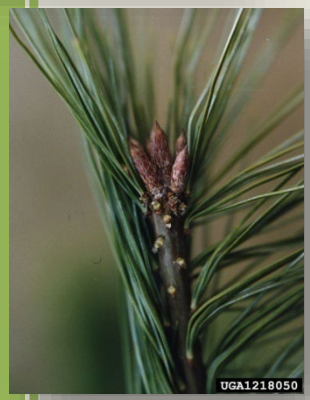
Eastern white pine

(*Pinus strobus*)



White pine is one of the largest and most long-lived species in Wisconsin. Once a significant component of our northern forests, most large trees were harvested during the Cutover Period of the late 19th century. Today, white pine is making a comeback.

The white pine resource has more than tripled in volume since 1983**.** The number of trees in all size classes has increased significantly indicating that white pine should remain a major species in future forests. Models indicate a sharp increase in volume in the next 40 years.

Growth rates are high and increasing. Mortality rates which are relatively quite low, have nearly doubled since 1996. Currently, white pine accounts for 8.6% of volume and 12.2% of growth statewide but only 3.2% of total mortality.

White pine makes up 3.2% of roundwood production and is mainly used for pulpwood and sawlogs. The density of white pine wood is very low making it a less desirable species for biomass production.

- *How has the white pine resource changed?*
  Volume and diameter class distribution:
- *Where is white pine found in Wisconsin?*
  Growing stock volume by region with map
- *What kind of sites does white pine grow on?*
  Habitat type and site index distribution
- *How fast is white pine growing?*
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- *How much white pine do we harvest?*
  Roundwood production by product and ratio of growth to removals
- *How much white pine biomass do we have?*
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- *Can we predict the future of spruce?*
  Modelling future volumes

Division of Forestry
WI Dept of Natural Resources
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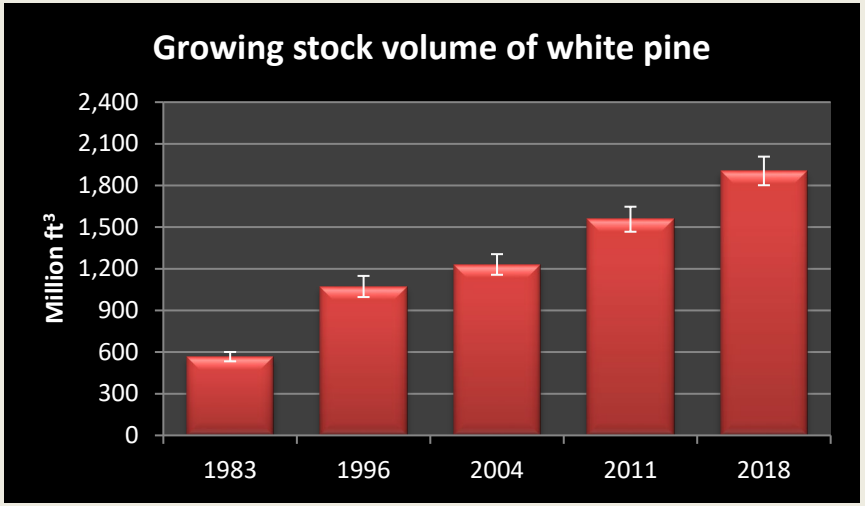
"How has the white pine resource changed?"

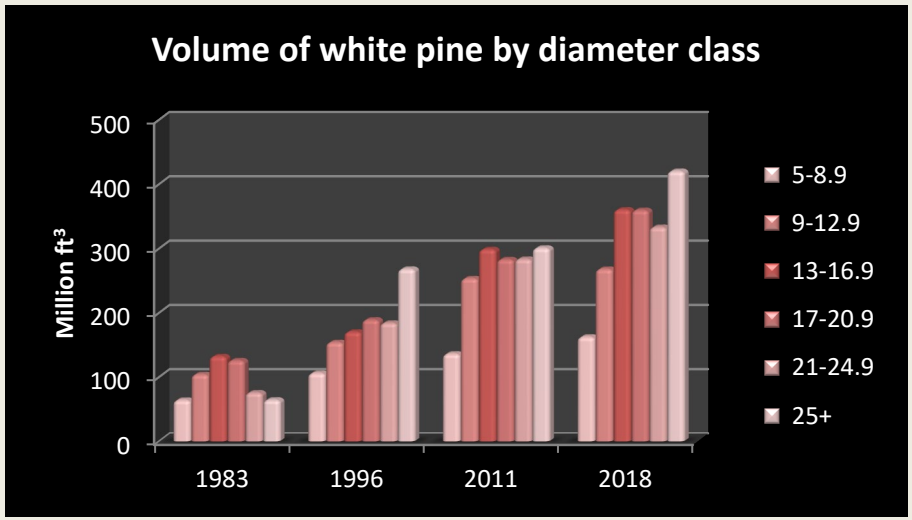
Growing stock volume and diameter class distribution

The growing stock volume of white pine is 1.9 billion cubic feet or about 8.6% of total statewide volume (chart on right). White pine volume has risen dramatically in the last 50 years, tripling since 1983. Volume in all diameter classes has increased significantly (chart below left).

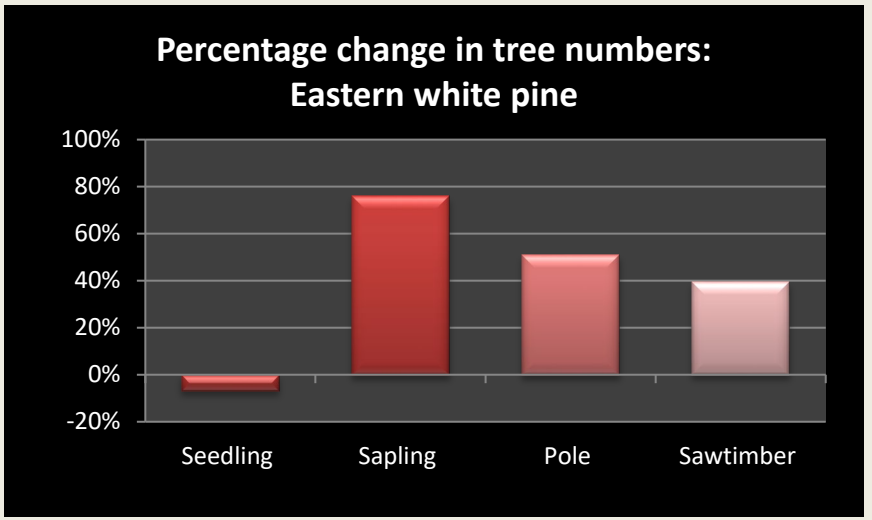
Since 2004, the number of saplings (76%), poles (51%), and sawtimber (40%) have all increased significantly (chart below right). Alarmingly, the number of seedlings has decrased, pointing to regeneration issues. Every size class (chart below) has at least doubled since 1983, suggesting that white pine may play a very significant role in future forests of Wisconsin.



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



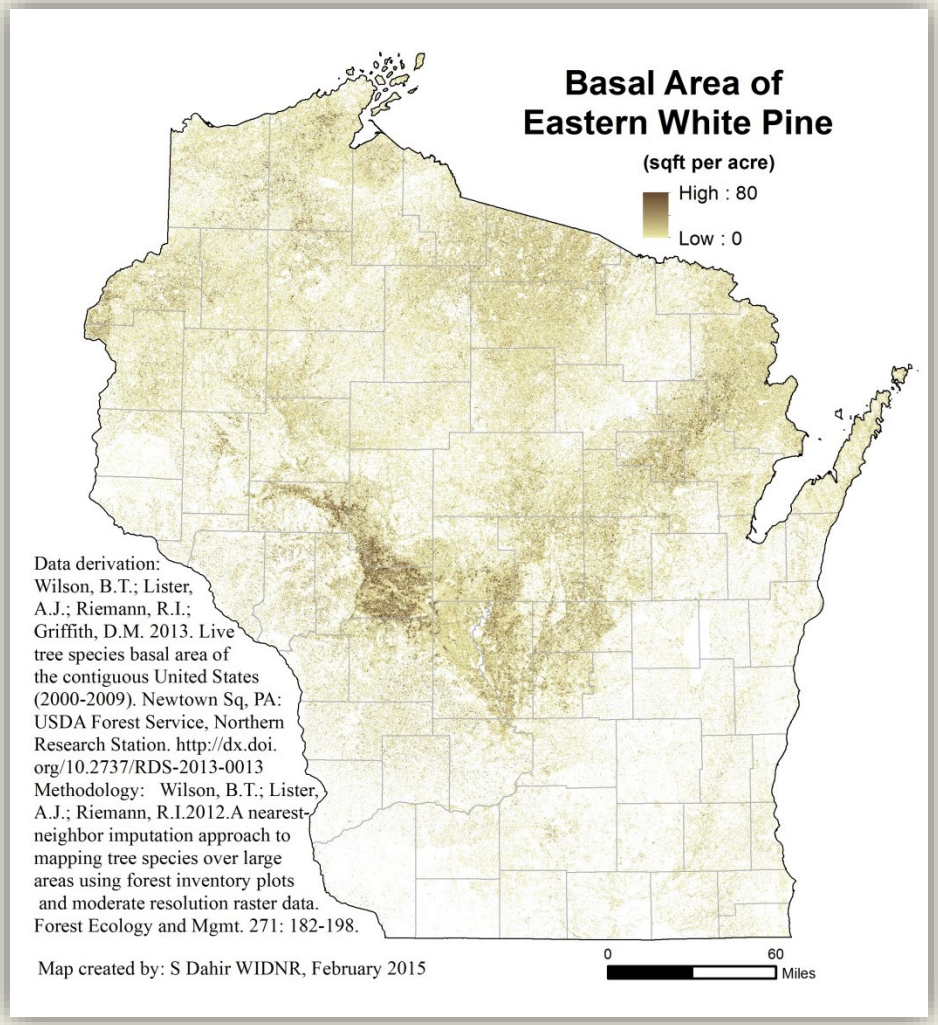
Growing stock volume (million cubic feet) by diameter class (inches).
Source: USDA Forest Inventory and Analysis data



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 white pine found in Wisconsin?"

Growing stock volume by region with map



Eastern white pine is a common species in northern and central forests (Table 1).

In addition to the pine forest types, white pine is typically found in combination with hardwoods in the oak-hickory, oak-pine, aspen-birch and maple-basswood forest types. About 25% of the white pine forest type is planted.

Table 1. Growing stock volume (million ft^3) by species and region of the state.

Species	Central	North east	North west	South east	South west	Total
White Pine	616	638	419	102	131	**1,905**
Percent of total	**32%**	**33%**	**22%**	**5%**	**7%**	**100%**

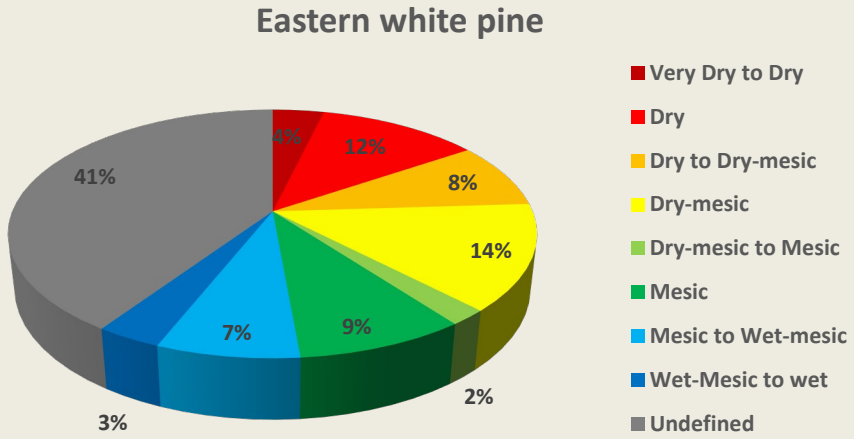
Source: USDA Forest Service, Forest Inventory and Analysis

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

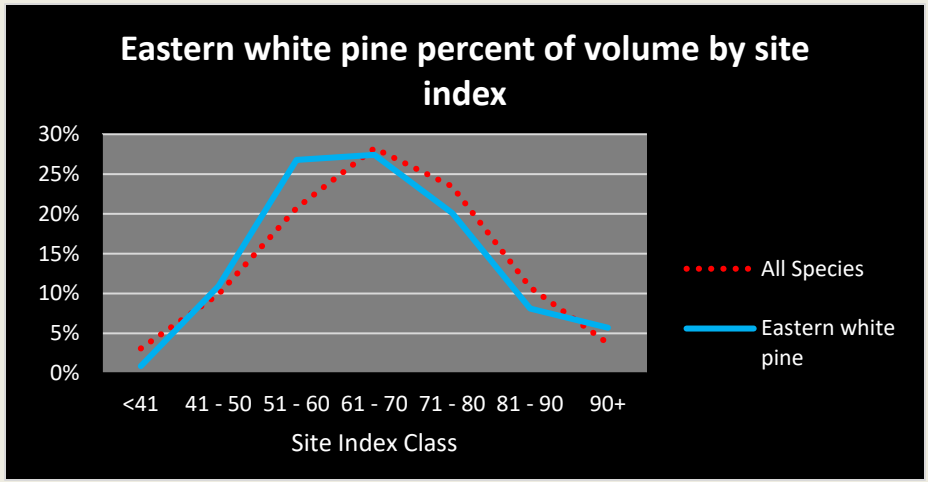
"What kind of sites does white pine grow on?"

Habitat type[1] and site index distribution

White pine grows on a wide variety of habitat types (chart below). White pine is most commonly found on drier and mesic habitat types, but is also common in wetter areas.



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 white pine growing stock volume, 61%, occurs in stands with site indices over 60 (chart on left).

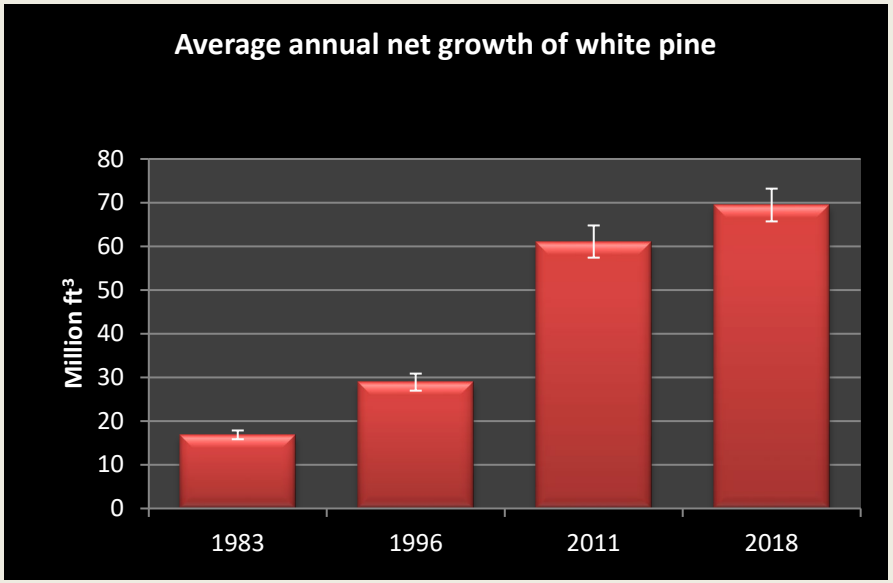
The average site index by volume for white pine is 66, equal to the average for all species which is also 66.

[1] 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 white pine growing?"

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

Average annual net growth of eastern white pine was about 69.5 million cubic feet per year between 2012 and 2018, representing 12.2% of statewide volume growth (chart on right). Growth rates have increased significantly in the last three decades, quadrupling since 1983.



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

Table 2. Average annual net growth (million ft³/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	18.0	26%	**2.8%**
Northwest	12.7	18%	**3.0%**
Central	26.9	39%	**4.4%**
Southwest	6.6	9%	**5.0%**
Southeast	5.3	8%	**5.2%**
Statewide	69.5	**100%**	**3.6%**

Source: USDA Forest Inventory and Analysis

Volume growth of white pine is highest in central and northeastern Wisconsin but growth rates are highest in the south (Table 2).

The average ratio of net growth to volume for white pine is 3.6%, much higher than the statewide average of 2.6% for all species.

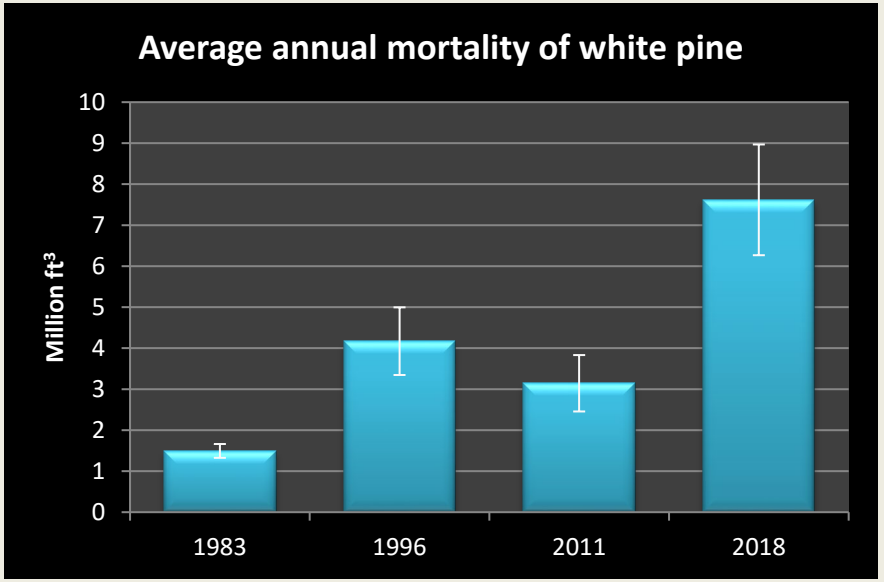
For a table of **Average annual growth, mortality and removals by region** go to:
http://dnr.wi.gov/topic/ForestBusinesses/documents/tables/GrowthMortalityRemovals.pdf

"How healthy is white pine in Wisconsin?"

Average annual mortality: trends and ratio of mortality to volume

Average annual mortality of white pine, about 7.6 million cubic feet per year from 2012 to 2018, has more than tripled since 1983 (chart on right). White pine accounts for 8.6% of total growing stock volume in the state but only 3.2% of total mortality.

The ratio of mortality to volume is 0.4% for white pine, much lower than the statewide average of 1.1%.



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 volume.

Species	Average annual mortality (ft^3)	Growing stock volume (ft^3)	Mortality / volume
Eastern White Pine	7,618,134	1,904,742,744	0.4%

Source: USDA Forest Inventory & Analysis data

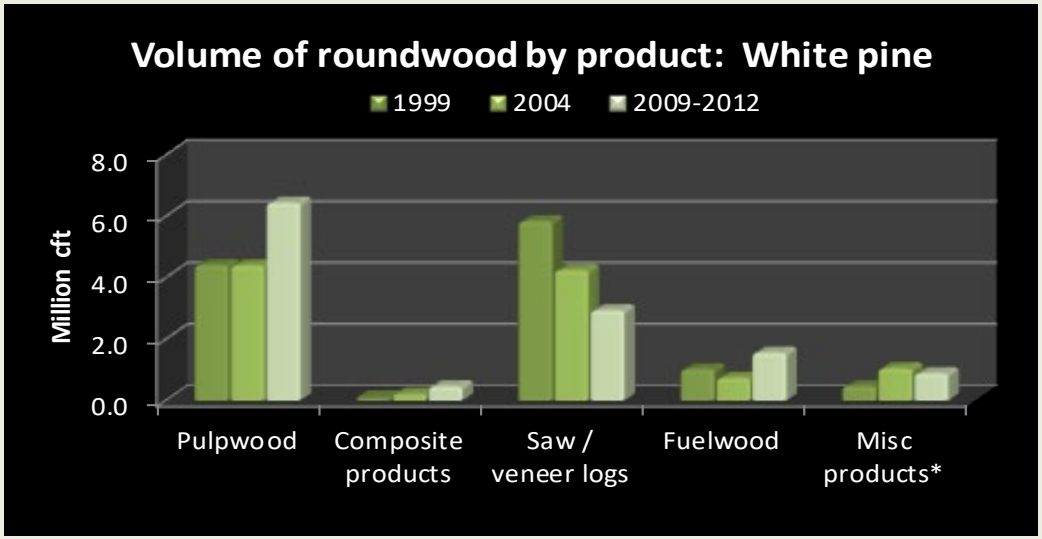
For a table of **Average annual growth, mortality and removals by region** go to:
http://dnr.wi.gov/topic/ForestBusinesses/documents/tables/GrowthMortalityRemovals.pdf

"How much white pine do we harvest?"

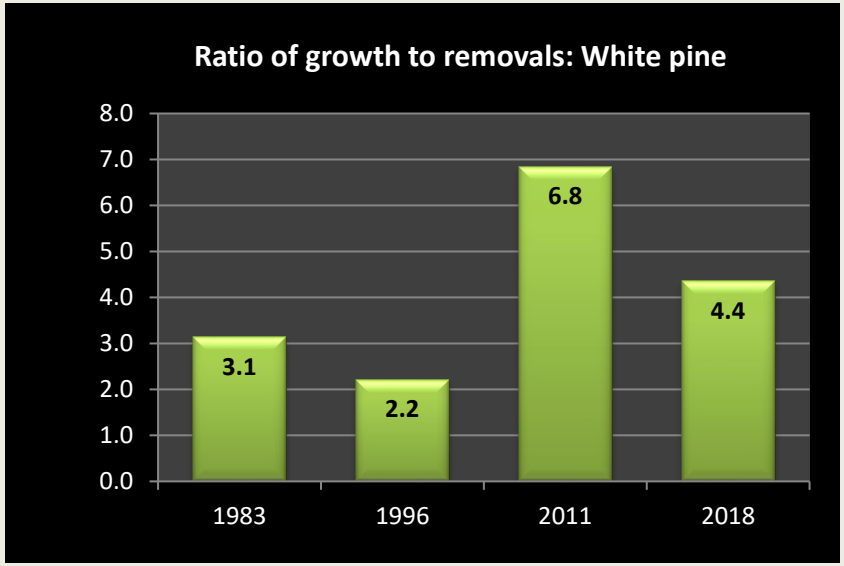
Roundwood production by product and ratio of removals to growth

In 2009-2012, white pine roundwood accounted for 12.3 million cubic feet or about 3.2% of Wisconsin's total production, an increase of 16% since 2004. About half is used for pulpwood , a quarter for sawlogs and veneer and 20% for fuelwood and miscellaneous products (chart on right).

From 2004 to 2012, pulpwood production increased by 47%. White pine supplies 6.4 million cubic feet or 3.8% of total pulpwood production.



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 white pine were 16.0 million cubic feet per year from 2012 to 2018 or 5.4% of total removals.

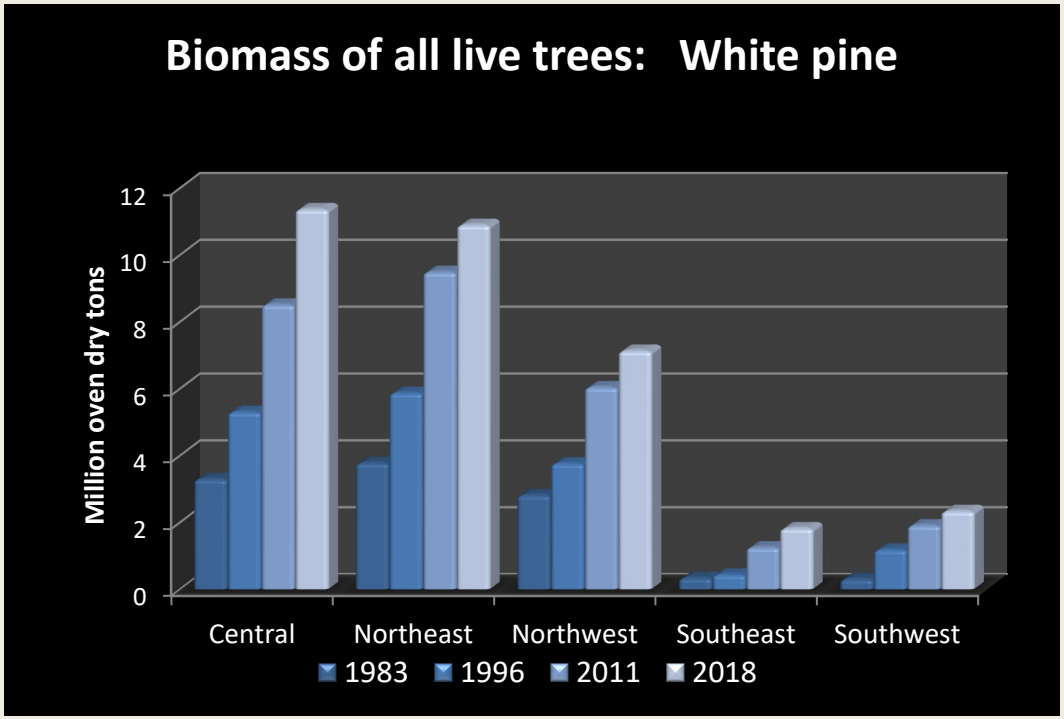
The ratio of average annual net growth to removals for eastern white pine was 4.4 from 2012 to 2018 (chart on left), much higher than the average ratio of 1.9 for all species. The ratio of growth to removals has increased slightly from 1996 due to a more than doubling of growth.

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 much white pine biomass do we have?"

Aboveground biomass by region of the state

There are 33.6 million tons of aboveground biomass in live white pine trees, an increase of 218% from 1983. This is equivalent to approximately 16.8 million tons of carbon and represents 5.2% of all aboveground biomass statewide. As with volume, most white pine is located in northeast and 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 white pine wood is fairly low with a ratio of biomass to volume of only 26 oven-dry lbs. per cubic foot (ODP/cubic feet). The average for all softwoods is about 26 ODP/cubic feet and for all species is 33 ODP/cubic feet.

Over 79% of all white pine biomass is located in the main stem, 4% in the stump, 3% in saplings and 13% in the branches.

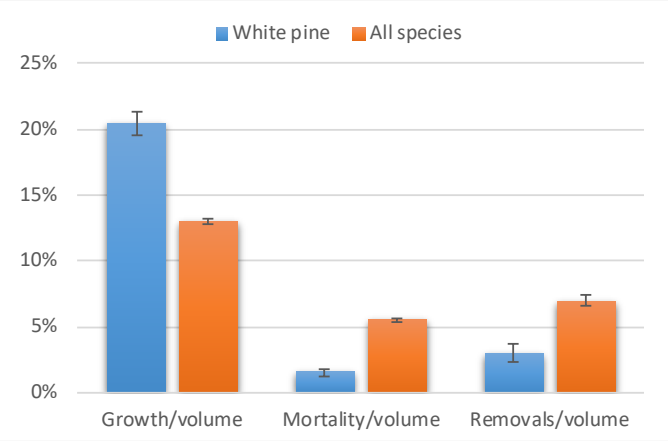
For a table of **Biomass by County** go to:
http://dnr.wi.gov/topic/ForestBusinesses/documents/tables/BiomassByCounty.pdf

"Can we predict the future of white pine?"

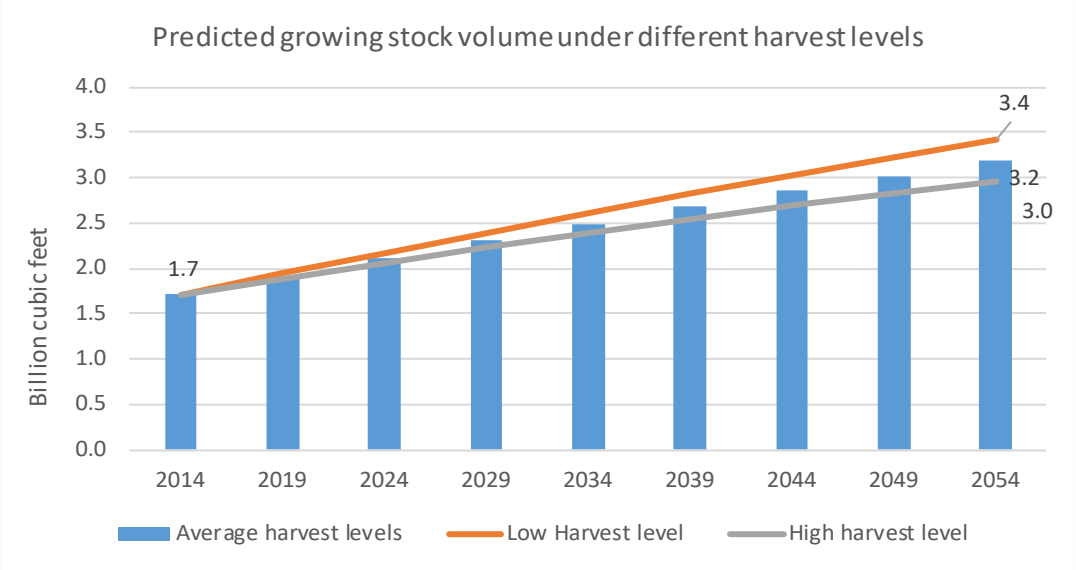
Predicted volumes based on current rates of mortality and harvest

The 5-year ratio of growth to volume is significantly higher for white pine compared to all species in the state (chart on right) and the rates of both mortality to volume and removals to volume are significantly lower. This would indicate a large volume increase in the future all else being equal.

The Forest Vegetation Simulator (FVS[1]) was used to predict future volumes of white pine through 2054. Three scenarios are forecast. One with current rates of mortality and removals (i.e. average annual mortality and removals for 2009 to 2014). Another with current mortality rates and the lower 67% confidence interval for current removals and another with the upper 67% confidence interval for removals.



Five year ratios of growth, mortality and removals to volume.
Source: USDA Forest Inventory & Analysis data



Volume increases in all three scenarios (chart on left), 86% by 2054 for current average removal levels, 100% for the lower confidence interval for removals and 74% for the upper confidence interval for removals.

Volume continues to increase linearly for all three scenarios, not peaking in the next 40 years. White pine will replace northern red oak by 2024 as the species with the third highest volume.

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/.