

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, but has risen slightly since 2011. The number of sawtimber-sized trees has decreased since 2004, while the number of saplings has decreased very slightly, and the number of poles has increased.

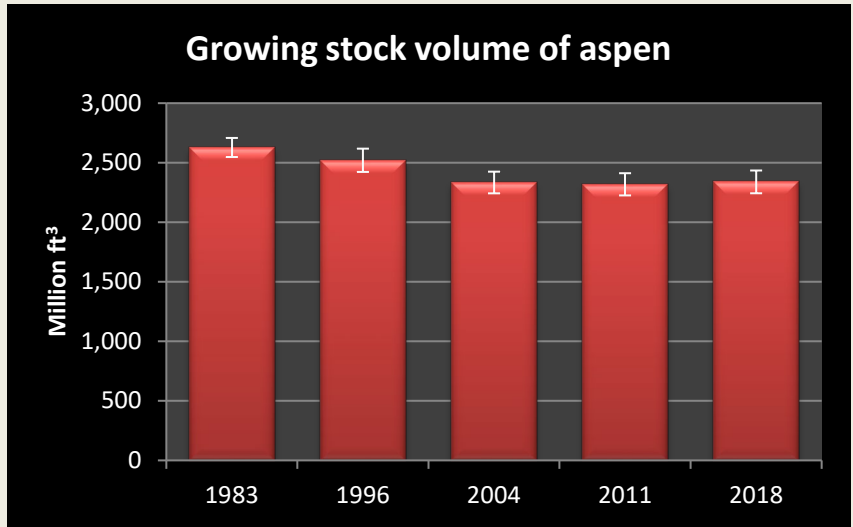
Both mortality and removals of aspen are very high. For instance, aspen makes up 10.5% of volume and 13.7 % of all growth in Wisconsin, but accounts for 25.4% of total mortality and 22.2% of removals. The ratio of growth to removals is 1.2 which means that we are harvesting almost all of aspen growth 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.

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“How has the aspen resource changed?”
Growing stock volume and diameter class distribution by year

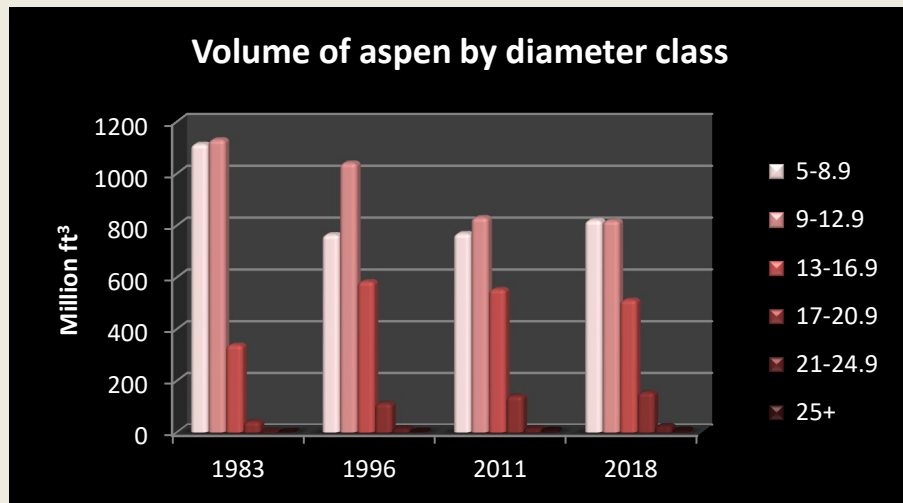
The [growing stock volume](#) of aspen in 2018 was about 2.3 billion cubic feet (Chart on right) or 10.5% of total volume in the state. Volume increased quickly in the first half of the last century but began decreasing in 1983. Since 2004, volume has remained statistically unchanged.



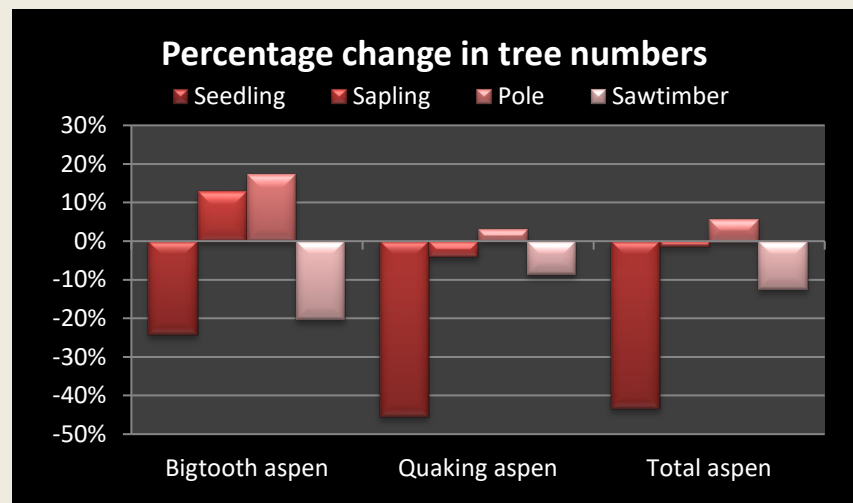
Growing stock volume (million cubic feet) by inventory year.
 Source: USDA Forest Inventory and Analysis data

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 11%. Volume continues to increase in the largest size classes.

A slight decline in the number of trees of across the size classes for both species (Chart on right below), suggests 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.



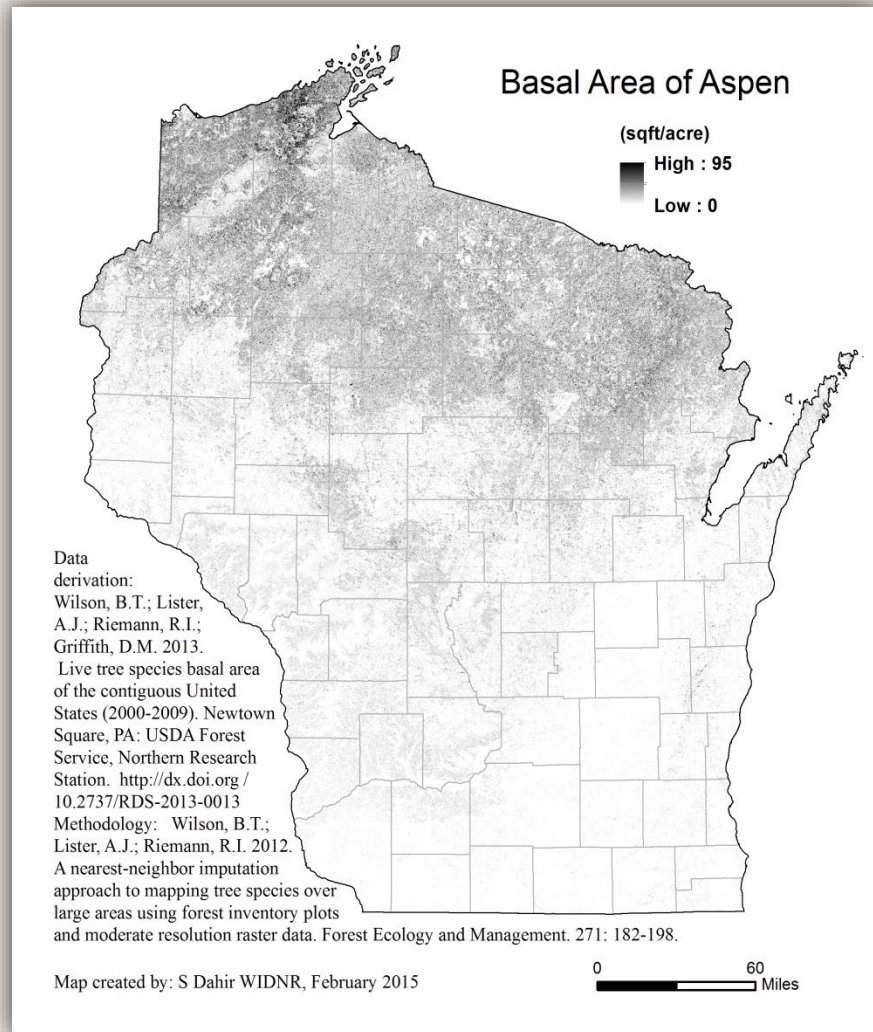
Growing stock volume (million cubic feet) by diameter class (inches).
 Source: USDA Forest Inventory and Analysis data



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 aspen found in Wisconsin?”

Growing stock volume by region with basal area map



About 75% of all aspen volume is located in northern Wisconsin with another 13% in the central part of the state.

Quaking aspen makes up over 2/3 of all aspen volume and the vast majority of this species occurs in northern Wisconsin.

Bigtooth aspen, which makes up the remaining 1/3 of volume, is more evenly distributed. About 33% 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 ft³) by species and region of the state.

Species	Central	North east	North west	South east	South west	Total	Percent of total
Bigtooth Aspen	97	180	234	32	124	667	29%
Quaking Aspen	200	576	767	68	62	1,672	71%
Total	296	756	1,001	100	186	2,339	100%
Percent of total	13%	32%	43%	4%	8%	100%	

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

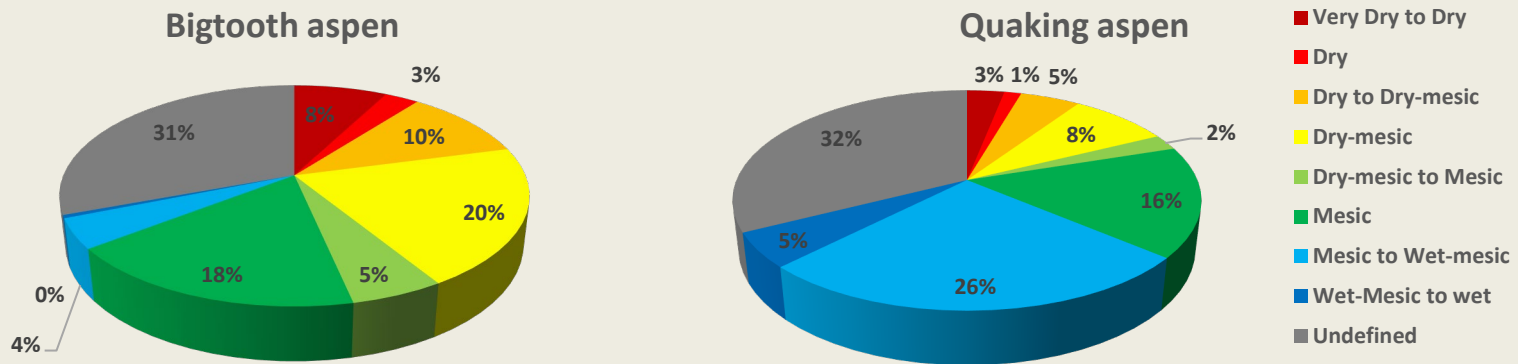
For a table on **Volume by County** go to:

<http://dnr.wi.gov/topic/ForestBusinesses/documents/tables/VolumeCountySpecies.pdf>



“What kind of sites does aspen grow on?”
Habitat type and site index distribution

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 quaking aspen volume is much more prevalent on mesic to wet sites.



Percent distribution of growing stock volume by habitat type group (USDA Forest Inventory & Analysis data).

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.

Percent distribution of growing stock volume by site index class (USDA Forest Inventory & Analysis data).



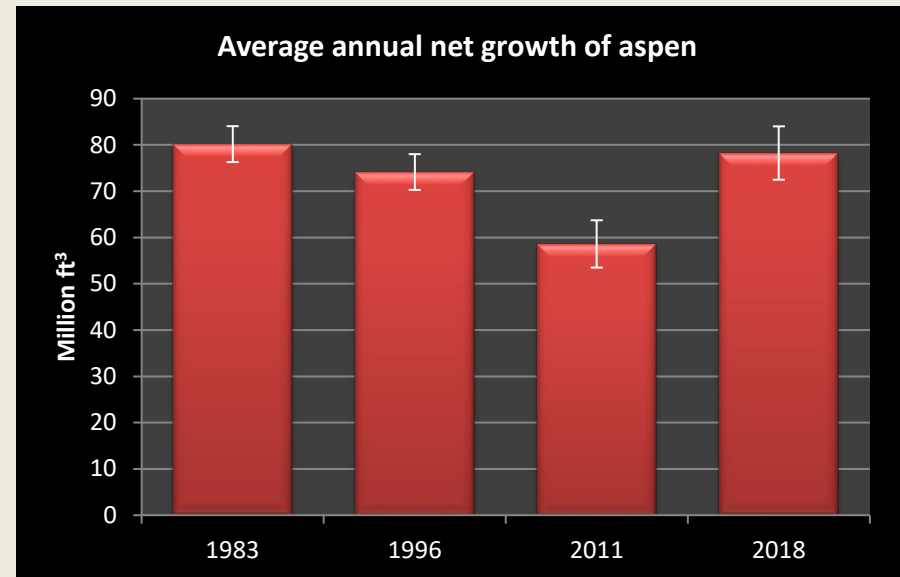
“How fast is aspen growing?”
Average annual net growth by region and year

The [annual net growth](#) rate of aspen has declined 2% since 1983, but has increased 6% since 1996 (Chart on right). From 2012 to 2018, growth was about 78.3 million cubic feet per year or 13.7% of total volume growth in the state.

Table 2. Average annual net growth (million ft³/year) and ratio of growth to volume by region of the state.

Region	Net growth	Percent of Total	Ratio of growth to volume
Northeast	25.9	33%	3.4%
Northwest	36.6	47%	3.7%
Central	10.8	14%	3.6%
Southwest	2.4	3%	1.3%
Southeast	2.6	3%	2.6%
Statewide	78.3	100%	3.3%

Source: USDA Forest Inventory and Analysis.



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

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

The average ratio of growth to volume for aspen is 3.3%, 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>

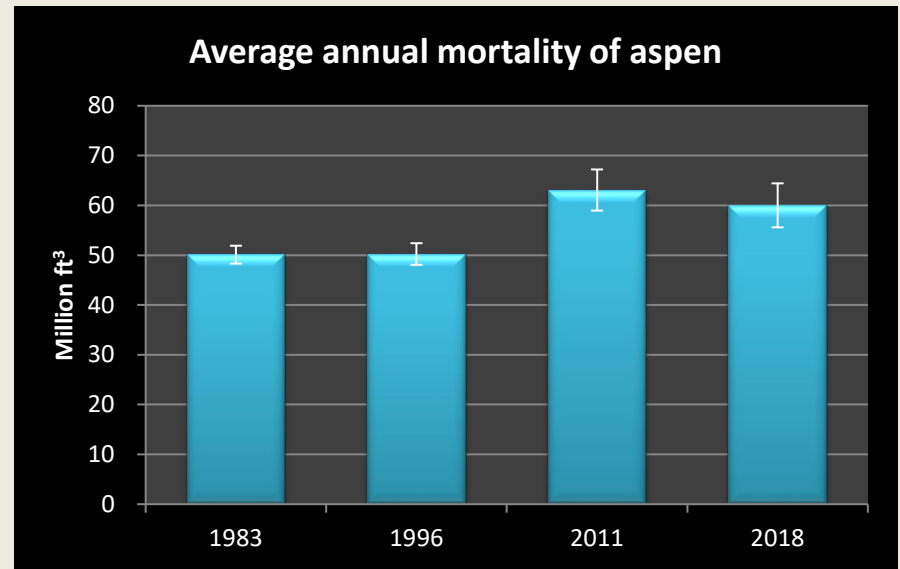


“How healthy is aspen in Wisconsin?”
Average annual mortality by year

Average annual mortality for aspen is 60 million cubic feet or 25.4% of total mortality in the state (Chart on right). This rate has increased about 19% since 1996.

The ratio of mortality to volume is about 2.6% 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 much higher than for bigtooth aspen.

Whereas aspen accounts for about 10.5% of total volume and 13.7% of growth statewide, these two species make up 25.4% of total mortality.



Average annual mortality (million cubic feet) by inventory year.
 Source: USDA Forest Inventory & Analysis data

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

Species	Average annual mortality (ft ³)	Volume of growing stock (ft ³)	Mortality / volume
Bigtooth Aspen	12,786,912	666,743,510	1.9%
Quaking Aspen	47,220,929	1,672,295,937	2.8%
Total Aspen	60,007,841	2,339,039,447	2.6%

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>

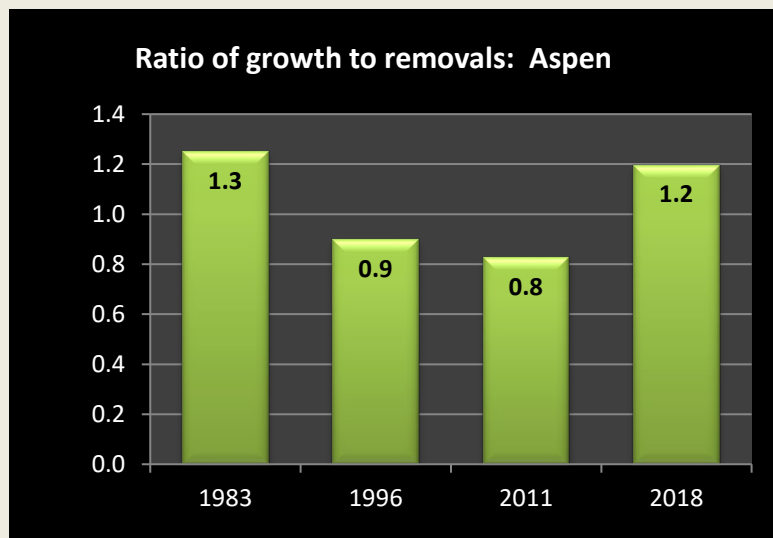


"How much aspen do we harvest?"

Roundwood production by product and year

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.



Ratio of volume harvested annually to net growth.
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 aspen totaled 65.3 million cubic feet per year from 2012 to 2018. Aspen accounts for 10.5% of total volume but 22.2% of total growing stock removals, over twice as high.

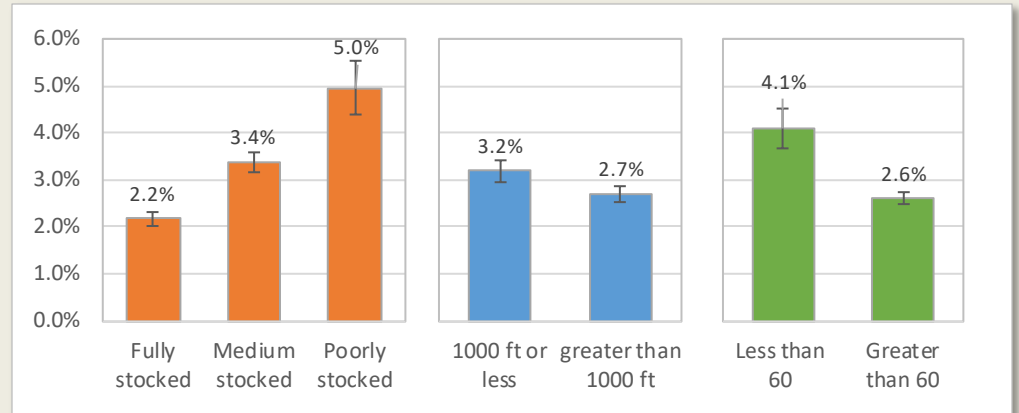
Average annual net growth is approximately equal to annual removals for aspen (Chart on left). This is much lower than the average ratio of 1.9 for all species. While statewide we harvest about half of all tree growth, for aspen almost all new growth is removed.

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

“Does aspen have any major disease or pest issues?”
Hypoxylon canker: biology, symptoms and impact

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.



The ratio of aspen mortality to volume for stocking level (left), distance to improved road (center) and site index category (right). Error bars represent the 67% confidence interval. Source: USDA Forest Inventory & Analysis data

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.



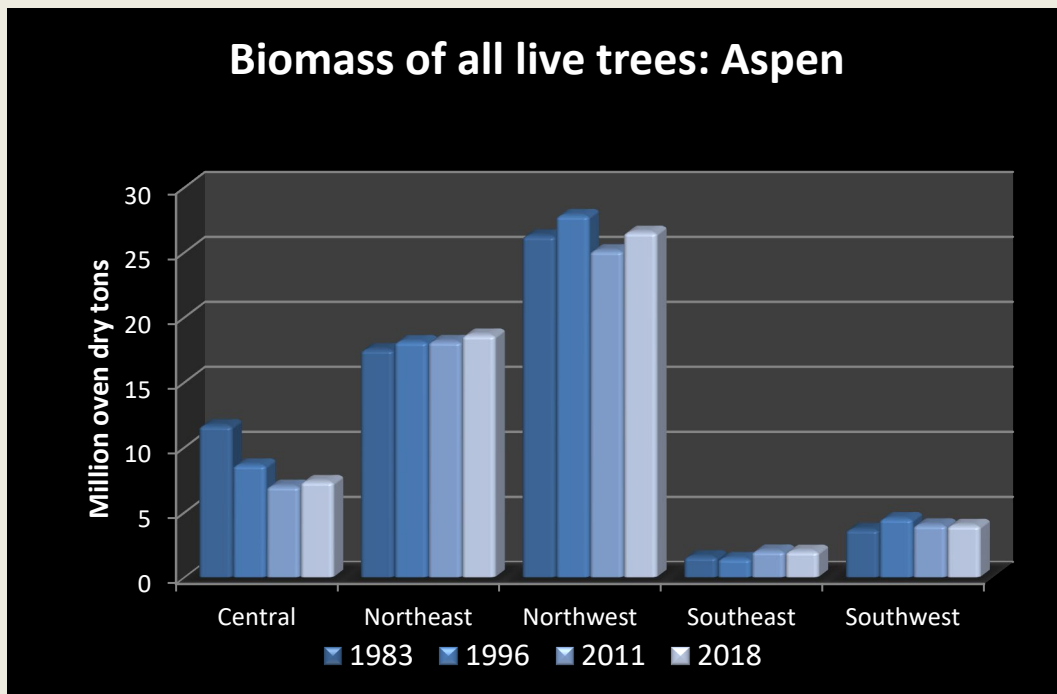
Top left: Young canker with sunken orange center. Bottom left: Old canker with callus tissue. Right: Large canker girdling aspen tree.



“How much aspen biomass do we have?”

Aboveground biomass by region of the state

There were 58.6 million short tons of [biomass](#) in live aspen trees in 2018, down from about 60.8 million tons in 1983, a decrease of 4%. This is equivalent to approximately 29.3 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 oven-dry weight of all species in Wisconsin, with a specific gravity of 0.39 and an oven-dry 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, 59% of all biomass is located in the stem, 19% in saplings, 3% in stumps, and 19% in the tops and limbs.

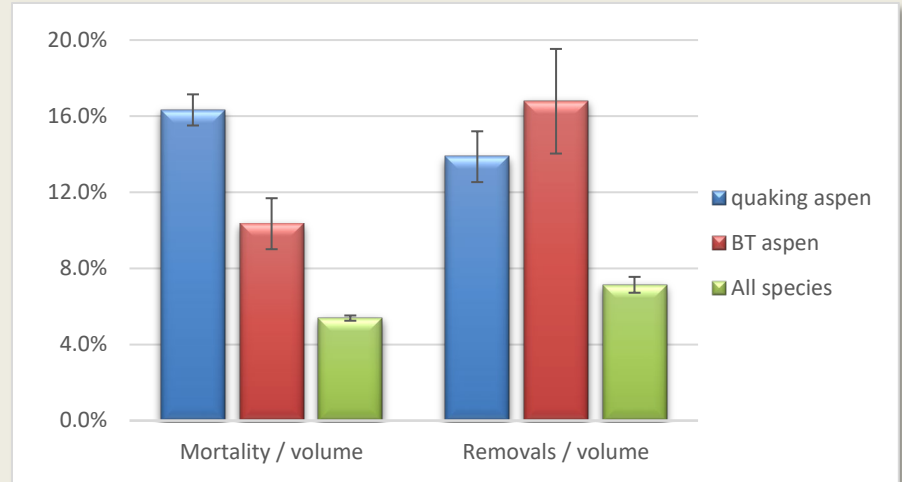
Biomass (above ground dry weight of live trees >1 in dbh, short tons) by year and region of the state.
 Source: USDA Forest Inventory & Analysis data

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

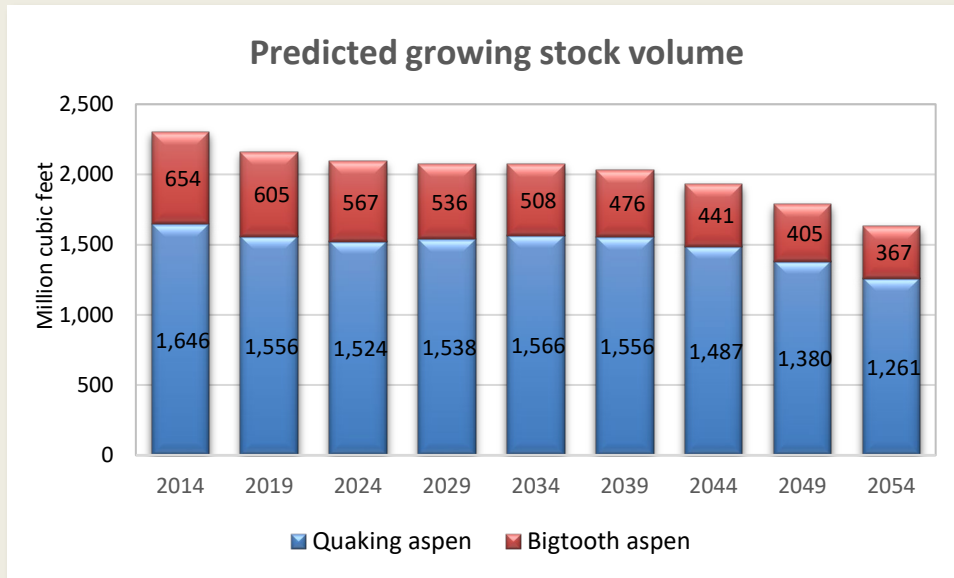
"Can we predict the future of aspen?"

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.



Ratio of mortality to volume and removals to volume of growing stock. Source: USDA Forest Inventory & Analysis



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

The Forest Vegetation Simulator (FVS¹) 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.

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/fmfc/fvs/>.