and dry to dry-mesic sites while only one third of black oak occurs on these sites (chart below).



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



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

The majority of black and northern pin oak growing stock volume is found in stands with lower than average site indices (chart on left). About 50% of volume is located on sites with site index less than 60.

The average site index by volume for black and northern pin oak is 62, lower than the average for all species, 66.

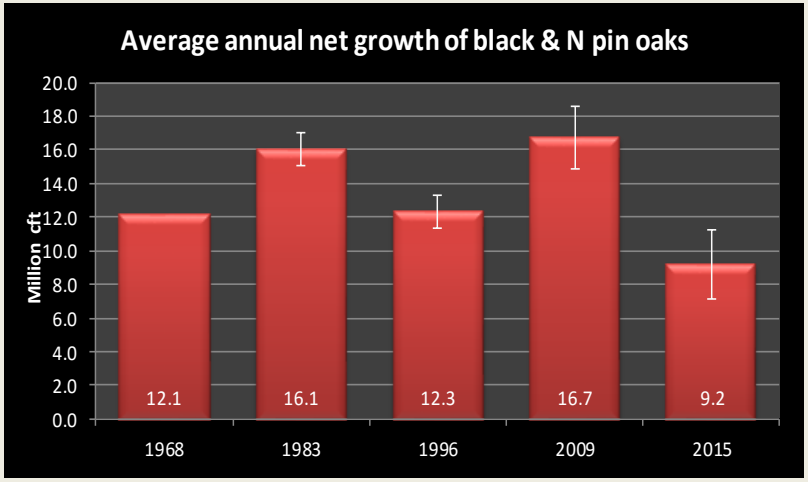
For more information on habitat types see Schmidt, Thomas L. 1997. Wisconsin forest statistics, 1996. Resource Bulletin NC-183. St. Paul, MN: U.S. Dept. of Agriculture, Forest Service, North Central

"How fast are black and northern pin oaks growing?"

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

The average annual net growth of black and northern pin oaks was about 9.2 million cubic feet/year from 2010 to 2015, representing 1.6% of statewide volume growth (chart on right). Growth rates have decreased significantly since 1983.

The highest volume growth for black and northern pin oaks occurs in central Wisconsin (Table 2) but the highest growth to volume ratio occurs in the southeast.



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

Table 2. Average annual net growth (million cubic feet/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	1.6	17%	**1.6%**
Northwest	-0.7	.	**-0.7%**
Central	6.2	67%	**1.5%**
Southwest	1.1	12%	**0.9%**
Southeast	1.1	12%	**1.9%**
Statewide	**9.2**	100%	**1.1%**

Source: USDA Forest Inventory and Analysis

The ratio of growth to volume for black and northern pin oaks is 1.1%, much lower than the statewide average of 2.7% for all species. High mortality will reduce net growth.

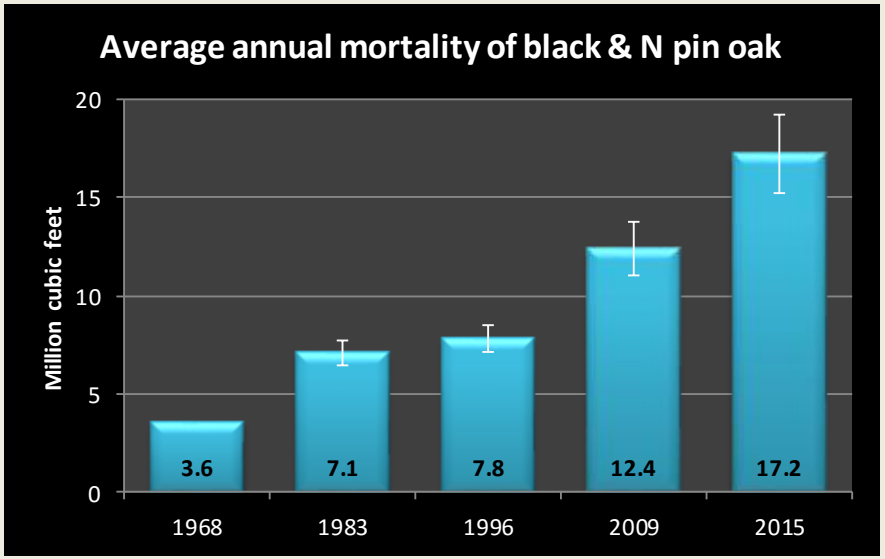
For a table of **Average annual growth, mortality and removals by region** go to:
http://dnr.wi.gov/topic/ForestBusinesses/documents/tables/GrowthMortalityRemovals.pdf

"How healthy are black and northern pin oaks in Wisconsin?"

Average annual mortality and the ratio of mortality to volume

The average annual mortality of black and northern pin oaks, about 17.2 million cubic feet per year from 2010 to 2015, has more than doubled since 1996 (chart on right). Black and northern pin oaks account for 3.7% of volume but 7.3% of mortality in the state.

The ratio of mortality to volume is 2.1% for black and northern pin oak species, almost twice as high as the statewide average of 1.1% (Table 3).



Average annual mortality (million cubic feet) by inventory year.
Source: USDA Forest Inventory & Analysis data:

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

Species	Average annual mortality (cft)	Growing stock volume (cft)	Mortality / volume
Black oak	6,721,668	348,656,900	**1.9%**
Northern pin oak	10,511,703	459,574,105	**2.3%**
Total black and N pin oaks	**17,233,370**	**808,231,005**	**2.1%**

Source: USDA Forest Inventory & Analysis data

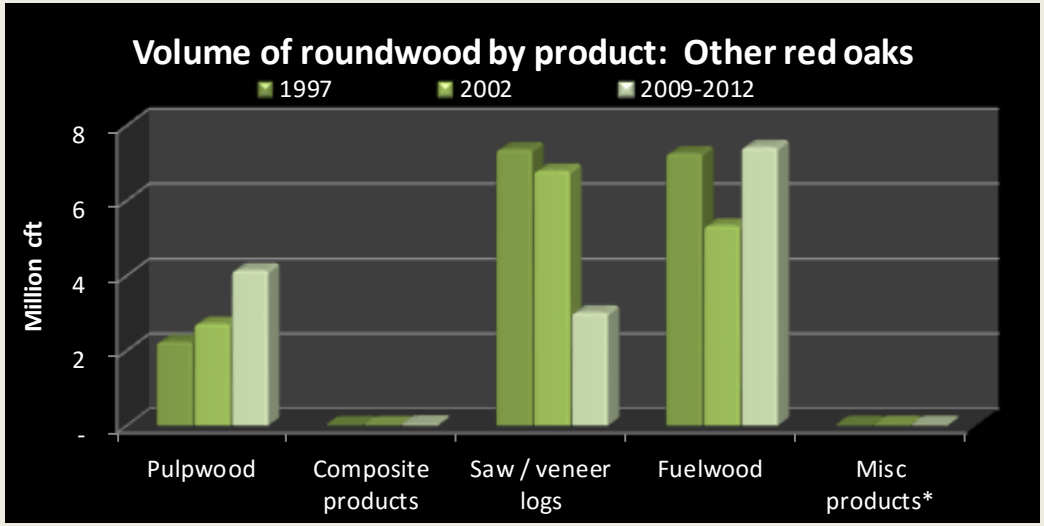
For a table of **Average annual growth, mortality and removals by region** go to:
http://dnr.wi.gov/topic/ForestBusinesses/documents/tables/GrowthMortalityRemovals.pdf

"How much black and northern pin oak do we harvest?"

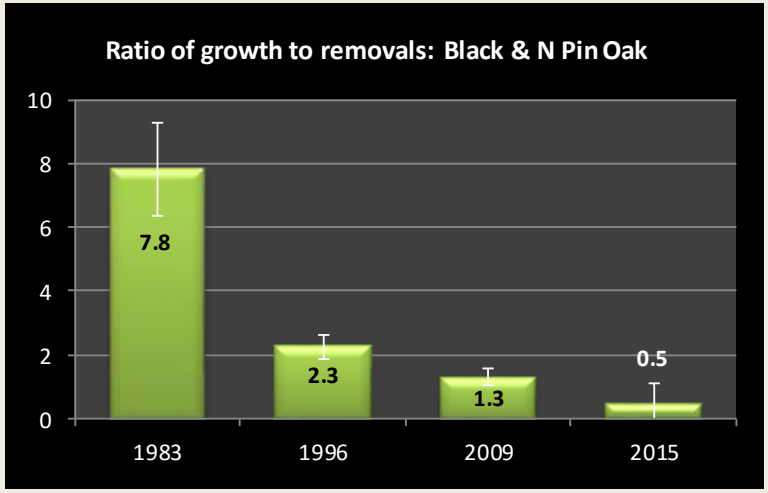
Roundwood production by product and the ratio of growth to removals

In 2009-2012, Wisconsin produced 14.7 million cubic feet of red oak roundwood or about 3.9% of the state's total volume (chart on right). Black and northern pin oaks account for about 2.5% of all pulpwood, 3.8% of sawlogs and 9% of all residential fuelwood.

Between 2002 and 2009-2012, pulpwood production increased by 52% and sawlog production decreased by 56%.



Volume of roundwood. Most recent figures for pulpwood and composite products are from 2012 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

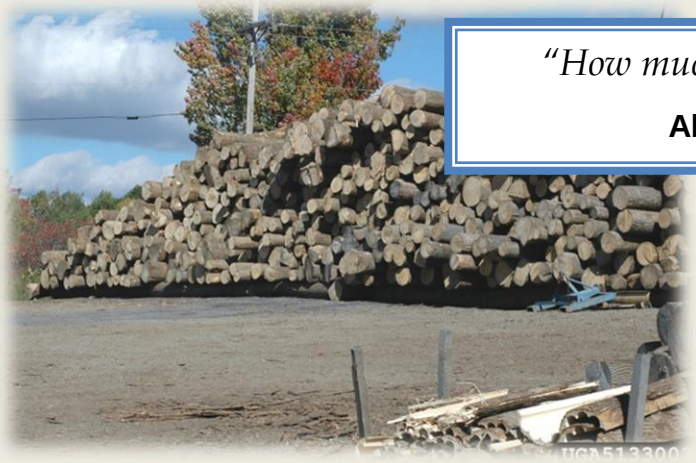


Source: USDA Forest Inventory & Analysis data

Removals of black and northern pin oaks averaged 19 million cubic feet per year between 2010 and 2015. Harvest was evenly divided between the 2 species.

The ratio of average annual growth to removals is currently 0.5 (chart on left) much lower than the statewide average of 1.9. This is due to both high mortality which reduces net growth significantly and higher than average removals. Black and northern pin oaks account for 3.7% of volume but only 1.6% of growth and 6.3% of removals.

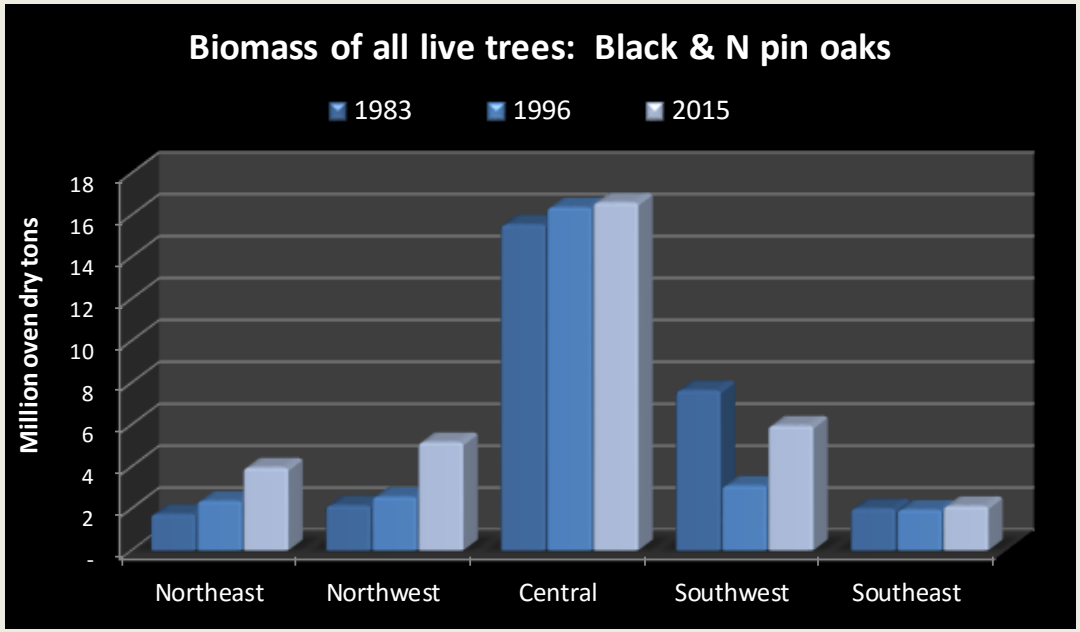
For a table of **Average annual growth, mortality and removals by region** go to:
http://dnr.wi.gov/topic/ForestBusinesses/documents/tables/GrowthMortalityRem



"How much black and northern pin oak biomass do we have?"

Aboveground biomass by region of the state

There were 34.3 million short tons of aboveground biomass in live trees in the black and northern pin oak group in 2013, an increase of 18% from 1983. This is equivalent to approximately 17.2 million tons of carbon and represents 5.5% of all aboveground carbon statewide. As with volume, most black and northern pin oak is located in central 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 black and northern pin oak wood is one of the highest of all species with a ratio of biomass to volume of 42 oven-dry lbs. per cubic foot (ODP/cubic feet). The average for all hardwoods is about 36 ODP/cubic feet and for all species is 33 ODP/cubic feet. Approximately, 73% of all red oak biomass is located in the main stem and 18% in the top branches.

The high volume of black and northern pin oaks combined with the high density of red oak wood may make it a valuable species for biomass production.

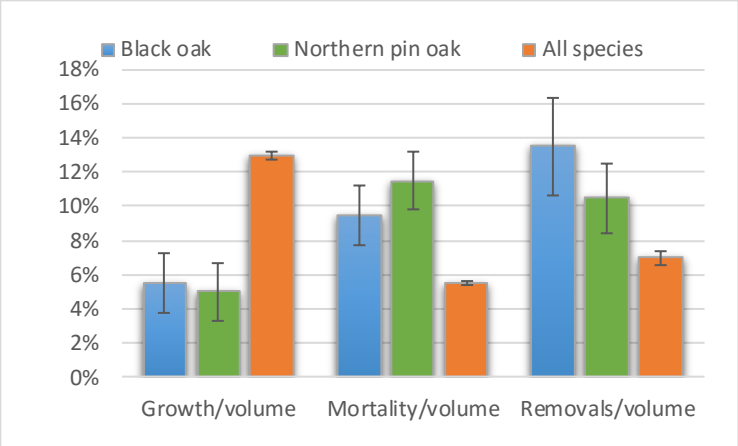
For a table of **Biomass by County** go to:
http://dnr.wi.gov/topic/ForestBusinesses/documents/tables/BiomassByCounty.pdf

"Can we predict the future of black and northern pin oak?"

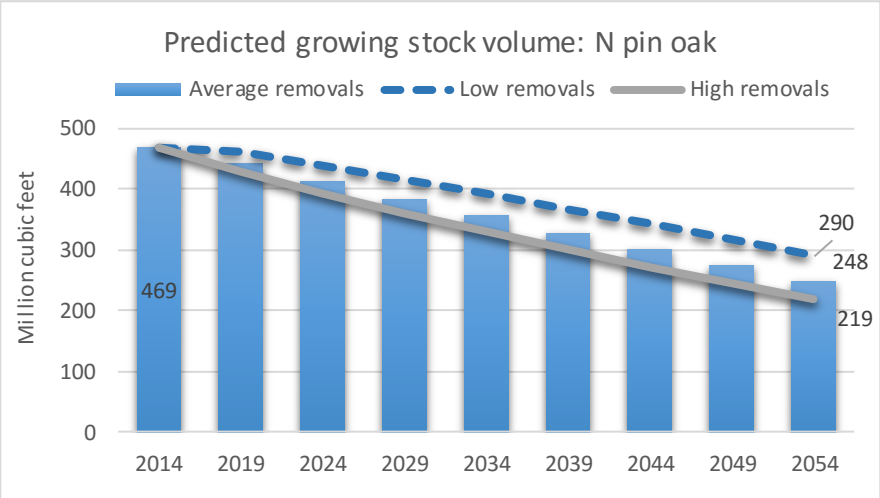
Modelled future volumes based on current mortality & harvest

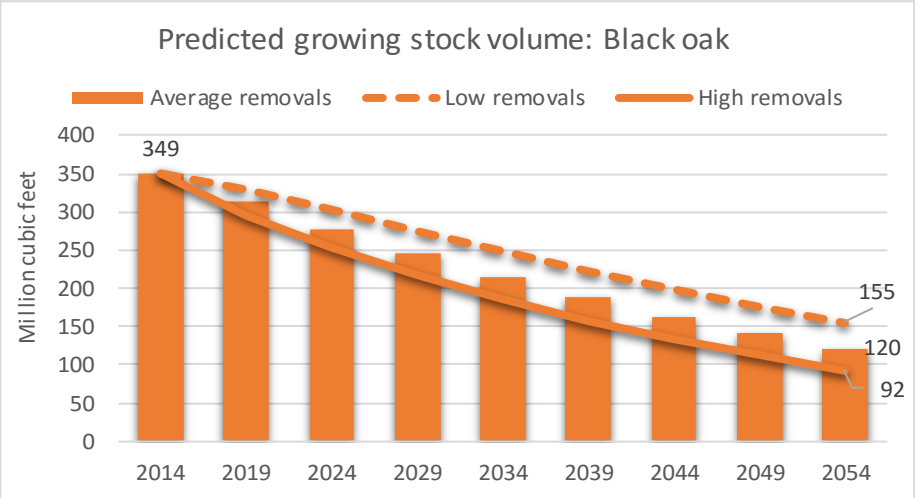
The ratios of both mortality and removals to volume are much higher for black and northern pin oaks compared to all species in the state (chart on right). The ratio of growth to volume is much lower.

FVS (Forest Vegetation Simulator[1]) was used to predict future volumes of black and northern pin oaks through 2054 based on these rates of mortality and removals. Due to the fact that they are so high, the volume of black and northern pin oaks decreases over the next fifty years, 66% for black oak and 47% for northern pin oak. Simulations were also done using a 67% confidence interval for removals to adjust for changes in harvesting levels. Mortality rates were assumed to remain unchanged.



Ratio of mortality to volume and removals to volume of growing stock.
Source: USDA Forest Inventory & Analysis





Predicted growing stock volumes based on 2005-2014 rates of mortality. Three levels of removals are used based on the 67% confidence intervals for average removals in 2009-2014.

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