Balsam fir

(*Abies balsamea*)

Balsam fir has been declining in recent decades but has shown signs of recovery since 2004. For instance, the number of sawtimber trees has decreased slightly since 2004 but the number of saplings and poles has increased. Since 2011, growth rates have increased and mortality, although still quite high, has decreased. Currently balsam fir accounts for 1.9% of growing stock volume in Wisconsin, 7.2% of total mortality and 2.0% of net growth. Growth models predict an increase in volume through 2044.

Balsam fir, located mostly in northern Wisconsin, is **not a major timber producing species**. It is used mainly for pulpwood and Christmas trees. Wood density is very low and may not be a major source of biofuel.

- *How has the balsam fir resource changed?*
  Growing stock volume and diameter class distribution
- *Where is balsam fir found in Wisconsin?*
  Growing stock volume by region with map
- *What kind of sites does balsam fir grow on?*
  Habitat type and site index distribution
- *How fast is balsam fir growing?*
  Average annual net growth: trends and ratio of growth to volume
- *How healthy is balsam fir in Wisconsin?*
  Average annual mortality: trends and ratio of mortality to volume
- *How much balsam fir do we harvest?*
  Roundwood production by product and ratio of growth to removals
- *How much balsam fir biomass do we have?*
  Tons of aboveground biomass by region of the state
- *Can we predict the future of balsam fir?*
  Modelled future volumes based on current rates of mortality and removals

Division of Forestry
WI Dept of Natural Resources
December 2019

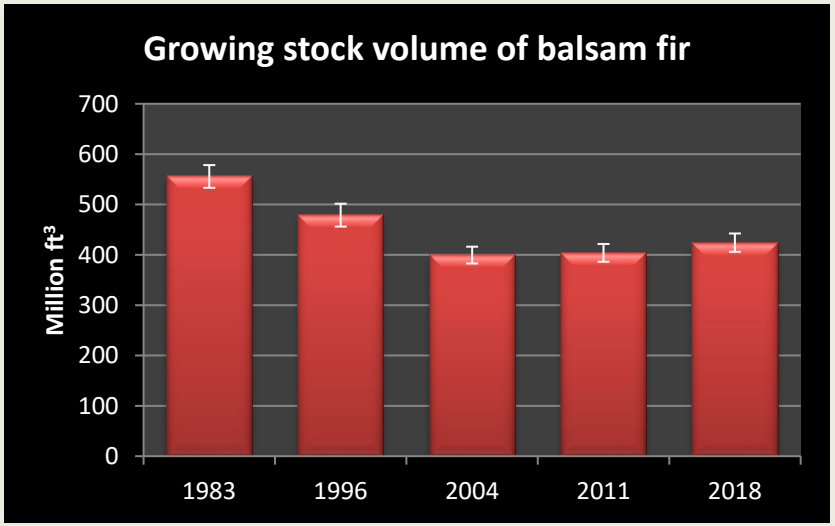
"How has the balsam fir resource changed?"

Growing stock volume and diameter class distribution

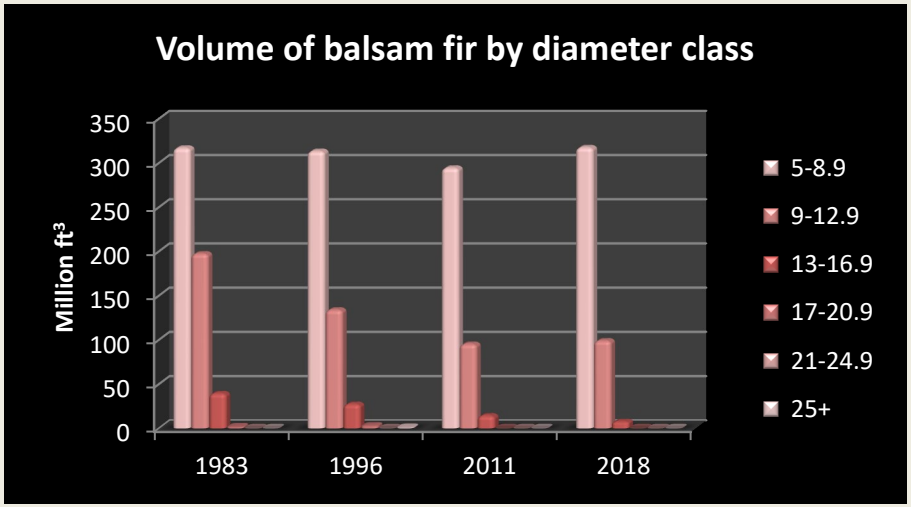
In 2018, the growing stock volume of balsam fir in Wisconsin (chart on right) was about 424 million cubic feet or 1.9% of total statewide volume. The volume of fir increased dramatically in the second half of the 20th century when natural succession promoted the growth of shade tolerant species over pioneer species such as aspen and birch. Volume has decreased by 24% since 1983 but remained statistically unchanged since 2004.

Since 1983, the volume of growing stock has decreased 82% for large trees (13+ inches dbh) and 19% for small trees (5 to 12.9 inches dbh, chart lower left).

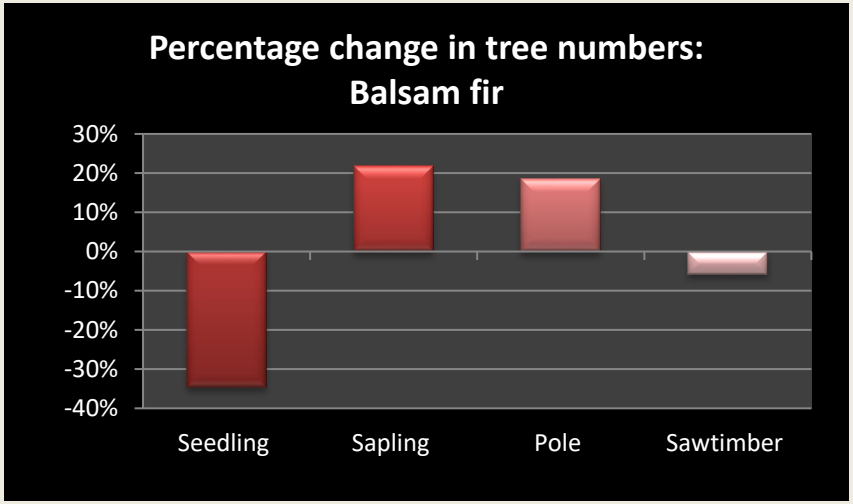
The number of saplings and poles (chart lower right) has increased since 2004, suggesting that balsam fir has cautiously optimistic future in Wisconsin's forests.



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



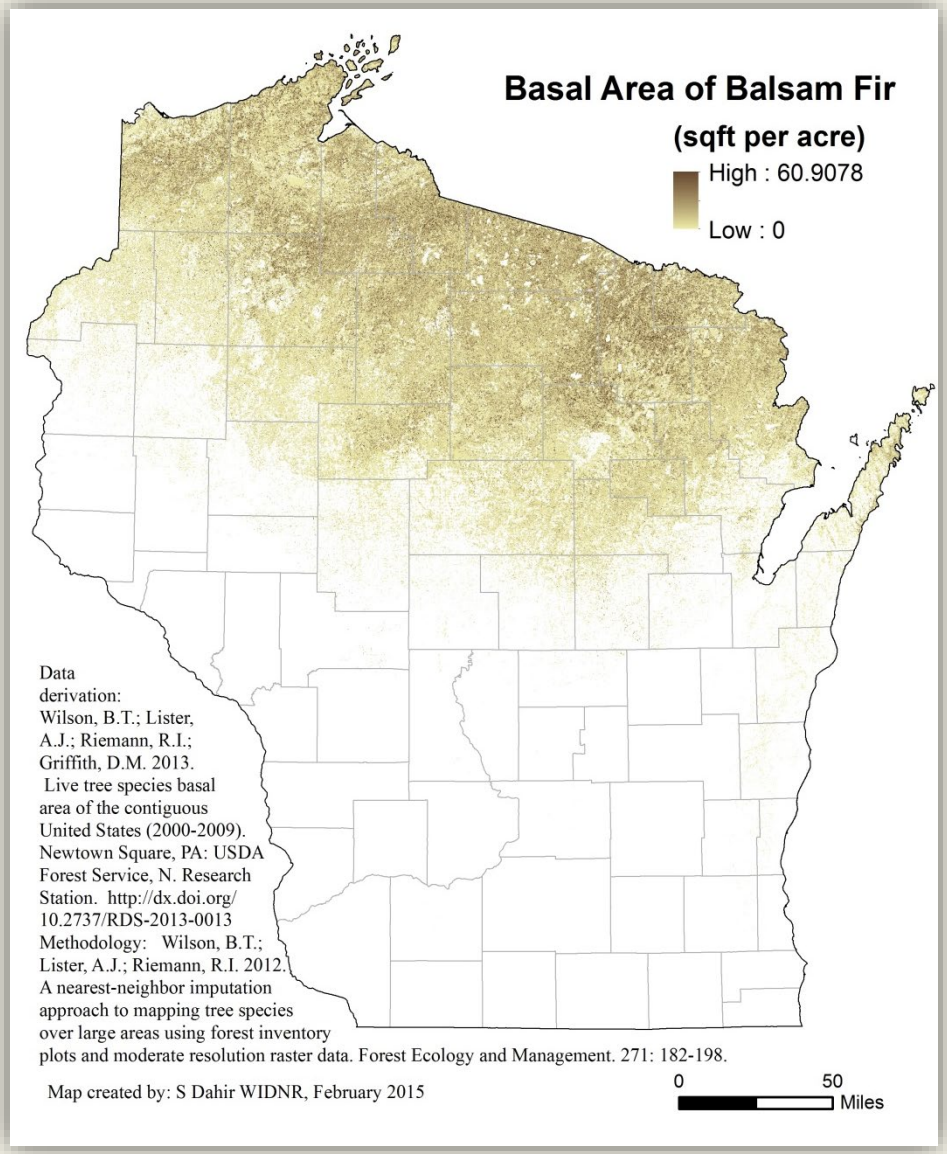
Growing stock volume (million cubic feet) by diameter class (inches).
Source: USDA Forest Inventory and Analysis data



Percentage change in the number of live trees by size class between 2004 and 2018.
Source: USDA Forest Inventory and Analysis data

"Where is balsam fir found in Wisconsin?"

Growing stock volume by region with map



About 96% of all balsam fir volume is located in northern Wisconsin (Table 1).

Balsam fir volume is distributed about equally on aspen / birch forest types and on spruce / fir forest types.

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
Balsam fir	13	211	197	3	1	424
% of total	3%	50%	46%	1%	0%	100%

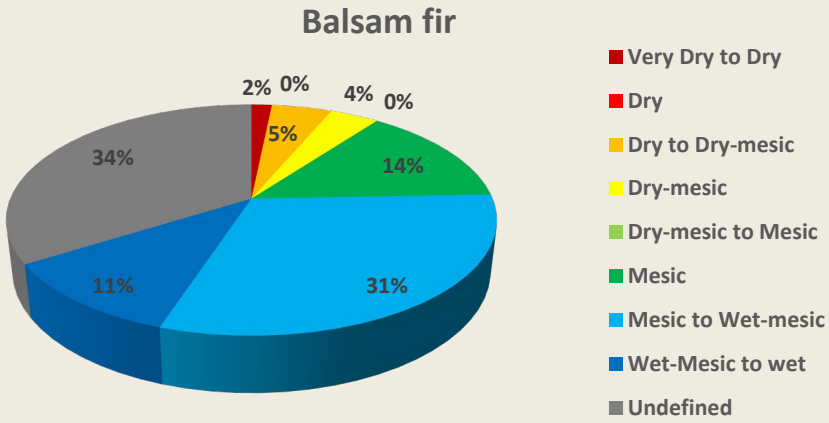
Source: USDA Forest Service, Forest Inventory and Analysis 2018 data

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

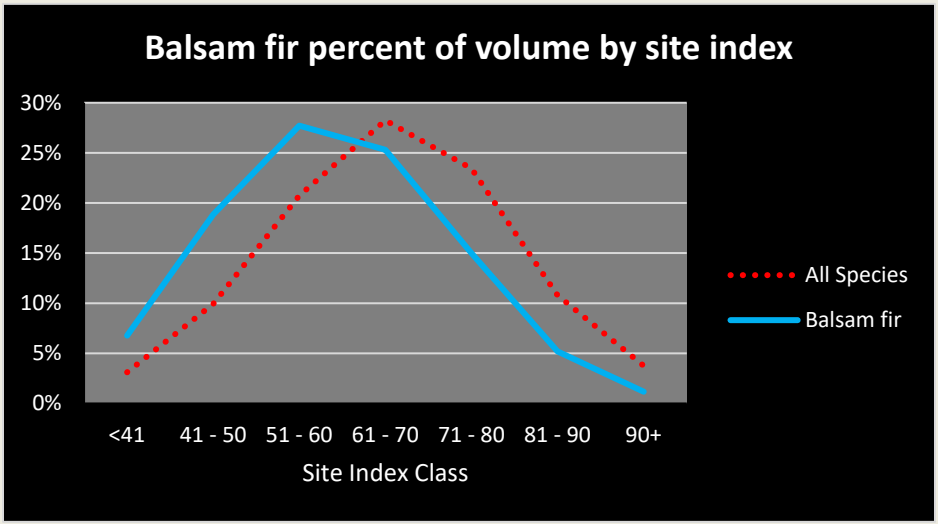
"What kind of sites does balsam fir grow on?"

Habitat type and site index distribution

The vast majority of balsam fir growing stock volume occurs on mesic to wet habitat types. A small amount is on dry or dry mesic sites.



Percent distribution of growing stock volume by habitat type group (USDA Forest Inventory & Analysis data 2018).



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

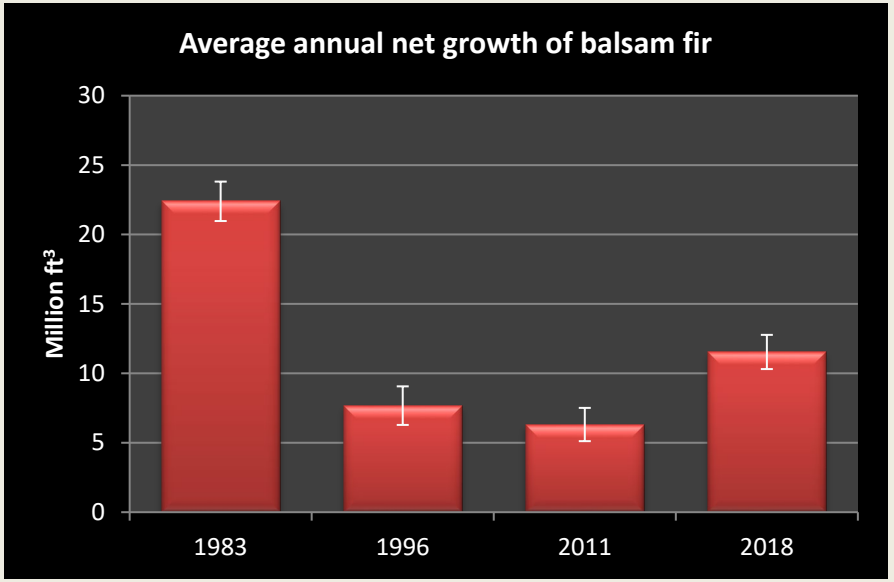
The majority of balsam fir volume occurs in stands with a site index less than 60. Fir has a higher representation on poorly drained soils which generally have low fertility, especially in northern Wisconsin.

The average site index by volume for balsam fir is 59, lower than the average of 66 for all species.

"How fast is balsam fir growing?"

Average annual net: trends and ratio of growth to volume

The rate of average annual net growth (chart on right), 11.5 million cubic feet per year from 2012 to 2018, has decreased by 49% since 1983 but has seen a significant increase since 2011. Balsam fir accounts for about 1.9% of total volume and 2.0% of total growth statewide.



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

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

Region	Net growth	Percent of total	Ratio of growth to volume
Northeast	6.9	60%	3.3%
Northwest	4.7	40%	2.4%
Central	-0.2	-	-
Southwest	0.1	1%	14.4%
Southeast	0.1	0%	2.1%
Statewide	11.5	100%	2.7%

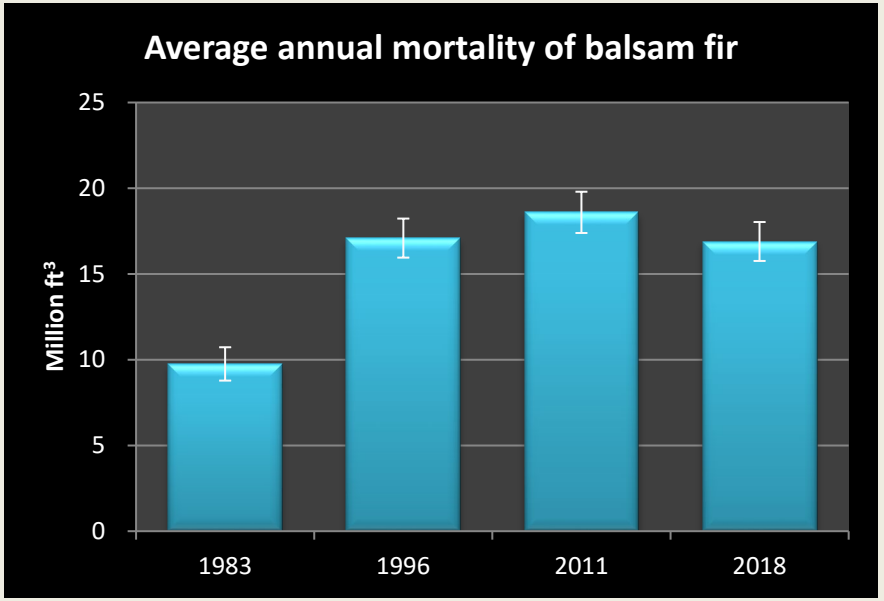
Source: USDA Forest Inventory and Analysis

As with volume, all growth for balsam fir is in the northern half of the state (Table 2). In central Wisconsin, mortality exceeds gross growth resulting in negative net growth. The average ratio of net growth to volume for balsam fir is 2.7%, slightly above 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 balsam fir in Wisconsin?"

Average annual mortality: trends and ratio of mortality to growth



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

Average annual mortality of balsam fir was about 16.9 million cubic feet from 2012 to 2018 (chart on right). This rate has increased 33% since 1983 but fallen since 2011. Balsam fir makes up 1.9% of total volume statewide but 7.2% of all mortality.

The ratio of mortality to volume is about 4.0% for balsam fir (Table 3). This is almost 4 times higher than the average for all species in Wisconsin which is 1.1%.

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

Species	Average annual mortality (ft^3)	Volume of growing stock (ft^3)	Mortality / volume
Balsam Fir	**16,895,349**	**424,185,318**	**4.0%**

Source: USDA Forest Inventory & Analysis data

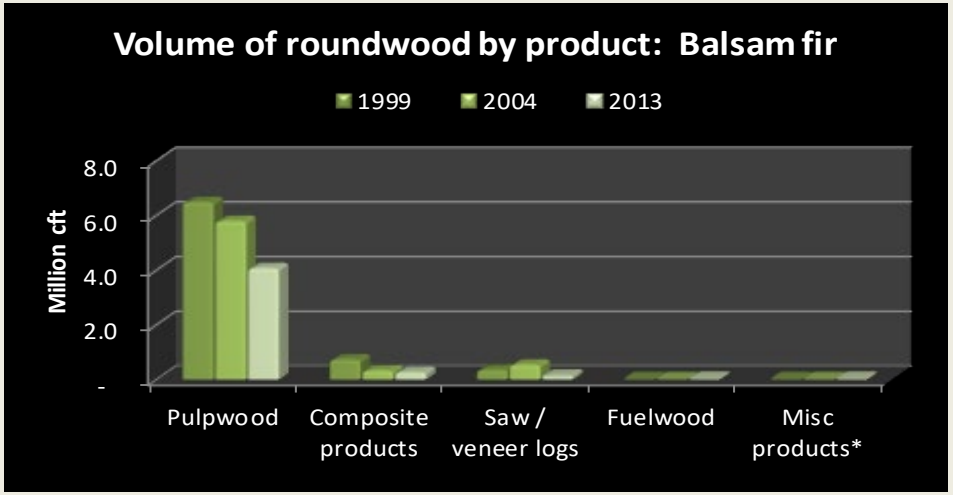
For a table of **Average annual growth, mortality and removals by region** go to:
http://dnr.wi.gov/topic/ForestBusinesses/documents/tables/GrowthMortalityRemovals.pd

"How much balsam fir do we harvest?"

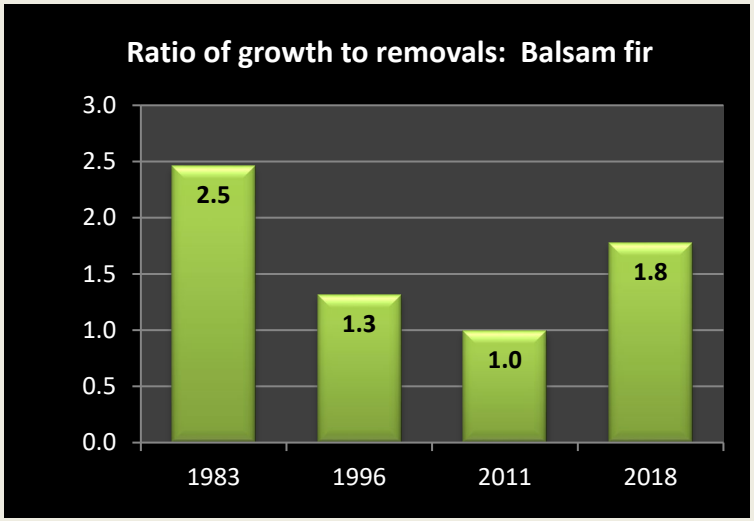
Roundwood production by product and ratio of removals to growth

In 2013, Wisconsin produced about 4.6 million cubic feet of balsam fir roundwood or about 1.4% of total roundwood production (chart on right).

Pulpwood accounts for almost all roundwood but makes up only 2.4% of statewide pulpwood production. Balsam fir pulpwood production has decreased steadily since 1999.



Volume of roundwood. * 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 balsam fir totaled 6.5 million cubic feet per year from 2012 to 2018. Balsam fir accounts for about 2.2% of removals statewide.

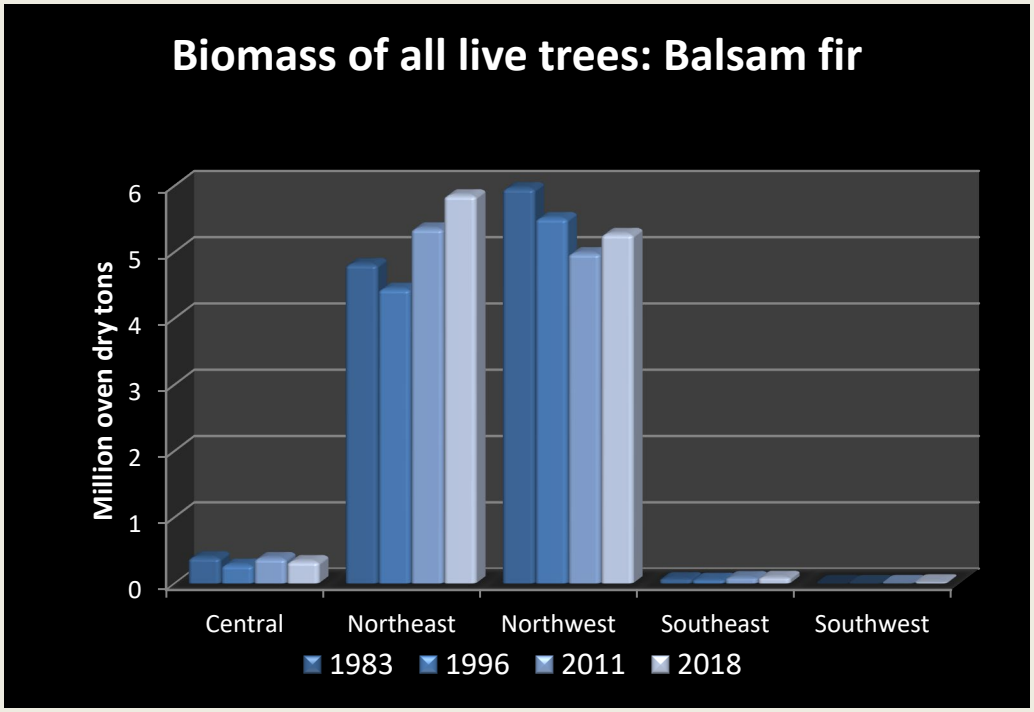
The ratio of annual net growth to average annual removals (chart on left) was 1.8 from 2012 to 2018, lower than the statewide average of 1.9 for all species. Since removals are low, this is mainly due to very low growth rates and high mortality.

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 balsam fir biomass do we have?"

Tons of aboveground biomass by region of the state

There were 11.6 million short tons of biomass in live balsam fir trees (> 1 in diameter) in 2018, which is slightly more than the 11.3 million tons of biomass present in 1983. This is equivalent to approximately 5.8 million tons of carbon and represents 1.8% of all aboveground carbon statewide. As with volume, most balsam fir is located in northern 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.

Balsam fir wood has the lowest specific gravity and oven-dry weight of all commercial species in Wisconsin. The specific gravity is 0.35 compared to 0.51 for all species and the oven-dry weight is 21.8 pounds per cubic foot compared to 31.4 for all species.

Approximately 45% of all biomass is located in the merchantable stem, 43% in saplings, 3% in stumps, 9% in the tops and limbs.

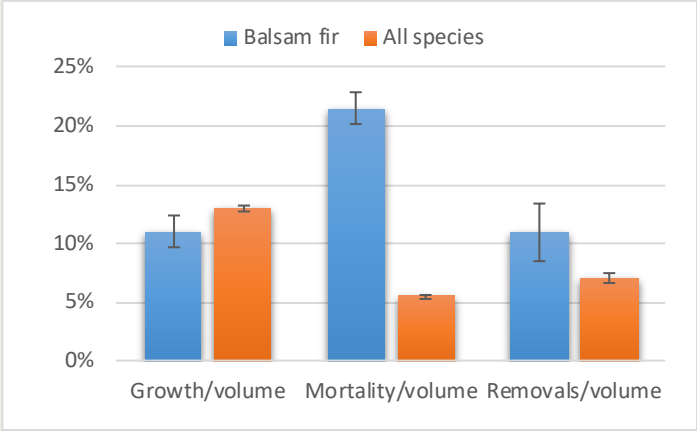
For a table of **Biomass by County** go to:
http://dnr.wi.gov/topic/ForestBusinesses/documents/tables/BiomassByCounty.pdf

"Can we predict the future of balsam fir?"

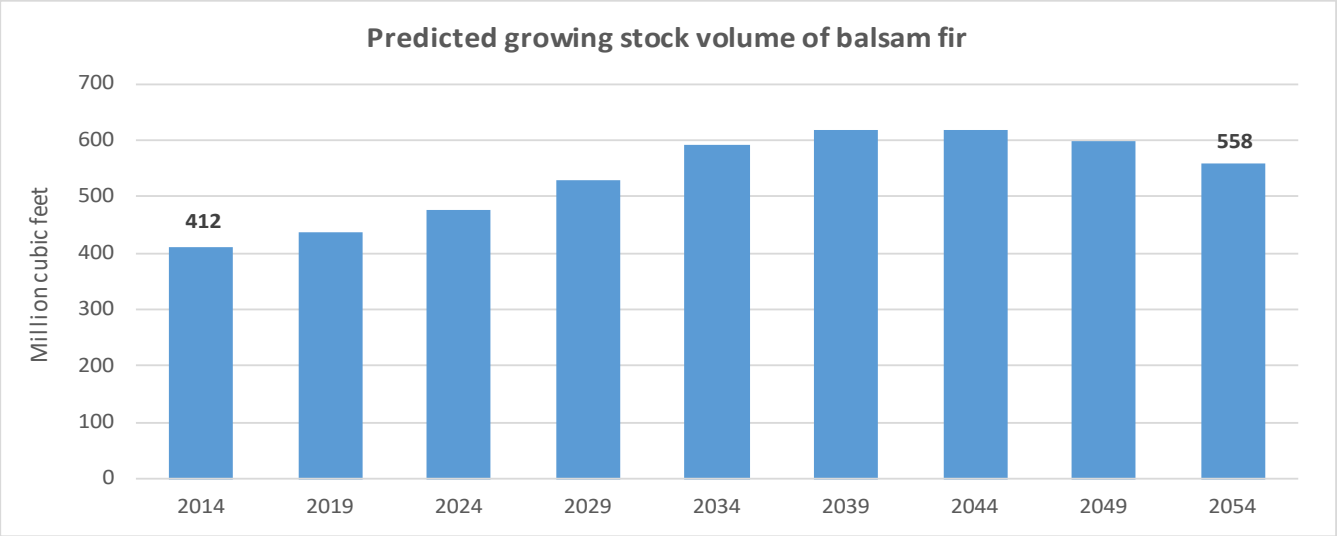
Modelled future volumes based on current rates of mortality and harvest

The ratio of 5-year mortality to volume of growing stock is much higher for balsam fir compared to all species in the state (chart on right). However, mortality has decreased steadily over the last 10 years and annual growth rates have increased significantly.

The Forest Vegetation Simulator (FVS[1]) was used to predict future volumes of balsam fir through 2054 based on these rates of mortality and removals. Due to the fact that growth is increasing and mortality decreasing, the volume of balsam fir increases 43% by 2054.



Ratio of five year mortality and removals to 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/.