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 doubled in volume in the last two decades. 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 increased slightly since 1996. Currently, white pine accounts for 8.1% of volume and 12.5% of growth statewide but only 2.3% 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?*
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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 1.8 billion cubic feet or about 8.1% of total statewide volume (chart on right). White pine volume has risen steadily and dramatically in the last 50 years, tripling since 1983 and increasing 43% since 2004. Volume in all diameter classes has increased significantly (chart below left).

The numbers of trees in all size classes has increased over 60% (chart below right), including a more than doubling in the number of **saplings**. This indicates that white pine will probably play a very significant role in future forests of Wisconsin.
“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 cft) by species and region of the state.

<table>
<thead>
<tr>
<th>Species</th>
<th>Central</th>
<th>North east</th>
<th>North west</th>
<th>South east</th>
<th>South west</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>White Pine</td>
<td>540</td>
<td>612</td>
<td>388</td>
<td>100</td>
<td>124</td>
<td>1,765</td>
</tr>
<tr>
<td>Percent of total</td>
<td>31%</td>
<td>35%</td>
<td>22%</td>
<td>6%</td>
<td>7%</td>
<td>100%</td>
</tr>
</tbody>
</table>

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](http://dnr.wi.gov/topic/ForestBusinesses/documents/tables/VolumeCountySpecies.pdf)
White pine grows on a wide variety of habitat types (chart below). About 40% of growing stock volume occurs on drier sites, another 16% on more mesic habitat types and 21% on wetter sites.

The majority of white pine growing stock volume, 62%, 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.

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“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 72.1 million cubic feet per year between 2010 and 2015, representing 12.5% of statewide volume growth (chart on right). Growth rates have increased significantly in the last three decades, quadrupling since 1983.

<table>
<thead>
<tr>
<th>Region</th>
<th>Net growth</th>
<th>Percent of Total</th>
<th>Ratio of growth to volume</th>
</tr>
</thead>
<tbody>
<tr>
<td>Northeast</td>
<td>21.0</td>
<td>29%</td>
<td>3.4%</td>
</tr>
<tr>
<td>Northwest</td>
<td>13.3</td>
<td>18%</td>
<td>3.4%</td>
</tr>
<tr>
<td>Central</td>
<td>24.6</td>
<td>34%</td>
<td>4.5%</td>
</tr>
<tr>
<td>Southwest</td>
<td>6.6</td>
<td>9%</td>
<td>5.3%</td>
</tr>
<tr>
<td>Southeast</td>
<td>6.7</td>
<td>9%</td>
<td>6.6%</td>
</tr>
<tr>
<td>Statewide</td>
<td>72.1</td>
<td>100%</td>
<td>4.1%</td>
</tr>
</tbody>
</table>

Source: USDA Forest Inventory and Analysis

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

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 4.1%, much higher than the statewide average of 2.7% for all species.

Average annual mortality of white pine, about 5.3 million cubic feet per year from 2009 to 2015, has more than tripled since 1983 (chart on right). White pine accounts for 8.1% of total growing stock volume in the state but only 2.3% of total mortality.

The ratio of mortality to volume is 0.3% for white pine, much lower than the statewide average of 1.1%.

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

<table>
<thead>
<tr>
<th>Species</th>
<th>Average annual mortality (cft)</th>
<th>Growing stock volume (cft)</th>
<th>Mortality / volume</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eastern White Pine</td>
<td>5,312,373</td>
<td>1,765,098,153</td>
<td>0.3%</td>
</tr>
</tbody>
</table>

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
White pine blister rust (WPBR) is a devastating disease of five-needled pines. Caused by the fungus, *Cronartium ribicola*, it can kill branches, create stem cankers and result in eventual death of a tree. The alternate host for this rust is most commonly a species of gooseberry or *Ribes*.

WPBR can be found throughout Wisconsin wherever *Ribes* is abundant. *Ribes* species grow mostly on mesic to wet habitat types and much less on dry sites (Figure on right). White pine volume is evenly distributed between mesic and dry types but white pine has a much higher mortality rate on mesic to wet sites (Figure on right).

The white pine blister rust fungus, *Cronartium ribicola*, needs to infect both white pine and a *Ribes spp.* to complete its lifecycle. Spores from infected gooseberry (Figure on left) are carried to white pine trees on cool moist air currents in late summer or fall. These spores infect pine needles if moisture is present. The fungus kills the needle and moves into the shoot or branch.

Once the fungus reaches the branch, a canker is formed. The canker will girdle the branch and the infection will continue down into the main trunk. Seedlings and small trees are in great danger of dying from this disease when a canker girdles the main stem.

Girdling stem cankers on older trees result in top-killing and the death of branches. This may not kill the tree but will expose it to increased stress. Branch flagging as seen in the figure on the left is a sign of probable rust infection.
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.

Removals of white pine were 11.9 million cubic feet per year from 2010 to 2015 or 3.9% of total removals.

The ratio of average annual net growth to removals for eastern white pine was 6.1 from 2010 to 2015 (chart on left), much higher than the average ratio of 1.7 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:  
There are 31.1 million tons of aboveground biomass in live white pine trees, an increase of 194% from 1983. This is equivalent to approximately 15.5 million tons of carbon and represents 4.9% of all aboveground biomass statewide. As with volume, most white pine is located in northeast and central Wisconsin (chart below).

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 78% of all white pine biomass is located in the main stem, 3% in the stump, 5% in saplings and 13% in the branches.
“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+) 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.

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/.

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