Aspen

Quaking aspen:  *Populus tremuloides*
Bigtooth aspen:  *Populus grandidentata*

The **volume of aspen has decreased** steadily since 1983, probably as a result of natural forest succession. The number of saplings and poles has decreased since 1996 which supports the conclusion of predictive models that aspen volume will decrease substantially in the future.

Both **mortality and removals of aspen are very high**. For instance, aspen makes up 10.6% of volume and 12.5% of all growth in Wisconsin, but accounts for 27.6% of total mortality and 22% of removals. The ratio of growth to removals is 110% which means that we are harvesting almost all of aspen growth in a year. A major cause of quaking aspen mortality is hypoxylon canker which decreases growth by an average of 30% annually.

**More aspen is harvested than any other species** group and is mainly used for pulpwood and composite products. Although there is plenty of aspen, the density of its wood is very low, which may make it a less valuable species for biofuel production.

- **How has the aspen resource changed?**
  Growing stock volume and diameter class distribution
- **Where is aspen found in Wisconsin?**
  Growing stock volume by region with basal area map
- **What kind of sites does aspen grow on?**
  Habitat type and site index distribution
- **How fast is aspen growing?**
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- **How healthy is aspen in Wisconsin?**
  Average annual mortality: trends and ratio of mortality to volume
- **How much aspen do we harvest?**
  Roundwood production by product and ratio of growth to removals
- **How much aspen biomass do we have?**
  Aboveground biomass by region of the state
- **Does aspen have any disease or pest issues?**
  Hypoxylon canker: Signs and possible impact
- **Can we predict the future of aspen?**
  Modelled future volumes 2014-2054
“How has the aspen resource changed?”
Growing stock volume and diameter class distribution by year

The growing stock volume of aspen in 2016 was about 2.3 billion cubic feet (Chart on right) or 10.6% of total volume in the state. Volume increased quickly in the first half of the last century but began decreasing in 1983. Since 2004, volume has remained statistically unchanged.

The volume in large growing stock trees (over 13” dbh) has remained unchanged since 1996 (Chart on left below) but the volume of smaller trees has decreased 12%. Volume continues to increase in the largest size classes.

The number of trees of all size classes for both species has remained unchanged or decreased (Chart on right below), suggesting a declining role for aspen in future forests of Wisconsin. Aspen is a pioneer species coming in mostly after disturbance. As our forests mature and disturbance becomes less frequent, it is replaced by more shade tolerant climax species.
“Where is aspen found in Wisconsin?”

Growing stock volume by region with basal area map

About 74% of all aspen volume is located in northern Wisconsin with another 13% in the central part of the state.

Quaking aspen makes up over \( \frac{2}{3} \) of all aspen volume and the vast majority of this species occurs in northern Wisconsin.

Bigtooth aspen, which makes up the remaining \( \frac{1}{3} \) of volume, is more evenly distributed. About 35% of the volume of this species occurs in the southwest and central parts of the state.

Both species are found mostly on the aspen / birch forest type and to a lesser extent on the oak / hickory type.

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>
<th>Percent of total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bigtooth Aspen</td>
<td>100</td>
<td>168</td>
<td>234</td>
<td>30</td>
<td>122</td>
<td>654</td>
<td>28%</td>
</tr>
<tr>
<td>Quaking Aspen</td>
<td>197</td>
<td>560</td>
<td>768</td>
<td>75</td>
<td>64</td>
<td>1,664</td>
<td>72%</td>
</tr>
<tr>
<td>Total</td>
<td>297</td>
<td>728</td>
<td>1,002</td>
<td>105</td>
<td>186</td>
<td>2,318</td>
<td>100%</td>
</tr>
<tr>
<td>Percent of total</td>
<td>13%</td>
<td>31%</td>
<td>43%</td>
<td>5%</td>
<td>8%</td>
<td>100%</td>
<td></td>
</tr>
</tbody>
</table>

Source: USDA Forest Service, Forest Inventory and Analysis 2016 data

For a table on 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)
The two aspen species differ with respect to volume representation by habitat type and site index. In the chart below, almost half of growing stock volume of bigtooth aspen occurs on drier habitat types whereas over 60% of quaking aspen volume occurs on mesic to wet sites.

Both species have similar representation by site index class. Growing stock volumes of both bigtooth aspen and quaking aspen have a higher representation on slightly richer sites. For instance, about 80% of aspen volume occurs on site indices above 60.

The average site index by volume for quaking aspen is 71 and for bigtooth aspen is 74, both higher than the average of 66 for all species.
The annual net growth rate of aspen has declined 10% since 1983 and 3% since 1996 (Chart on right). From 2011 to 2016, growth was about 72 million cubic feet per year or 12.5% of total volume growth in the state.

The highest volume growth for aspen is in the northern part of the state but the highest ratio of growth to volume is in Central Wisconsin (Table 2).

The average ratio of growth to volume for aspen is 3.1%, 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:

Table 2. Average annual net growth (million cft/year) and ratio of growth to volume by region of the state.

<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>23.0</td>
<td>32.0%</td>
<td>3.2%</td>
</tr>
<tr>
<td>Northwest</td>
<td>32.0</td>
<td>44.5%</td>
<td>3.2%</td>
</tr>
<tr>
<td>Central</td>
<td>10.8</td>
<td>15.0%</td>
<td>3.6%</td>
</tr>
<tr>
<td>Southwest</td>
<td>2.8</td>
<td>3.9%</td>
<td>1.5%</td>
</tr>
<tr>
<td>Southeast</td>
<td>3.3</td>
<td>4.6%</td>
<td>3.2%</td>
</tr>
<tr>
<td>Statewide</td>
<td>71.9</td>
<td>100.0%</td>
<td>3.1%</td>
</tr>
</tbody>
</table>

Source: USDA Forest Inventory and Analysis.
Average annual mortality for aspen is 64.4 million cubic feet or 27.6% of total mortality in the state (Chart on right). This rate has increased about 30% since 1996.

The ratio of mortality to volume is about 2.8% for aspen (Table 3). The average for all species in Wisconsin is 1.1% indicating that aspen has a much higher ratio of mortality to volume than average. The ratio for quaking aspen is 72% higher than for bigtooth aspen.

Whereas aspen accounts for about 10.6% of total volume and 12.5% of growth statewide, these two species make up 27.6% of total mortality.

Table 3. Mortality, growing stock volume and the ratio of mortality to volume by species of aspen.

<table>
<thead>
<tr>
<th>Species</th>
<th>Average annual mortality (cft)</th>
<th>Volume of growing stock (cft)</th>
<th>Mortality / volume</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bigtooth Aspen</td>
<td>11,905,181</td>
<td>654,090,521</td>
<td>1.8%</td>
</tr>
<tr>
<td>Quaking Aspen</td>
<td>52,483,933</td>
<td>1,663,574,411</td>
<td>3.2%</td>
</tr>
<tr>
<td>Total Aspen</td>
<td>64,389,114</td>
<td>2,317,664,932</td>
<td>2.8%</td>
</tr>
</tbody>
</table>

Source: USDA Forest Inventory & Analysis data

For a table of Average annual growth, mortality and removals by region go to:
In 2013, Wisconsin produced about 71.1 million cubic feet of aspen roundwood (Chart on right) or 22% of statewide production. This was a decrease of 24% since 2004.

In 2013, aspen accounted for about 14% of all pulpwood and 81% of all composite products. Production of all aspen industrial roundwood products has decreased since 2004.

Removals of aspen totaled 66.0 million cubic feet per year from 2011 to 2016. Aspen accounts for 10.6% of total volume but 22% of total growing stock removals, over twice as high.

Average annual net growth is approximately equal to annual removals for aspen (Chart on left). This is much lower than the average ratio of 1.9 for all species. While statewide we harvest about half of all tree growth, for aspen almost all new growth is removed.

Hypoxylon canker is one of the most important killing diseases of aspen in eastern North America. The total impact of Hypoxylon canker has been estimated to be 30 percent of the annual net growth of aspen.

The fungus is primarily a pathogen of quaking aspen, with infection levels averaging 12 percent. Susceptibility of aspen to Hypoxylon is apparently greater on poor sites. Poor stocking as well as open areas and edges seem to create conditions favorable to the fungus.

These factors are reflected in the forest inventory data on quaking aspen mortality in Wisconsin (figure above). The mortality rate increases as stocking decreases, increases with proximity to improved roadways (stand edge) and with lower site index (i.e. poorer sites).

Young cankers first appear on aspen bark as slightly sunken, yellowish-orange areas with irregular margins (figure on left). The bark eventually sloughs off exposing a black center. Old cankers can be several feet long and will eventually girdle the tree.

The fungus will invade new tissue so rapidly that callus has no time to form. Aspen trees can die quickly from girdling cankers, stem breakage and suppression.
There were 57.8 million short tons of biomass in live aspen trees in 2016, down from about 60.8 million tons in 1983, a decrease of 5%. This is equivalent to approximately 28.9 million tons of carbon and represents 9% of all aboveground biomass statewide. As with volume, most aspen is located in northwest Wisconsin (Chart below).

Aspen has the one of the lowest values for specific gravity and ovendry weight of all species in Wisconsin, with a specific gravity of 0.39 and an ovendry weight of 22.5 pounds per cubic foot (lb/cft). The average for all hardwoods is 0.56 and 34.4 lb/cft, respectively. Approximately, 60% of all biomass is located in the stem, 22% in the bark and 19% in the tops and limbs.
Can we predict the future of aspen?

Modelled future volumes of bigtooth and quaking aspen

The ratios of both mortality and removals to volume of growing stock are much higher for quaking aspen and bigtooth aspen compared to all species in the state (chart on right). Both the mortality and removals ratios are two to three times higher for aspen.

The Forest Vegetation Simulator (FVS) was used to model future volumes of aspen through 2054 based on these rates of mortality and removals. Due to the fact that they are so high, the volume of aspen decreases over the next fifty years, 23% for quaking aspen and 44% for bigtooth aspen.

Predicted growing stock volume

Predicted growing stock volumes based on 2009-2014 rates of mortality and removals to volume.

1 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/. 