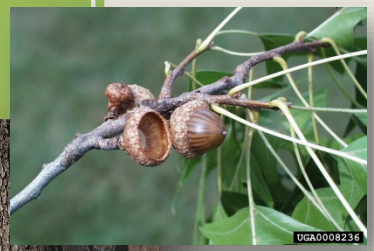
Black oak and Northern pin oak

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



The volume in black and northern pin oak is decreasing. However, there are significant differences between the species. Since 2004, the number of black oak trees has declined in all size classes while the number of northern pin oak has increased in all size classes except poles. Modelling suggests that volumes will continue to decrease especially for black oak.

Since 2009, growth rates have decreased and mortality has increased especially for northern pin oak, while growth rates have increased and mortality has decreased for black oak. Whereas black and northern pin oak species make up about 3.6% of all volume of trees in Wisconsin, they account for only 2.0% of net growth and 6.4% of mortality.

Black and northern pin oaks are important timber species, comprising 6.1% of total removals. The ratio of growth to removals is 0.6 indicating we remove nearly 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.

Division of Forestry
WI Dept of Natural Resources
December 2019

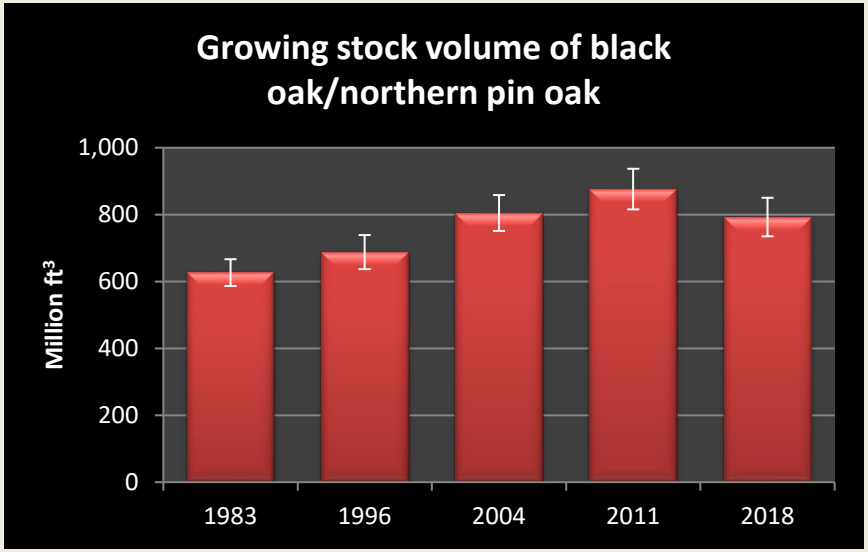
"How has the black and northern pin oak resource changed?"

Growing stock volume and diameter class distribution

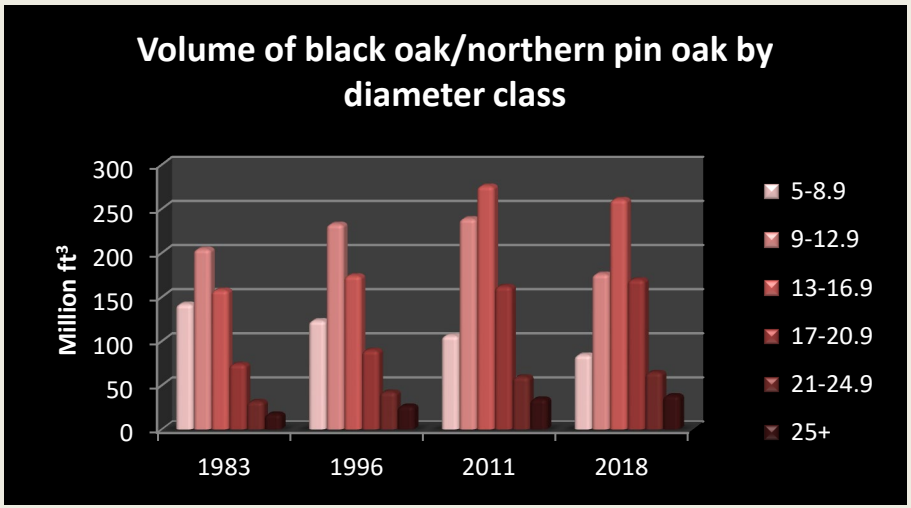
The growing stock volume of black and northern pin oaks is about 793 million cubic feet or 3.6% of total statewide volume (chart on right). The volume of black and northern pin oaks rose between 1983 and 2011 but has declined since 2011.

The red oak resource is maturing; the total volume in small growing stock (5-12.9 inches dbh) has decreased by 25% since 1983 while the volume in large trees (13+ inches dbh) has increased by 90% (chart below left).

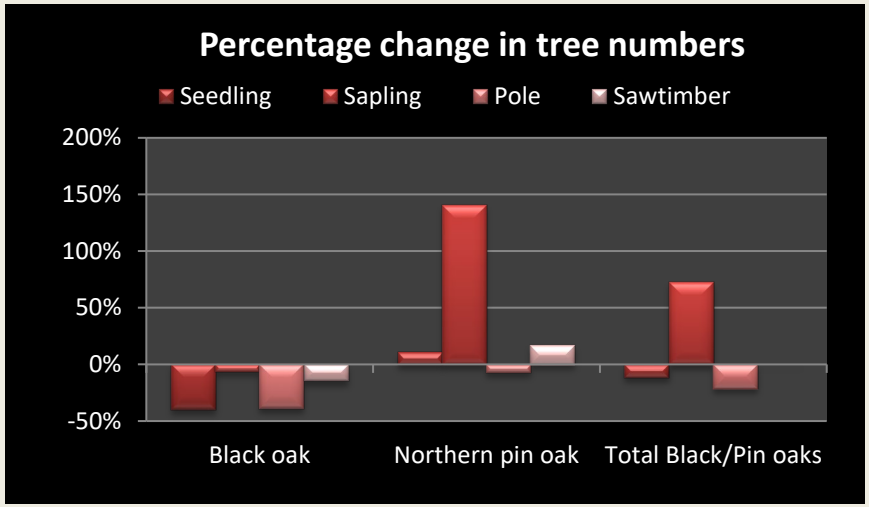
There is a significant difference in the change in tree numbers between the two species (chart below right). The number of N pin oak trees has increased in all size classes except poles, while the number of black oak has decreased.



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



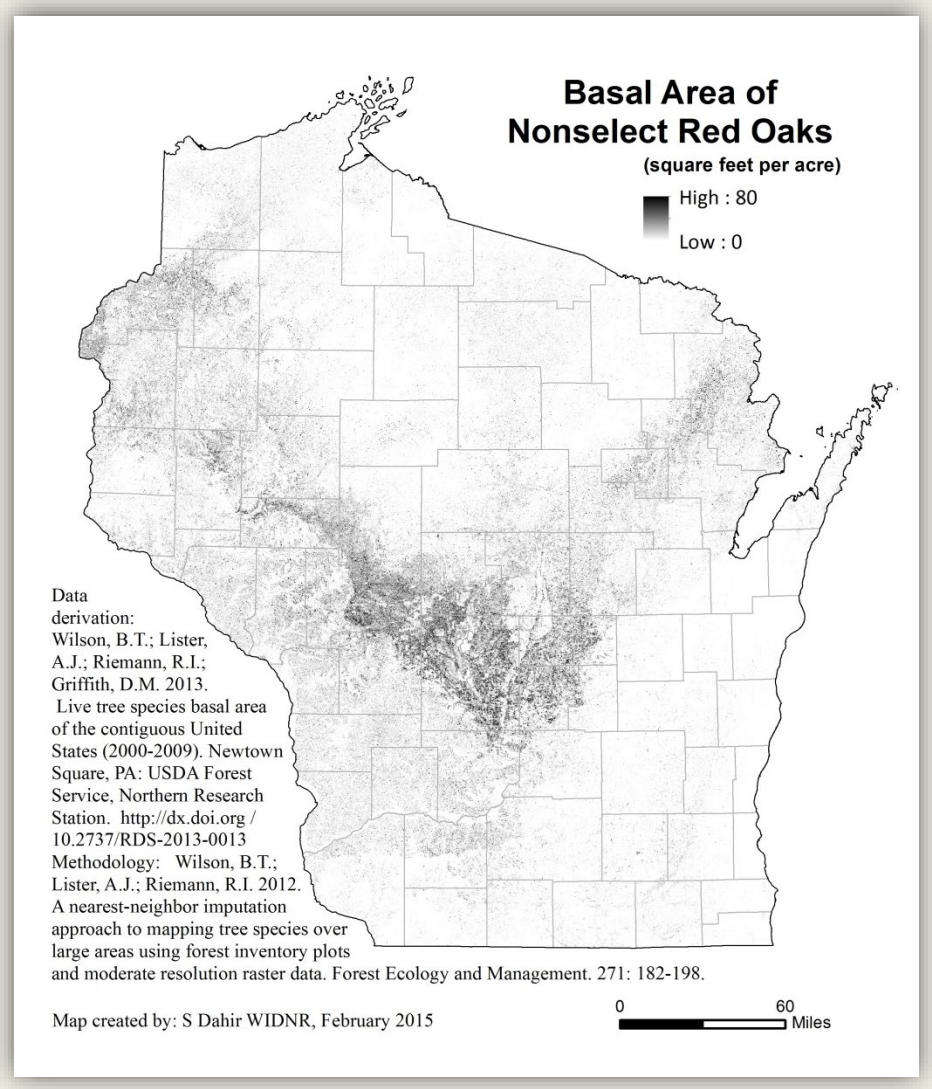
Growing stock volume (million cubic feet) by diameter class (inches).
Source: USDA Forest Inventory and Analysis data



Percentage change in the number of live trees by size class between 2004 and 2018.
Source: USDA Forest Inventory and Analysis data 2004 and 2018.

"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 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	249	4	2	36	81	**373**	**42%**
N pin oak	216	99	125	19	66	**526**	**58%**
Total	**465**	**104**	**128**	**55**	**147**	**900**	**100%**
Percent of total	**52%**	**12%**	**14%**	**6%**	**16%**	**100%**	

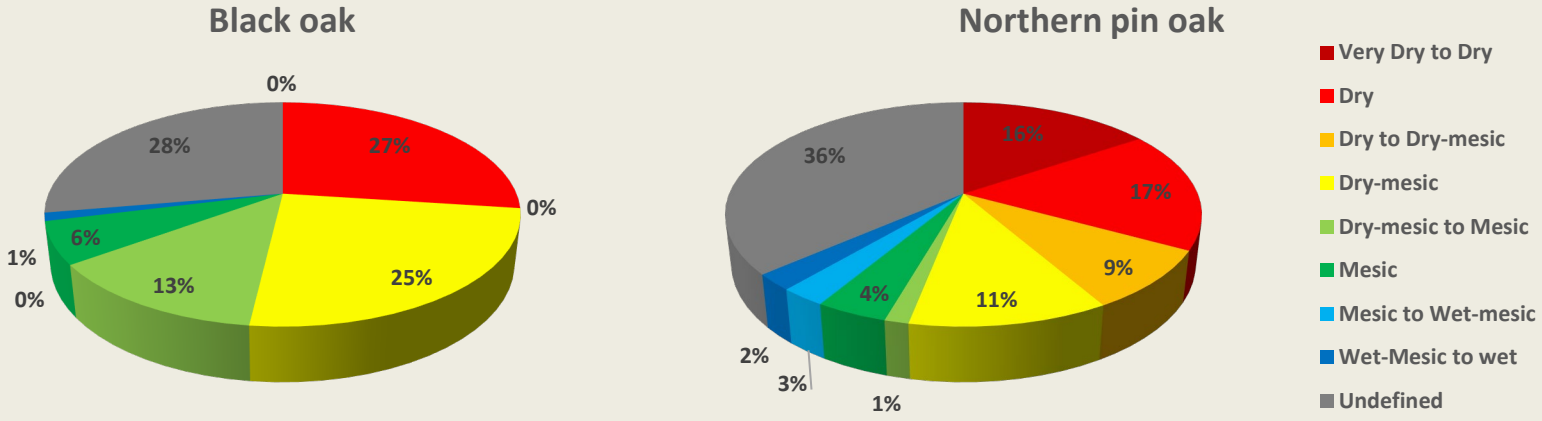
Source: USDA Forest Service, Forest Inventory and Analysis 2018

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

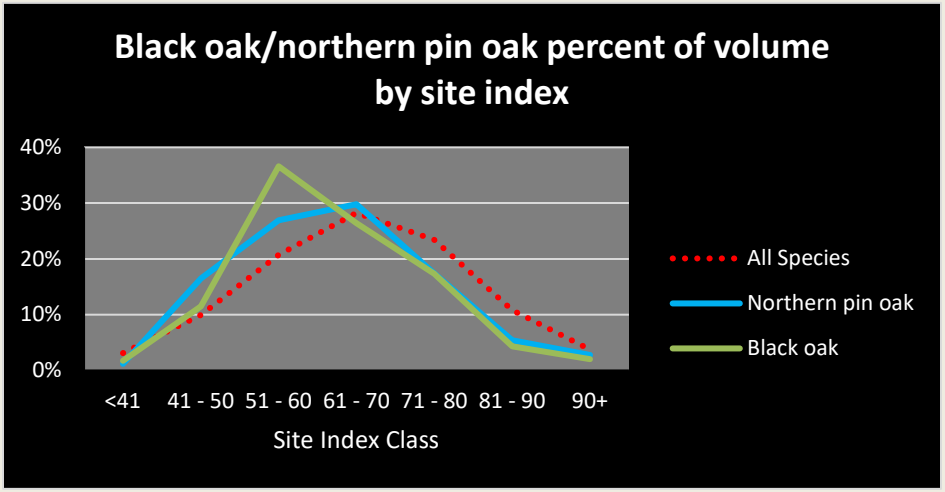
"What kind of sites does black and northern pin oak grow on?"

Habitat type and site index distribution

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, nearly half of pin oak volume is found on very dry and dry to dry-mesic sites while less than a third of black oak occurs on these habitat types (chart below).



Percent distribution of growing stock volume by habitat type group[1] (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). Nearly 50% of volume is located on sites with site indices 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.

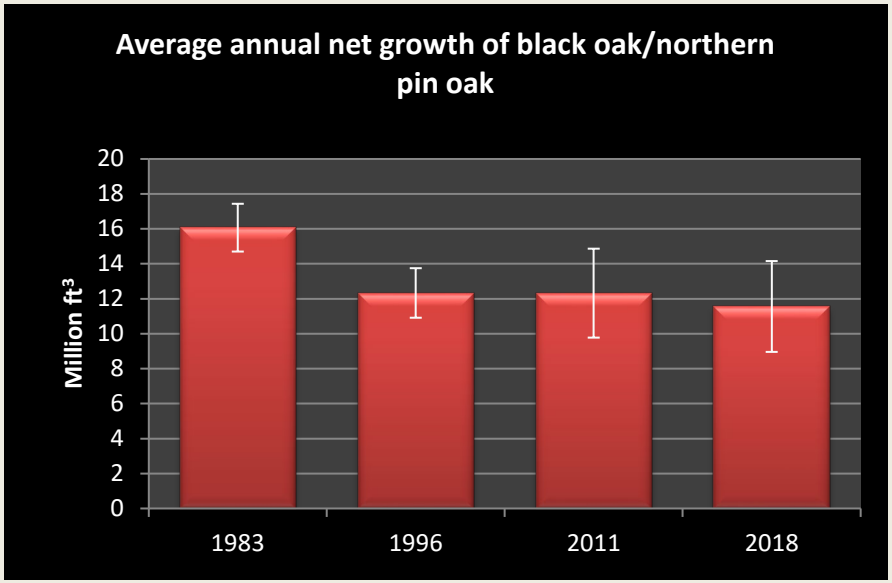
For more information on habitat types see Schmidt, Thomas L. 1997. Wisconsin forest statistics, 1996. Resource Bulletin NC-183. St. Paul, MN: U.S. Dept. of Agriculture, Forest Service, North Central

"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 11.6 million cubic feet/year from 2012 to 2018, representing 2.0% 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 northeast.



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	2.3	20%	**2.2%**
Northwest	-0.1	-	**-0.1%**
Central	7.5	64%	**1.9%**
Southwest	1.1	10%	**0.8%**
Southeast	0.8	7%	**1.4%**
Statewide	**11.6**	100%	**1.5%**

Source: USDA Forest Inventory and Analysis

The ratio of growth to volume for black and northern pin oaks is 1.5%, much lower than the statewide average of 2.6% for all species. High mortality will reduce net growth.

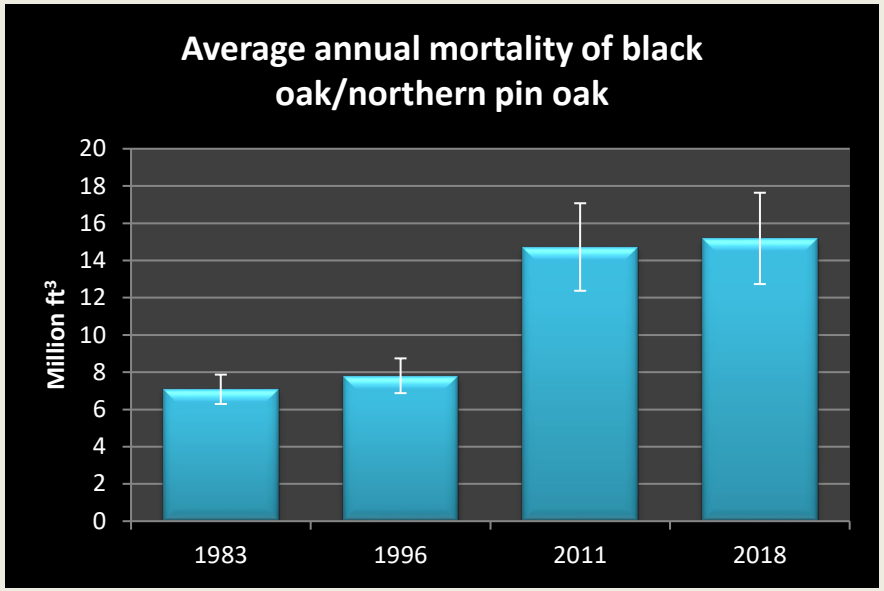
For a table of **Average annual growth, mortality and removals by region** go to:
http://dnr.wi.gov/topic/ForestBusinesses/documents/tables/GrowthMortalityRemovals.pdf

"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 15.2 million cubic feet per year from 2012 to 2018, has nearly doubled since 1996 (chart on right). Black and northern pin oaks account for 3.6% of volume but 6.4% of mortality in the state.

The ratio of mortality to volume is 1.9% 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 (ft^3)	Growing stock volume (ft^3)	Mortality / volume
Black oak	6,116,988	343,012,930	1.8%
Northern pin oak	9,068,680	449,778,362	2.0%
Total	15,185,668	792,791,292	1.9%

Source: USDA Forest Inventory & Analysis data

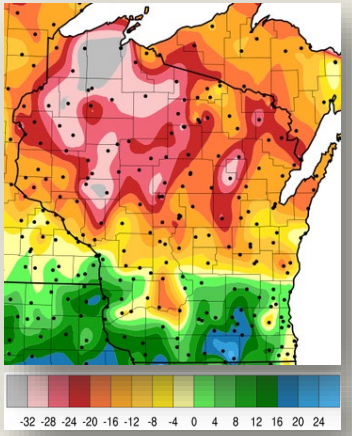
For a table of **Average annual growth, mortality and removals by region** go to:
http://dnr.wi.gov/topic/ForestBusinesses/documents/tables/GrowthMortalityRemovals.pdf

"Do black and northern pin oak have any major disease or pest issues?"

Defoliators and drought

Mortality of northern pin and black oaks has increased dramatically in the past decade in northern and central Wisconsin but remained unchanged in the south (figure on the right). This mortality is probably due to oak wilt and/or defoliation accompanied by drought stress. This stress is aggravated by the fact that these species occur mainly on very dry sites.

Defoliation can lead to mortality when accompanied by prolonged and severe drought. This is exactly what occurred is most of central and northern Wisconsin between 2005 and 2009 and again in 2011 – 2013 (map on right).



Left. Mortality ratio for black and northern pin oaks by region of the state and inventory year. Error bars represent the 68% confidence interval. Source: FIA data
Right. Departure from normal accumulated precipitation 2005 – 2009. Midwest Regional Climate Center

Upper left: forest tent caterpillar. Upper right: Gypsy moth.
Lower left: Twolined chestnut borer. Lower right: Elm spanworm.

Major defoliators of oak in Wisconsin (figure on left) include the forest tent caterpillar (*Malacosoma disstria*), gypsy moth (*Lymantria dispar*), elm spanworm (*Ennomos subsignarius*), and the fall cankerworm (*Alsophila pometaria*).

Several of these pests can defoliate oaks year after year sometimes with populations building to outbreak levels. This type of repeated defoliation can lead to mortality either directly or by predisposing trees to infestations by other pests.

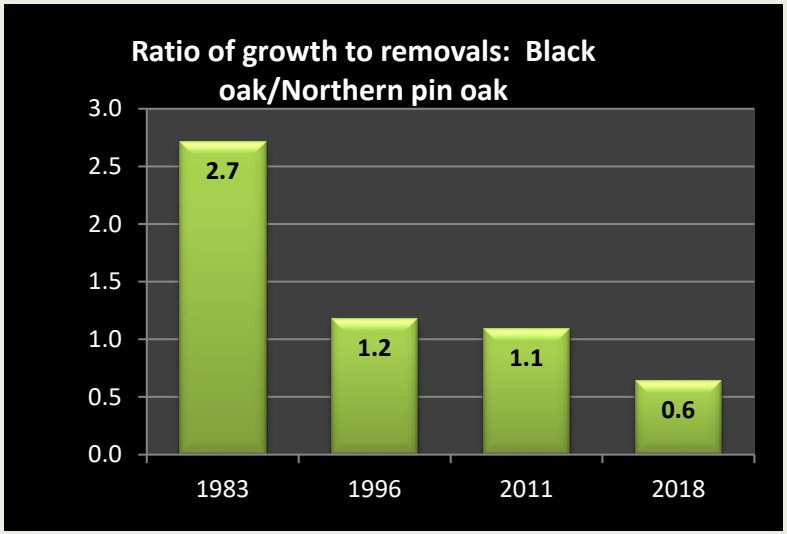
A wood-borer that often attacks drought-stressed red oaks is the two-lined chestnut borer (*Agrilus bilineatus*). This insect can kill oaks, especially after two or three years of defoliation and especially when defoliation is accompanied by drought conditions.

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

Roundwood production by product and the ratio of growth to removals

In 2013, Wisconsin produced 35.7 million cubic feet of black and northern pin oak roundwood (including northern red oak) or about 11.5% of the state's total volume (chart on right). Black and northern pin oak account for about 9% of all pulpwood and 21% of sawlogs.

The volume of black and northern pin oak sawtimber is about a third of that of northern red oak although about equal amounts of each species group is harvested. In addition, only 17% of black and northern pin oak sawtimber is considered high grade (1 & 2) whereas 60% of northern red oak sawtimber meets these standards.



Source: USDA Forest Inventory & Analysis data

Volume of roundwood. * Miscellaneous products include poles, posts and pilings.
Source: Ronald Piva, USDA Forest Service, Northern Research Station, St. Paul MN

Removals of black and northern pin oaks averaged 18.0 million cubic feet per year between 2012 and 2018. Harvest was evenly divided between the two species.

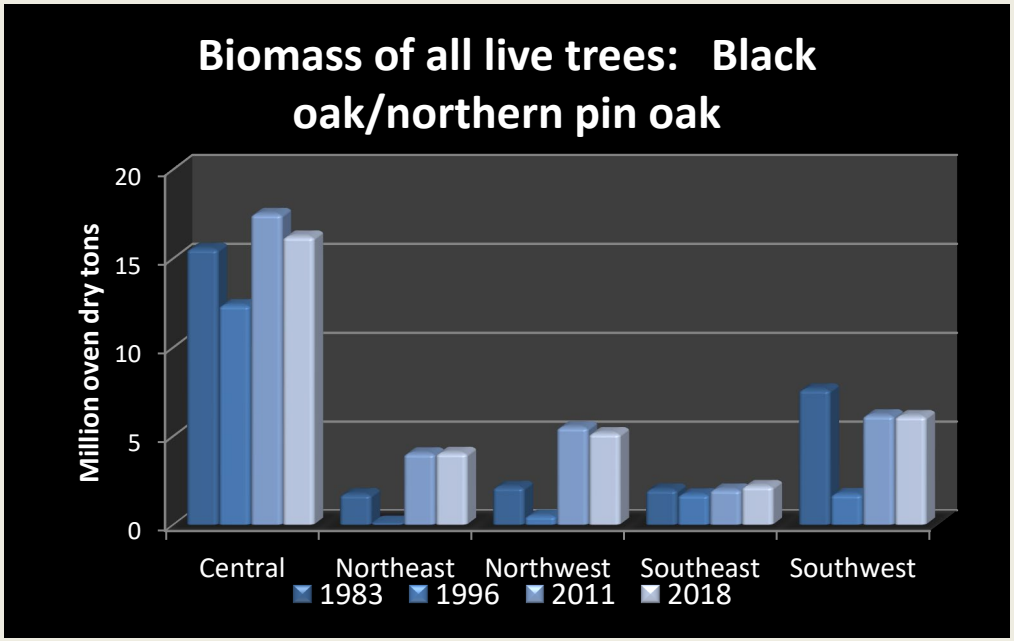
The ratio of average annual growth to removals is currently 0.6 (chart on left) much lower than the statewide average of 1.9. This is due to both high mortality which reduces net growth significantly and higher than average removals. Black and northern pin oaks account for 3.6% of volume but only 2.0% of growth and 6.1% 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 33.8 million short tons of aboveground biomass in live trees in the black and northern pin oak group in 2018, an increase of 16% from 1983. This is equivalent to approximately 16.9 million tons of carbon and represents 5.2% of all aboveground carbon statewide. As with volume, most black and northern pin oak is located in central Wisconsin (chart below).

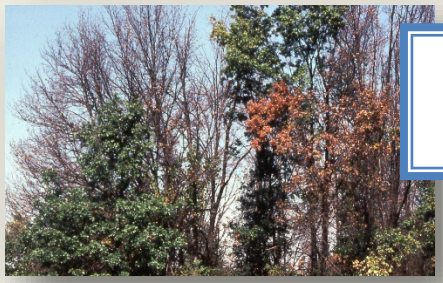


Biomass (above ground dry weight of live trees >1 in dbh, short tons) by year and region of the state.
Source: USDA Forest Inventory & Analysis data

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, 6% in saplings, 4% in stumps, 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

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

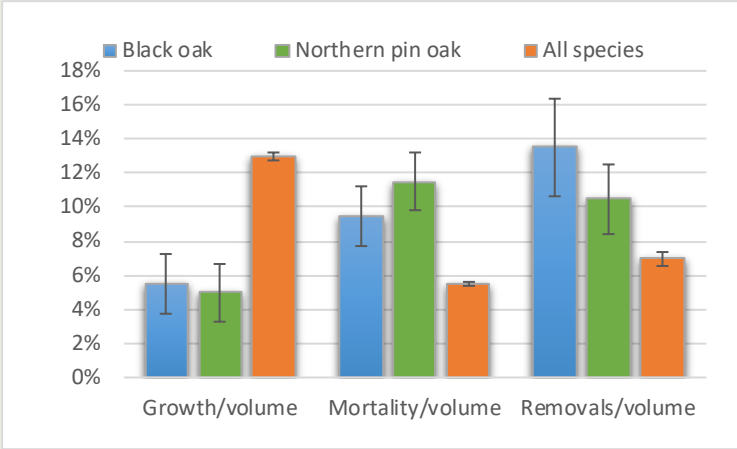


"Can we predict the future of black and northern pin oak?"

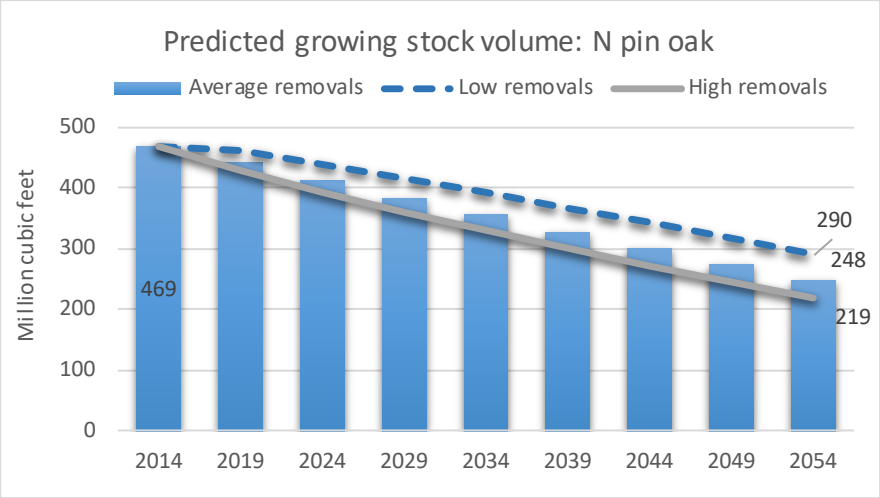
Modelled future volumes based on current mortality & harvest

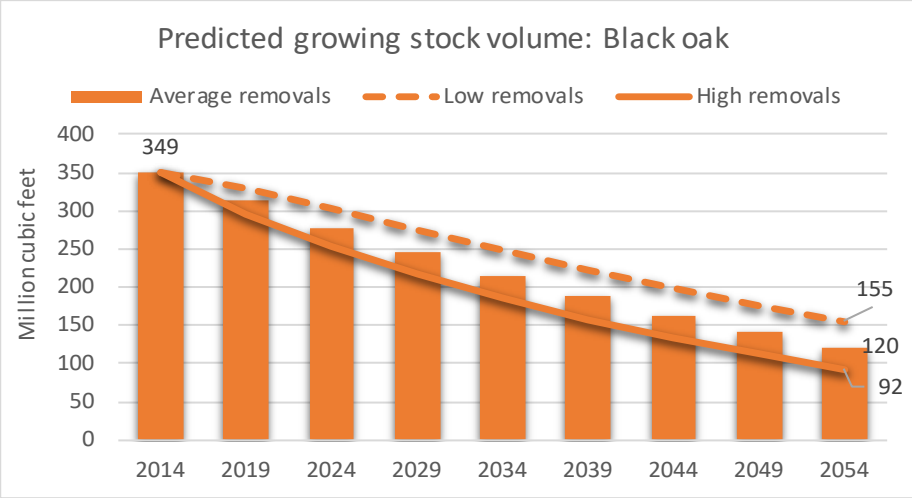
The ratios of both mortality and removals to volume are much higher for black and northern pin oaks compared to all species in the state (chart on right). The ratio of growth to volume is much lower.

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/.