Red Pine

*Pinus resinosa*

The volume of red pine has increased significantly since 1983. This volume increase has occurred almost exclusively in sawtimber-sized trees. The number of saplings has decreased in the last 14 years, suggesting that red pine volume may diminish in the future. Models project increased volume for the next 30 years.

Growth rates of red pine have increased and the ratio of growth to volume is much higher than the average for all species. The ratio of mortality to volume for red pine is much lower than average. Red pine makes up about 8.1% of all volume of trees in Wisconsin, 11.8% of growth but only 1.3% of total mortality.

Red pine is an important timber species, accounting for 10% of roundwood production in 2013. Red pine roundwood is mainly used for pulpwood and sawlogs, ranking first in sawlog production and third in pulpwood.

- How has the red pine resource changed? Volume and diameter class distribution:
- Where is red pine found in Wisconsin? Growing stock volume by region with map
- What kind of sites does red pine grow on? Habitat type and site index distribution
- How fast is red pine growing? Average annual net growth: trends and ratio of growth to volume
- How healthy is red pine in Wisconsin? Average annual mortality: trends and ratio of mortality to volume
- How much red pine do we harvest? Roundwood production by product and ratio of growth to removals
- How much red pine biomass do we have? Tons of aboveground biomass by region of the state
- Does red pine have any disease or pest issues? Heterobasidium annosum: Signs and possible impact
- Can we predict the future of red pine? Modelling future volumes
“How has the red pine resource changed?”
Growing stock volume and diameter class distribution

The growing stock volume of red pine has more than doubled since 1983 to 1.8 billion cubic feet or 8.1% of statewide volume (chart on right).

The increased volume has occurred mainly in sawtimber trees (charts below).

The red pine resource has aged since 1983. For instance, the volume in large trees (over 13 inches in diameter) has quadrupled in this time (chart on left below).

Growing stock volume (million cubic feet) by inventory year. 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.

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

Volume of red pine by diameter class

Percentage change in tree numbers: Red pine

Seedling Sapling Pole Sawtimber
The majority of red pine, 78%, is planted with 93% occurring in central and northern Wisconsin (Table 1). In addition, this species occurs sporadically on more mesic soils throughout the state.

Table 1. Growing stock volume (million ft³) by 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>Red pine</td>
<td>501</td>
<td>648</td>
<td>520</td>
<td>47</td>
<td>85</td>
<td>1,800</td>
</tr>
<tr>
<td>Percent of total</td>
<td>28%</td>
<td>36%</td>
<td>29%</td>
<td>3%</td>
<td>5%</td>
<td>100%</td>
</tr>
</tbody>
</table>

Source: USDA Forest Service, Forest Inventory and Analysis 2018 data

For a table of **Volume by County** go to:
http://dnr.wi.gov/topic/ForestBusinesses/documents/tables/VolumeCountySpecies.pdf
Red pine occurs most commonly on very dry to dry mesic habitat types (chart below).

The majority of red pine growing stock volume (81%) is found in stands with site indices over 60 (chart on left).

The average site index by volume for red pine is 70, higher than the average for all species which is 66. Of all the softwood species in Wisconsin, red pine has a greater occurrence on richer sites.

---

**Average annual net growth** of red pine was about 67.4 million cubic feet from 2012 to 2018, or 11.8% of statewide volume growth (chart on right). Growth rates have increased by nearly 50% since 1996, mainly due to the increased growth of aging red pine forests.

**Table 2.** Average annual net growth (million ft$^3$/year) and ratio of growth to volume by region of the state.

<table>
<thead>
<tr>
<th>Unit</th>
<th>Net growth of red pine (million ft$^3$/yr)</th>
<th>Percent of total</th>
<th>Ratio of growth to volume</th>
</tr>
</thead>
<tbody>
<tr>
<td>Northeast</td>
<td>20.9</td>
<td>31%</td>
<td>3.2%</td>
</tr>
<tr>
<td>Northwest</td>
<td>21.6</td>
<td>32%</td>
<td>4.2%</td>
</tr>
<tr>
<td>Central</td>
<td>29.8</td>
<td>29%</td>
<td>3.9%</td>
</tr>
<tr>
<td>Southwest</td>
<td>3.7</td>
<td>6%</td>
<td>4.4%</td>
</tr>
<tr>
<td>Southeast</td>
<td>1.3</td>
<td>2%</td>
<td>2.8%</td>
</tr>
<tr>
<td>Statewide</td>
<td>67.4</td>
<td>100%</td>
<td>3.7%</td>
</tr>
</tbody>
</table>

Source: USDA Forest Inventory and Analysis data

Although the highest volume of red pine occurs in central and northern Wisconsin, the highest growth to volume ratio occurs in the southwest part of the state (Table 2).

The ratio of growth to volume for red pine is 3.7%, 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](http://dnr.wi.gov/topic/ForestBusinesses/documents/tables/GrowthMortalityRemovals.pdf)
Average annual mortality of red pine, about 3.1 million cubic feet per year from 2012 to 2018, has more than doubled since 1996 (chart on right). Red pine accounts for 8.1% of volume, 11.8% of growth but only 1.3% of statewide mortality.

The ratio of mortality to volume is 0.2% for red pine, much lower than the statewide average of 1.1%, and one of the lowest of all commercial species (Table 3).

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

<table>
<thead>
<tr>
<th>Species</th>
<th>Average annual mortality (ft³)</th>
<th>Growing stock volume (ft³)</th>
<th>Mortality / volume</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red pine</td>
<td>3,059,057</td>
<td>1,800,345,392</td>
<td>0.2%</td>
</tr>
</tbody>
</table>

Source: USDA Forest Inventory and 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
In 2009-2012, red pine accounted for 36.9 million cubic feet or about 9.7% of Wisconsin’s total roundwood. Pulpwood accounted for 51% and sawlogs for another 43% (chart on right).

Red pine pulpwood made up 13% of total pulpwood in the state and sawlogs accounted for over 20% of all sawlog production.

Removals of red pine totaled 36.4 million cubic feet per year from 2012 to 2018. This is equal to 12.4% of total removals in the state.

The ratio of average annual net growth to removals is 1.8 for red pine, about equal to the average of 1.9 for all species (chart on left). This ratio has decreased dramatically since 1983 due to a six-fold increase in removals.
There were 33.1 million short tons of aboveground biomass in live red pine trees in 2018, a doubling since 1983. This is equivalent to approximately 16.5 million tons of carbon and represents 5.1% of all aboveground biomass statewide. As with volume, most red pine is located in central and northern Wisconsin (chart below).

The density of red pine wood is about average for softwoods with a ratio of biomass to volume of 28 oven-dry lbs. per cubic foot (ODP/ft³). The average for all softwoods is about 26 ODP/cubic feet and for all species is 33 ODP/cubic feet.

Approximately 79% of all red pine biomass is located in the main stem, 2% in saplings, 4% in stumps, and 14% in the branches.

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

For a table of Biomass by County go to:
Since 1993, heterobasidion root disease (formerly annosum root rot) has been confirmed in 27 Wisconsin counties (map on right).

Annosum root rot is most damaging in plantation-grown conifers (especially pines) where freshly cut stumps offer a place for infection to start. Basidiospores, produced by the fungus *Heterobasidion irregulare*, land and grow on the surface of a freshly cut stump. This infection process is why annosum can be so damaging in an area where trees are cut down. These basidiospores can be carried by the wind over hundreds of miles. The fungus starts living in the stump and moves into the root. Where roots connect, it moves from tree to tree. Infected trees and stumps may have fruit bodies (spore-producing part of the fungus) or conks (Figure below) at the base of the trunk.

Annosum root rot causes a decay of the roots and lower stem, attacks the cambium and kills infected trees. Infected trees show thin foliage, reduced height, diameter and shoot growth and eventual mortality. This process can take 3 to 5 years after harvesting.

Understory seedlings and saplings that are near infected older trees may also become infected. As pockets of trees die, gaps are created in the forest canopy where brush and early successional trees can grow.

Annosum root rot can be prevented by treating freshly cut stumps with fungicide immediately after cutting. Fungicides such a powdered Sporax and liquid Cellu-Treat, will help prevent new infections, but will not stop the growth of the fungus if the stump is already infected.

Left: Annosum fruit bodies on stump. Upper right: Fruit bodies on white pine seedling. Lower right: Sporax fungicide applied to freshly cut stump.
“Can we predict the future of red pine?”

Predicted volumes based on current rates of mortality and harvest

The 5-year ratios of growth to volume and removals to volume are significantly higher for red pine compared to all species in the state and the ratio of mortality to volume is significantly lower (chart on right). These trends would likely indicate an increase in future volume.

The Forest Vegetation Simulator (FVS¹) was used to predict future volumes of red 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.

As expected, volume increases in all three scenarios by 2054, 32% for average current removal levels, 49% for low removals and 17% for high removals.

Probably due to a higher than average rate of removals, volume levels out in 2049 using average harvest levels. Volume never peaks for low harvest levels and peaks in 2044 for high levels of harvest.

¹The 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 mortality, removals and growth to volume.
Source: USDA Forest Inventory & Analysis data