

Forest characteristics of the Governor Knowles State Forest



WisCFI data 2007 - 2012

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Summary of the Governor Knowles State Forest

There are approximately 17,556 ($\pm 1.1\%$ sampling error or SE) acres of [timberland](#) on the Governor Knowles State Forest. The major [forest types](#) are oak and scrub oak. These 2 types account for one third of all timberland. Governor Knowles State Forest is a young forest, lacking the middle-aged bulge of other properties. This state forest has the highest percentage of acreage in stands under 21 years of age and the lowest percentage of stands aged 41-80 years. Average site index on the forest is 52 which is below the average of 56.8 for all state forests. The low average site index is probably correlated with the fact that almost $\frac{2}{3}$ of timberland is classified as having a [habitat type](#) that is either very dry to dry or somewhat wet to wet.

There are 11.1 million trees ($\pm 8.8\%$ SE), 17.2 million cubic feet of growing stock volume ($\pm 12.0\%$ SE) and 50.5 million board feet of sawtimber ($\pm 17.3\%$ SE) on the Governor Knowles State Forest. The most numerous [growing stock](#) species are black ash, northern pin oak, red maple and northern white-cedar. Northern pin oak and black ash are also the most common seedling species. The majority of growing stock and sawtimber volume is in four species: eastern white pine, northern pin oak, northern white cedar and black ash. The majority of grade 1 sawtimber is in northern white-cedar with eastern white pine accounting for the majority of grade 2 sawlogs. The Governor Knowles State Forest has the lowest volume of growing stock, 980 cft/acre, and the second lowest volume of sawtimber per timberland acre of all the state forests, 2.9 MBF/acre.

Several measures are reported which assess forest health and species sustainability. All are approximations, either based on only one year of data, such as growth and mortality, or peripheral measures of health, such as crown characteristics and the number and volume of standing dead trees. Caution should be used in drawing firm conclusions from this data.

It is difficult to assess forest health on Governor Knowles State Forest because it's a small property with few trees and with only a fifth of the plots re-measured for growth and mortality, sampling errors are very high. Of the major species, eastern white pine has a higher than average mortality rate, percent of volume in standing dead trees and crown dieback. Northern pin oak is doing fine. Northern white cedar has a slightly high ratio of mortality to growth. Black ash has a slower than average growth rate, a larger than average volume of standing dead trees, and a higher percentage of crown dieback than average. Red maple also has a slower than average growth rate and a higher than average percentage of crown dieback. Only more data will reveal if these trends are significant.

Overall, there are no consistent trends revealing forest health problems. For instance, the growth to volume ratio is higher on Governor Knowles State Forest compared to all state forests combined, the mortality to gross growth ratio is much lower, the percent volume in standing dead trees is slightly higher and the average percent of crown dieback is twice as high.

As far as trends in growing stock volume from 2008 to 2012, there are a few visible trends but none are statistically significant. For instance, there is a slight decrease in the volume of northern white cedar, an increase in red maple, and a decrease in quaking aspen from 2008 to 2012.

Forward

There has always been a strong demand for timely, consistent, and reliable forest inventory and monitoring information for State Forests. Recently, the demand for timely and relevant information has been growing. Partners interested in State Forests want more recent information, covering a broader scope of forest attributes with more analysis and reporting capabilities. In response, the Wisconsin Department of Natural Resources implemented a State Forest Continuous Forest Inventory (WisCFI) program that will increase our capacity to collect, analyze and publish data on an annual basis for each State Forest individually and as a group (over 500,000 acres of forest and nonforest land).

The primary purpose of the Wisconsin CFI is to collect and report on the condition of the forest in a statistically sound manner on an annual basis for each State Forest. The information will be used to track the status and trends in forest extent, cover, growth, mortality, habitat, and overall health. The continuous forest inventory will provide unbiased, reliable information at the property level with the ability to incorporate regional trends. The inventory will assist in planning, management and monitoring.

Inventory goals:

- Provide information on the condition and health of the forest and track changes over time.
- Integrate effectively data, methods and tools in the planning and decision making processes.
- Develop and maintain data input models and methods for forestry analysis and planning.
- Develop up-to-date and easy-to-use information products and services for property managers and our public and partners.

Difference between WISFIRS (forest reconnaissance data) and WisCFI data

The WISFIRS (Wisconsin Forest Inventory and Reporting System or Recon) and the WisCFI (Wisconsin Continuous Forest Inventory) datasets are used to describe the same forests but their purpose, methodology and results are very different.

WISFIRS is a stand-based dataset and is used to **manage individual stands**. A stand is defined as having a fairly uniform composition of trees with a common management objective. The emphasis is on management. Since forests are never consistent throughout, data on cover type and tree composition must be generalized in order to describe the stand as a whole. Generalizing by stand is crucial for scheduling management activities but not for determining accurate forest-wide statistics such as volume by species, growth or mortality rates. In addition, since forest reconnaissance is performed at different intervals for different stands, tracking forest-wide trends such as changes in acreage by forest type, size class or other stand descriptors, is difficult.

WisCFI data is an analytical tool which can provide **statistically consistent and accurate** information as well as trends in this data. It is based on systematically randomized located plots (each plot represents c. 200 acres of forest) which are re-measured every five years. There are many stands defined by forest reconnaissance which will not have even one WisCFI plot and many stands which will have more than one. Many WisCFI plots will be assigned a cover type, size class or stand age which may be quite

different from the forest reconnaissance typing of the stand in which they are located. As previously stated, stands may be very inconsistent from one location to the next. The important thing is that the data is measured very consistently from plot to plot and from inventory to inventory and that each plot is located in a systematic and random manner. This allows a statistical determination of the amount of error attached to each measure. The more plots, the lower the sampling error. Knowing the amount of error means we can determine the accuracy of the measurement. For instance, for the NHAL an area of c. 2,500 acres yields a sampling error of about 25%. This means that there is a 2/3 probability that the actual value will be between 1,900 and 3,100.

WisCFI data cannot be used to describe small areas because of the large amount of error associated with small samples but it can be used to describe acreage by stand age, size class, forest type, soil type, habitat type, site index, and productivity for an entire state forest. It can be used to determine volume or number of trees by tree size class, crown class, stocking class, site index, etc. With the addition of P3 data, many other measures such as crown dieback or transparency, area of compacted or bare soil, quantity of coarse woody debris, or cover of invasive species can be estimated. These measures will initially have a large sampling error but as the plots are re-measured, the amount of error will diminish and trends will emerge from the data. Again, all of these measures have an associated sampling error and therefore their accuracy can be gauged. This allows us to say whether there is or is not, for instance, a significant change in the acreage of a forest type or the volume of a species.

As plots are re-measured for the first time in 2012, changes in these measures will emerge. For instance, as trees are re-inventoried, mortality or removals will be recorded. Growth rates will emerge as will changes in acreage by size class or forest type. As the definitions become clearer, the WisCFI data will become more and more useful as a tool to describe the effects of management forest-wide, including whether a State Forest is meeting the management goals set out in its Master Plan.

Sampling Error

The process of sampling (selecting a random subset of a population and calculating estimates from this subset) causes estimates to contain error they would not have if every member of the population (e.g., every tree in had been observed and included in the sample). The WisCFI inventory is based on a sample of 3,908 selected plots with an average sampling rate of about one plot for every 135 acres of state forest land.

Along with every estimate is an associated sampling error that is typically expressed as a percentage of the estimated value (the estimated value plus or minus the sampling error). This sampling error is the primary measure of the reliability of an estimate. We use a sampling error based on one standard error, that is, the chances are two in three that the results would have been within the limits indicated had a 100-percent inventory been conducted using these methods.

For instance, the Brule River State Forest has an estimated timberland acreage of 35,704 acres with a sampling error of 2.14%. This means that there is a 67% probability that the actual value is between 34,940 and 36,468 acres. The smaller the value being measured, the larger the sampling error. For instance the sampling error for seedling acreage is 22% and the error for seedling aspen acreage is 48%.

Sampling error must be considered when making assumptions about this data.

Stand Characteristics

Acres by forest type and stand size

One third of the timberland acreage on the Governor Knowles State Forest is in oak and scrub oak, 48% of which is in pole-sized stands and 37% of which is in sawtimber stands. About 57% of sawtimber acreage is in oak or white pine stands.

Acres of timberland by WisDNR forest type and size class

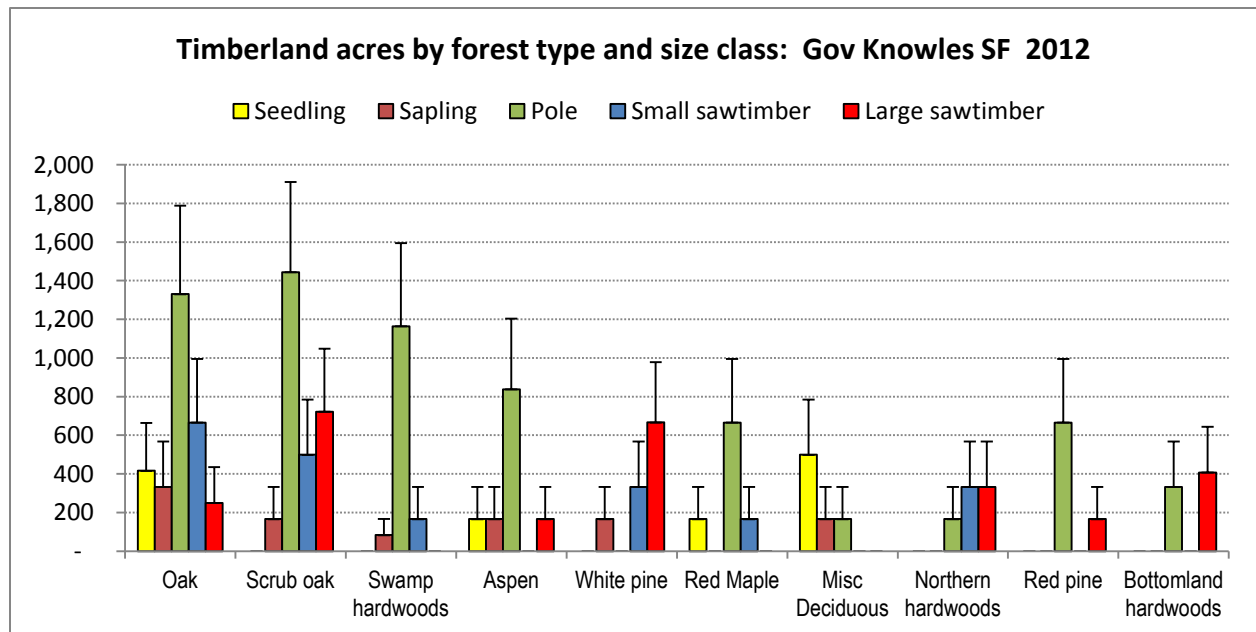
Forest type	Seedling	Sapling	Pole*	Small sawtimber*	Large sawtimber*	Total WisCFI**	Total WISFIRS
Oak	416	333	1,331	666	250	2,995	317
Scrub oak	-	166	1,444	499	722	2,832	4,647
Swamp hardwoods	-	83	1,165	166	-	1,414	3,215
Aspen	166	166	838	-	166	1,337	2,442
White pine	-	166	-	333	667	1,166	733
Red Maple	166	-	666	166	-	998	177
Misc Deciduous***	499	166	166	-	-	832	-
Northern hardwoods	-	-	166	333	333	832	907
Red pine	-	-	666	-	166	832	1,819
Bottomland hardwoods	-	-	333	-	407	740	127
Tamarack	-	333	333	-	-	666	104
Jack pine	-	-	333	166	-	499	2,437
White cedar	-	-	-	333	166	499	354
Spruce/fir	-	-	166	-	-	166	621
White birch	-	-	166	-	-	166	-
All forest types	1,248	1,414	7,773	2,662	2,877	17,556	17,900

*Pole: 5-9" softwood, 5-11" hardwoods Small sawtimber: 9-15" softwoods, 11-15" hardwoods Large sawtimber: 15+ "

**Lowland brush and unsurveyed acreage have been omitted. Some WISFIRS types have been combined under misc conifers.

*** Misc Deciduous is mostly American basswood and green ash

Figures in red have a sampling error of at least 50% and should be used with caution



Acres by forest type and stand age

Due to high sampling error, the following statements are only estimates.

Governor Knowles State Forest has the highest percentage, 27%, of acreage under 21 years of age and the lowest percent of acreage, 29%, in the middle-aged class of 41-80 yrs. It is the only forest that is skewed towards younger stands.

Acres of timberland by forest type and stand age

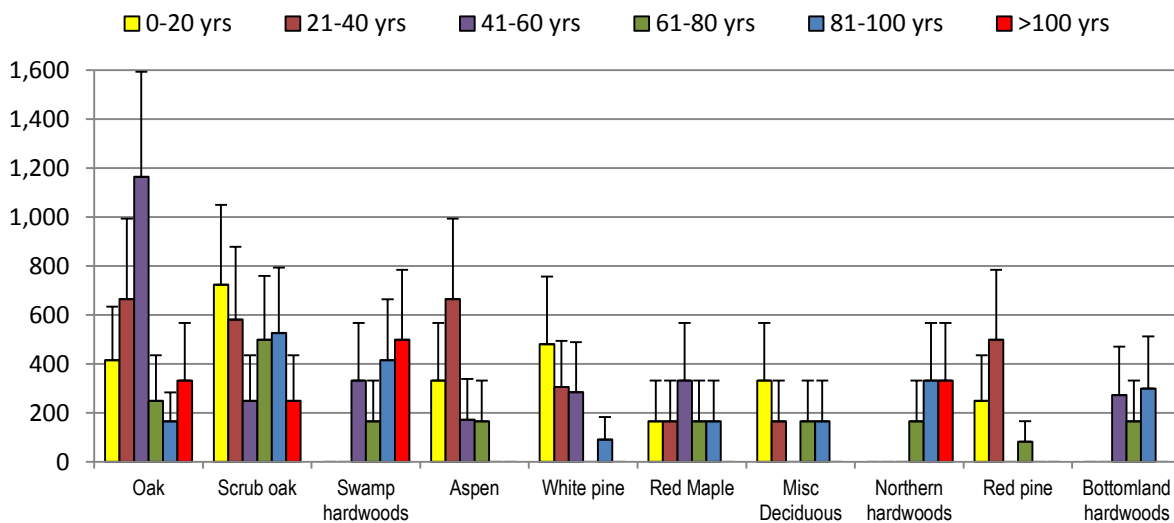
Forest type	0-20 yrs	21-40 yrs	41-60 yrs	61-80 yrs	81-100 yrs	>100 yrs	Total
Oak	416	666	1,165	250	166	333	2,995
Scrub oak	724	582	250	499	527	250	2,832
Swamp hardwoods	-	-	333	166	416	499	1,414
Aspen	333	666	173	166	-	-	1,337
White pine	481	307	286	-	92	-	1,166
Red Maple	166	166	333	166	166	-	998
Misc Deciduous	333	166	-	166	166	-	832
Northern hardwoods	-	-	-	166	333	333	832
Red pine	250	499	-	83	-	-	832
Bottomland hardwoods	-	-	273	166	300	-	740
Tamarack	166	166	166	83	83	-	666
White cedar	-	-	-	-	166	333	499
Jack pine	312	187	-	-	-	-	499
White birch	-	-	-	166	-	-	166
Balsam Fir	-	-	-	-	166	-	166
Total WisCFI*	4,653	3,406	2,978	2,080	2,692	1,747	17,556
Total WISFIRS**	4,210	2,524	1,938	2,219	3,994	2,664	17,900

*Lowland brush and unsurveyed acreage have been omitted.

**351 acres were not recorded as to age.

Numbers in red have a sampling error of at least 50% and should be used with caution.

Timberland acreage by forest type and stand age: Governor Knowles SF 2012



Acres by [site index](#) and forest type

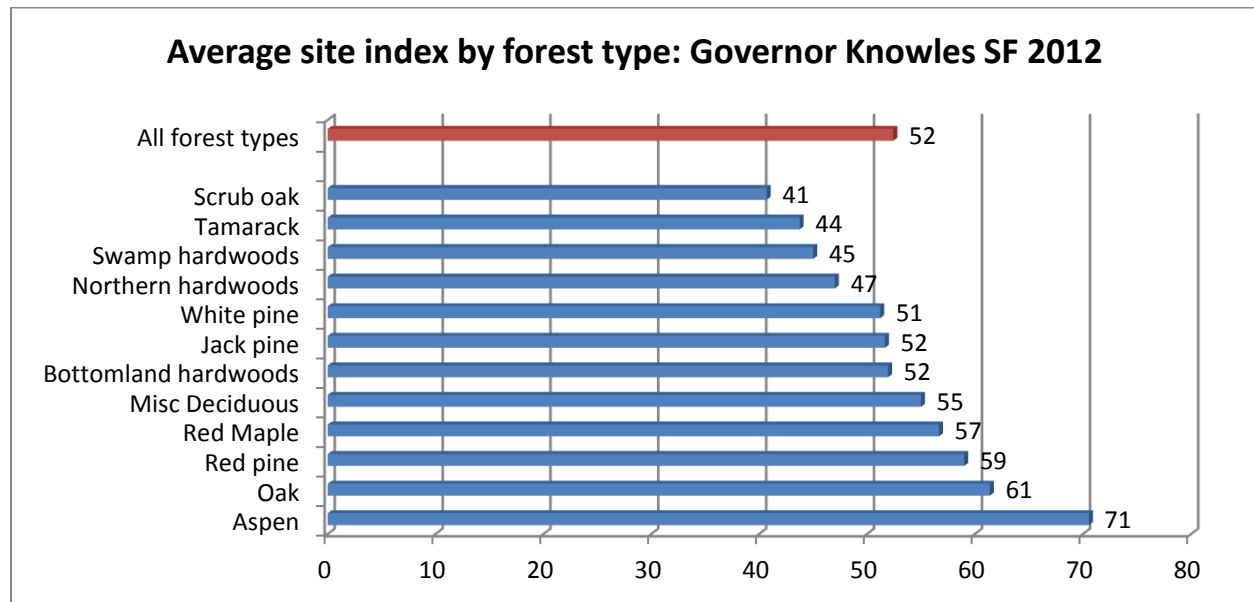
Due to high sampling error, the following statements are only estimates.

The average site index on the Governor Knowles State Forest is 52.4. The forest types with the highest average site index are aspen, oak and red pine and the types with the lowest site index are scrub oak and wetland types such as tamarack and swamp hardwoods.

Acres of timberland by forest type and site index.

Forest type*	<=30	31 - 40	41 - 50	51 - 60	61 - 70	71 - 80	>80	Average SI
Oak			83	1,414	998	499		61
Scrub oak		1,219	1,612					41
Swamp hardwoods		499	416	499				45
Aspen				89	749	166	333	71
White pine		166	591	166		242		51
Red Maple			166	499	333			57
Misc Deciduous		166	166		499			55
Northern hardwoods		250	166	416				47
Red pine			166	333	166	166		59
Bottomland hardwoods			333	300	107			52
Tamarack	83		499	83				44
White cedar		499						52
Jack pine			166	333				61
Total	83	2,967	5,141	4,441	3,352	1,240	333	52.4

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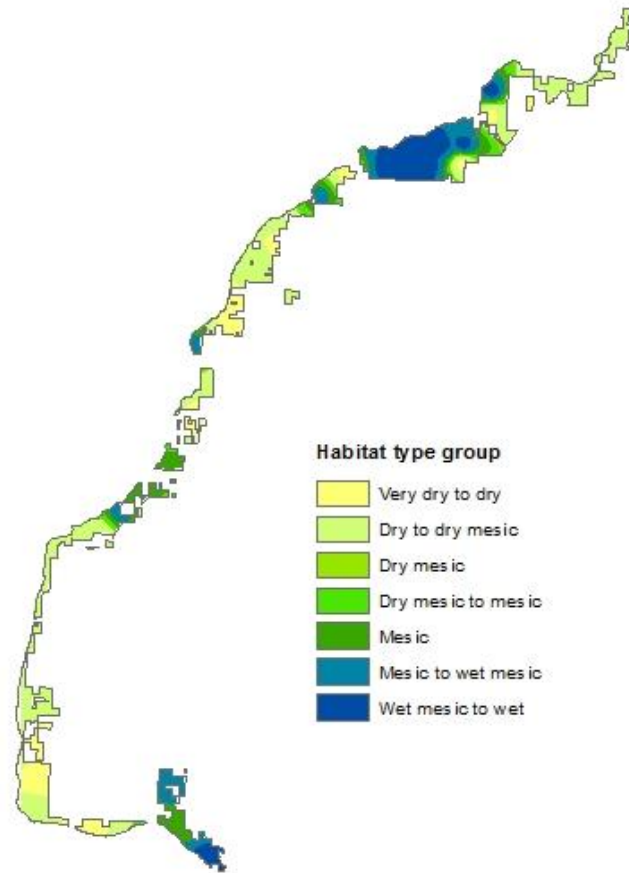


Habitat types

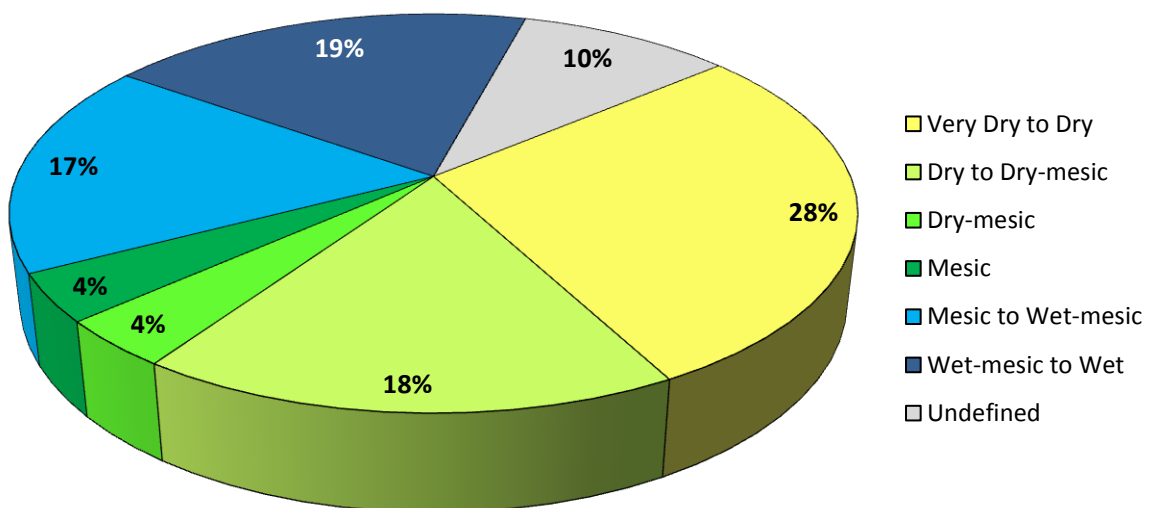
The habitat type system is a method of site classification that uses the floristic composition of a forest community (understory herbs and shrubs as well as trees) as an indicator of site capability along a moisture/nutrient gradient ranging from very dry to wet and nutrient poor to nutrient rich (Kotar et al. 1999).

Only 24% of acreage on the state forests was sampled for habitat type so percentages are reported instead of actual acres.

Almost half of all timberland on the Governor Knowles State Forest is classified as very dry to dry or dry to dry mesic and 36% is classified as mesic to wet mesic or wet-mesic to wet. These wetter types are in the northern and far southern parts of the forest.



Governor Knowles State Forest



Tree Numbers and Volume

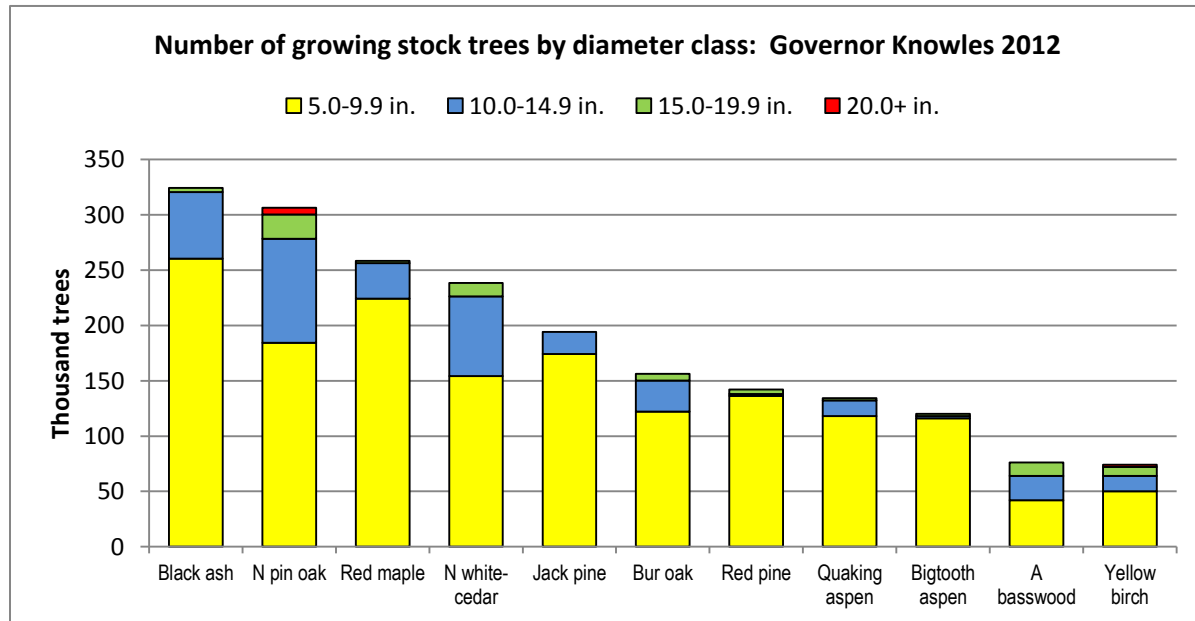
Number of trees by species and diameter

Due to high sampling error, the following statements are only estimates. Black ash, northern pin oak and red maple are the most populous species accounting for 43% of all trees. The vast majority (95%) of trees are less than 10 inches dbh. Northern pin oak, eastern white pine and northern red oak make up over half of all trees over 15 inches dbh.

Number (thousands) of trees by species and diameter class.

Species	1.0-4.9 in.	5.0-9.9 in.	10.0-14.9 in.	15.0-19.9 in.	20.0+ in.	Total	% of trees > 5 in dbh	% of all trees
red maple	1,421	190	30	2	-	1,643	16%	17%
N pin oak	1,446	108	78	20	2	1,654	16%	17%
black ash	598	244	56	4	-	903	10%	9%
jack pine	623	160	20	-	-	803	8%	8%
quaking aspen	623	116	12	2	-	753	8%	8%
bigtooth aspen	598	116	2	2	-	718	7%	8%
red pine	274	134	2	4	-	414	5%	4%
bur oak	299	90	24	6	-	419	5%	4%
N white-cedar	-	150	66	10	-	226	4%	2%
E white pine	199	10	10	8	16	243	2%	3%
green ash	199	34	6	-	-	239	2%	3%
black cherry	224	10	-	-	-	234	2%	2%
paper birch	125	44	10	-	-	179	2%	2%
yellow birch	125	30	10	2	2	169	2%	2%
sugar maple	125	36	-	-	-	161	2%	2%
tamarack	150	18	-	-	-	168	2%	2%
balsam fir	100	36	6	-	-	142	2%	1%
A basswood	25	40	20	12	-	97	1%	1%
Minor species	274	58	12	20	6	370	4%	4%
Species	8,625	1,894	415	110	30	11,074		

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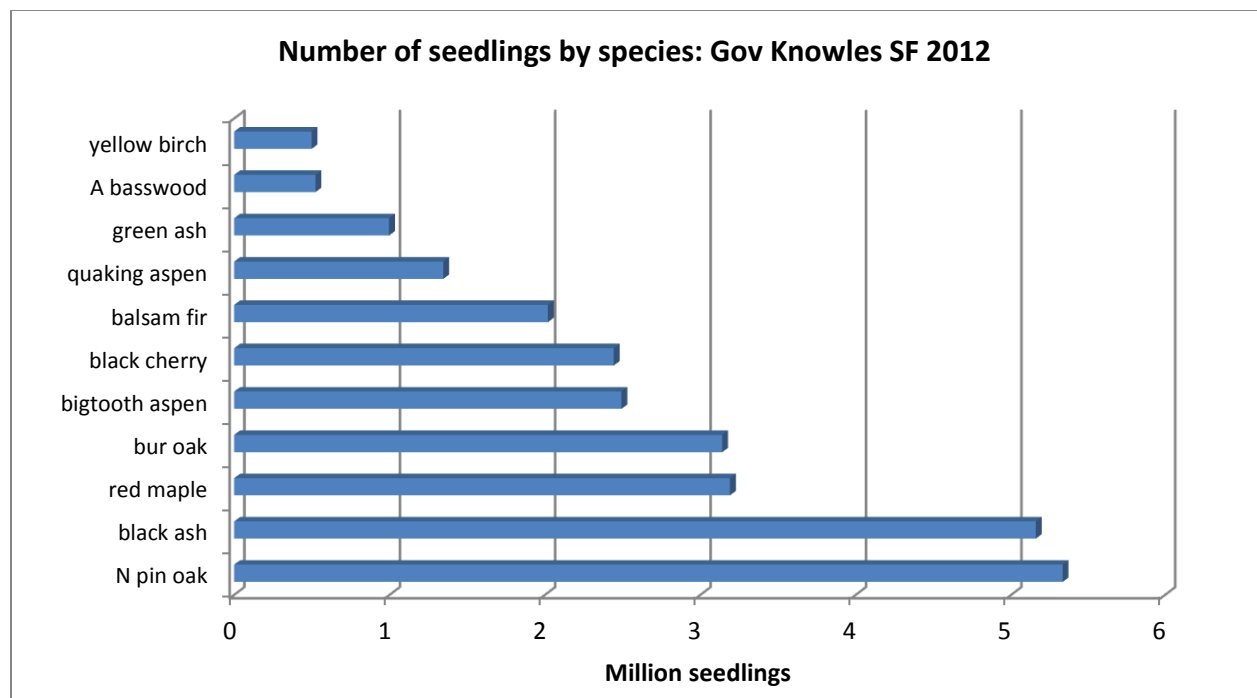


Number of seedlings by species and forest type group

Northern pin oak and black ash are the two most common seedling species. Over half of all seedlings are on two forest type groups: oak / hickory and maple / beech / birch.

Number (thousands) of live seedlings on timberland by forest type group and species

Species	Aspen / birch	Elm / ash / cottonwood	Spruce / fir	Maple / beech / birch	White / red / jack pine	Oak / hickory	Total	Percent of total
N pin oak	274	25	0	274	2,019	1,720	5,335	11%
black ash	174	1,396	50	2,443	299	623	5,160	10%
red maple	474	399	474	424	125	897	3,191	6%
bur oak	224	25	0	274	773	1,097	3,141	6%
bigtooth aspen	424	0	0	1,570	0	449	2,493	5%
black cherry	125	50	0	523	150	748	2,443	5%
balsam fir	0	25	1,994	0	0	0	2,019	4%
quaking aspen	75	0	0	150	50	648	1,346	3%
green ash	0	100	0	374	25	499	997	2%
A basswood	125	75	0	50	25	150	523	1%
yellow birch	0	199	224	75	0	0	499	1%
black spruce	0	0	474	0	0	0	474	1%
sugar maple	0	0	0	424	0	25	449	1%
A elm	0	249	0	150	0	25	449	1%
white ash	0	0	0	0	50	274	424	1%
E white pine	0	0	0	50	249	0	399	1%
Total	3,939	3,839	3,565	11,168	5,135	16,976	50,256	
% total	8%	8%	7%	22%	10%	34%		



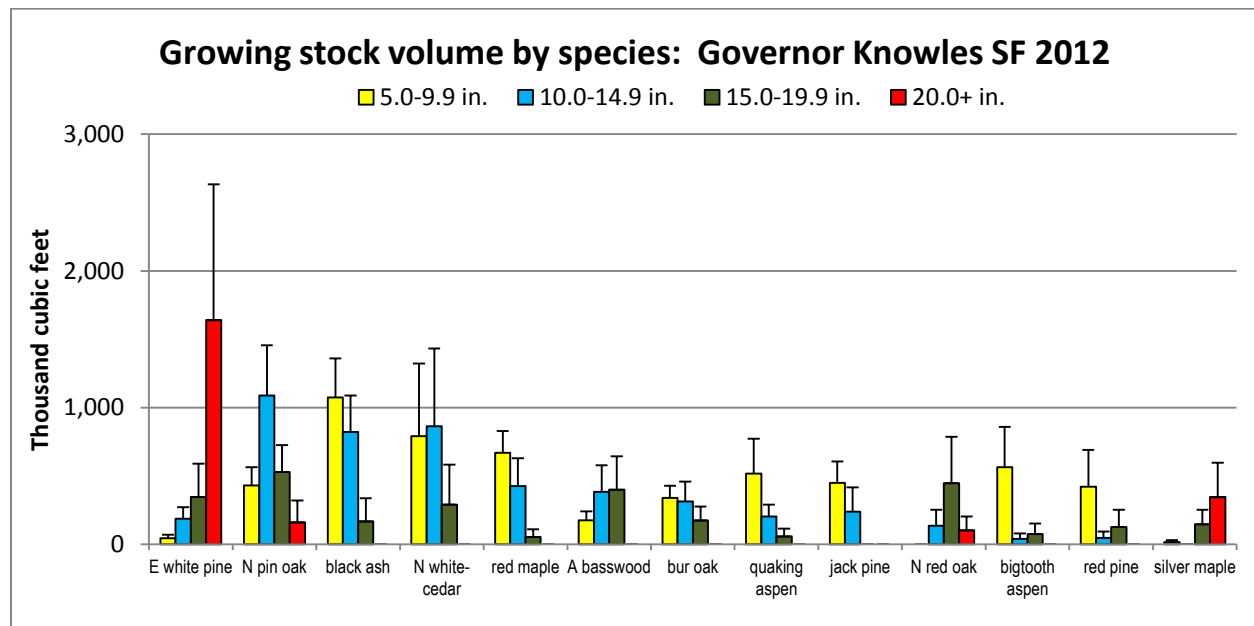
Volume of growing stock (>4.9in dbh) by species and diameter

Due to high sampling error, the following statements are only estimates. Four species account for half of all growing stock volume on the Governor Knowles State Forest: eastern white pine, northern pin oak, black ash and northern white-cedar. About 38% of all volume is in trees that are less than 10 inches. Only the Brule River State Forest has more volume in small trees. Eastern white pine accounts for 70% of volume in trees over 20 inches. Governor Knowles State Forest has the lowest growing stock volume per acre of all the state forests, 980 cft/acre compared to 1,274 cft/acre for all properties.

Volume of growing stock (thousand cubic feet) by species and diameter class.

Species	5.0-9.9 in.	10.0-14.9 in.	15.0-19.9 in.	20.0+ in.	Total Volume	% volume
E white pine	45	186	346	1,640	2,217	13%
N pin oak	430	1,089	530	161	2,209	13%
black ash	1,073	823	168		2,064	12%
N white-cedar	791	865	291		1,946	11%
red maple	669	425	55		1,148	7%
A basswood	174	384	399		957	6%
bur oak	340	313	174		827	5%
quaking aspen	516	204	58		778	5%
jack pine	450	239			689	4%
N red oak		137	447	102	686	4%
bigtooth aspen	563	39	76		678	4%
red pine	422	47	126		595	3%
silver maple	17		147	346	510	3%
yellow birch	97	189	63	142	491	3%
paper birch	181	154			335	2%
balsam fir	171	65			236	1%
white oak	12	68	154		233	1%
green ash	105	71			176	1%
sugar maple	138				138	<1%
Total	6,474	5,296	3,034	2,391	17,196	100%
% of total	38%	31%	18%	14%	100%	

Figures in red have a sampling error of over 50% and must be used with caution.



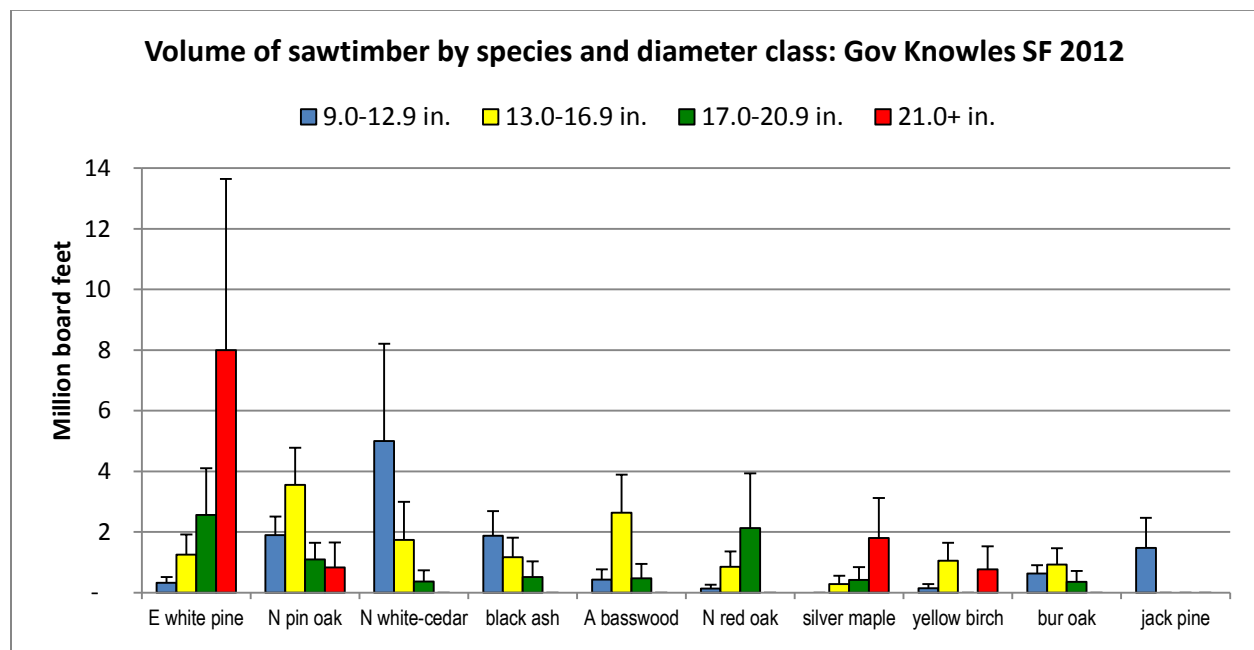
Volume of sawtimber by species and diameter class

Due to high sampling error, the following statements are only estimates. Over half of all sawtimber volume on the Governor Knowles State Forest is in eastern white pine, northern pin oak and northern white-cedar. Governor Knowles State Forest is second to the Brule River State Forest for the lowest volume of sawtimber per timberland acre of all the state forests, 2.9 MBF/acre compared to 4.2 MBF/acre for all forests.

Volume of sawtimber (thousand board feet) by species and diameter class

Species	9.0-12.9 in.	13.0-16.9 in.	17.0-20.9 in.	21.0+ in.	Total	Percent total
E white pine	322	1,249	2,559	7,995	12,125	24%
N pin oak	1,897	3,550	1,098	827	7,373	15%
N white-cedar	5,003	1,740	369		7,111	14%
black ash	1,874	1,170	513		3,557	7%
A basswood	432	2,634	471		3,538	7%
N red oak	130	854	2,131		3,115	6%
silver maple		278	423	1,806	2,507	5%
yellow birch	139	1,055		766	1,960	4%
bur oak	625	923	355		1,902	4%
jack pine	1,479				1,479	3%
red maple	1,006	421			1,427	3%
white oak	136	154	725		1,015	2%
red pine		565	383		948	2%
quaking aspen		897			897	2%
balsam fir	543				543	1%
bigtooth aspen	167		375		542	1%
Total	13,987	15,727	9,402	11,394	50,510	100%
Percent total	28%	31%	19%	23%	100%	

Figures in red have a sampling error of over 50% and must be used with caution.

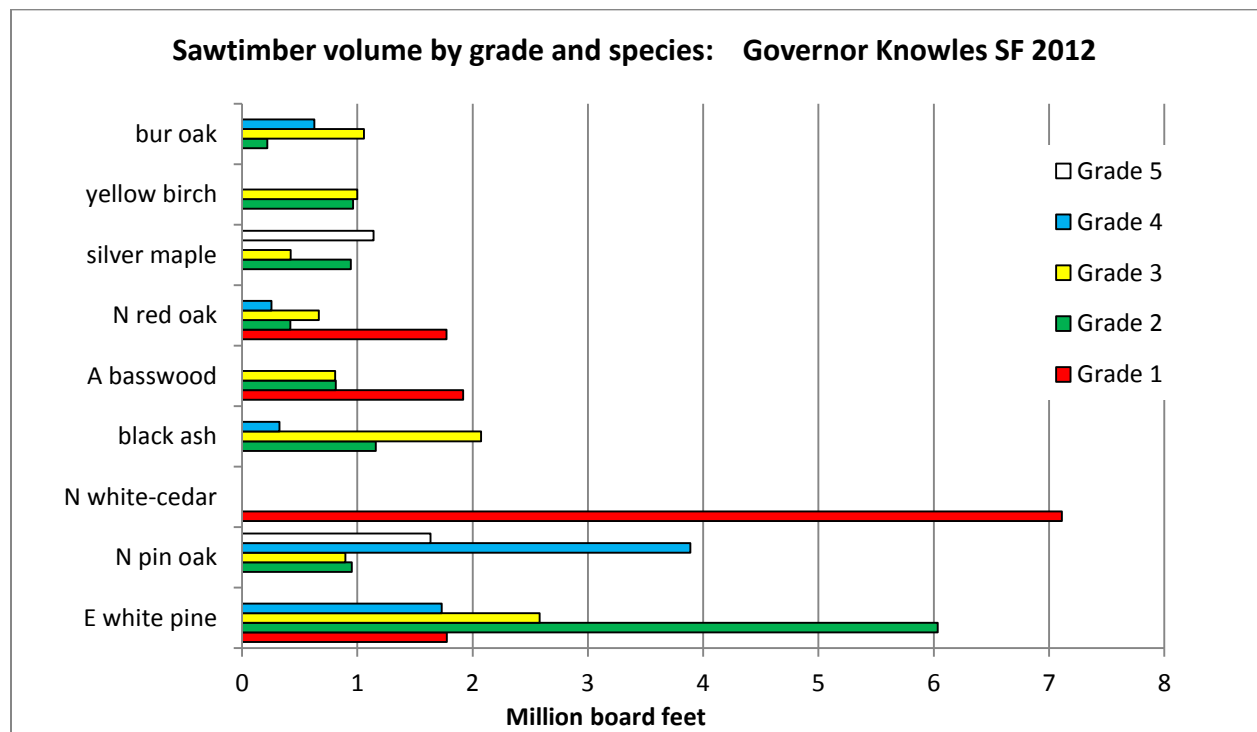


Volume of sawtimber by tree grade and species

Although about half of all sawtimber is in eastern white pine, northern pin oak and northern white-cedar only white cedar is mostly Grade 1. Northern pin oak is mostly Grade 4.

Volume of sawtimber (thousand boardfeet) on timberland by species and tree grade

Species	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5	Total	% Grade 1
E white pine	1,776	6,036	2,582	1,731		12,125	15%
N pin oak		953	896	3,889	1,635	7,373	
N white-cedar	7,111					7,111	100%
black ash		1,160	2,072	325		3,557	
A basswood	1,917	813	807			3,538	54%
N red oak	1,773	419	667	256		3,115	57%
silver maple		944	423		1,141	2,507	
yellow birch		962	998			1,960	
bur oak		220	1,056	626		1,902	
jack pine			1,479			1,479	
red maple		421	1,006			1,427	
white oak	725	154	136			1,015	71%
red pine		312	636			948	
quaking aspen		504	163	229		897	
balsam fir	543					543	100%
Total	13,846	12,897	13,935	7,057	2,776	50,510	27%
Percent total	27%	26%	28%	14%	5%		



Forest Health and Sustainability

There are several measures that serve as indicators of forest health and sustainability. These include the ratio of average annual net growth to volume, the ratio of mortality to gross growth, the number and volume of standing dead trees and the percentage of crown dieback and transparency. These measures assess very different aspects of forest health and have varying degrees of precision and statistical reliability. Since growth and mortality are based on only one year of data, sampling errors are high. For this reason and in order to normalize between site variability, ratios are presented as well as absolute values.

The ratio of growth to volume and the ratio of mortality to gross growth are measures of sustainability of species. So long as the growth rate is positive and maintained over time and so long as mortality does not surpass growth for long periods, a species should continue to play a sustainable role in the forest.

Mortality may be caused by insects, disease, adverse weather, succession, competition, fire, old age or human and animal activity and is often the result of a combination of these factors. The ratio of mortality to gross growth (growth plus mortality) indicates whether a species is declining or maintaining its current position in a particular forest. By normalizing mortality by growth rate, the ratio allows comparisons across diverse landscapes.

The number and volume of standing dead trees is much less precise as there is little indication of when trees died and some species will remain vertical for a longer period. But numbers are larger and the sampling error will be lower. Standing dead trees serve as an indicator of forest health and diversity in several ways, functioning as indicators of past mortality events, as habitat for many species and as carbon storage.

The condition of tree crowns within a stand reflects the overall health of a forest. Crown indicators can also vary by species and are often temporary. Dieback is the percentage of dead branch tips in the crown. Crown transparency is a measure of the proportion of the crown through which the sky is visible. A forest suffering from a disease epidemic or insect infestation will have obvious dieback and high transparency.

Because these measures are all approximations with a certain degree of error, taken together they can give a general accounting of forest health and sustainability.

Ratio of annual net growth to volume

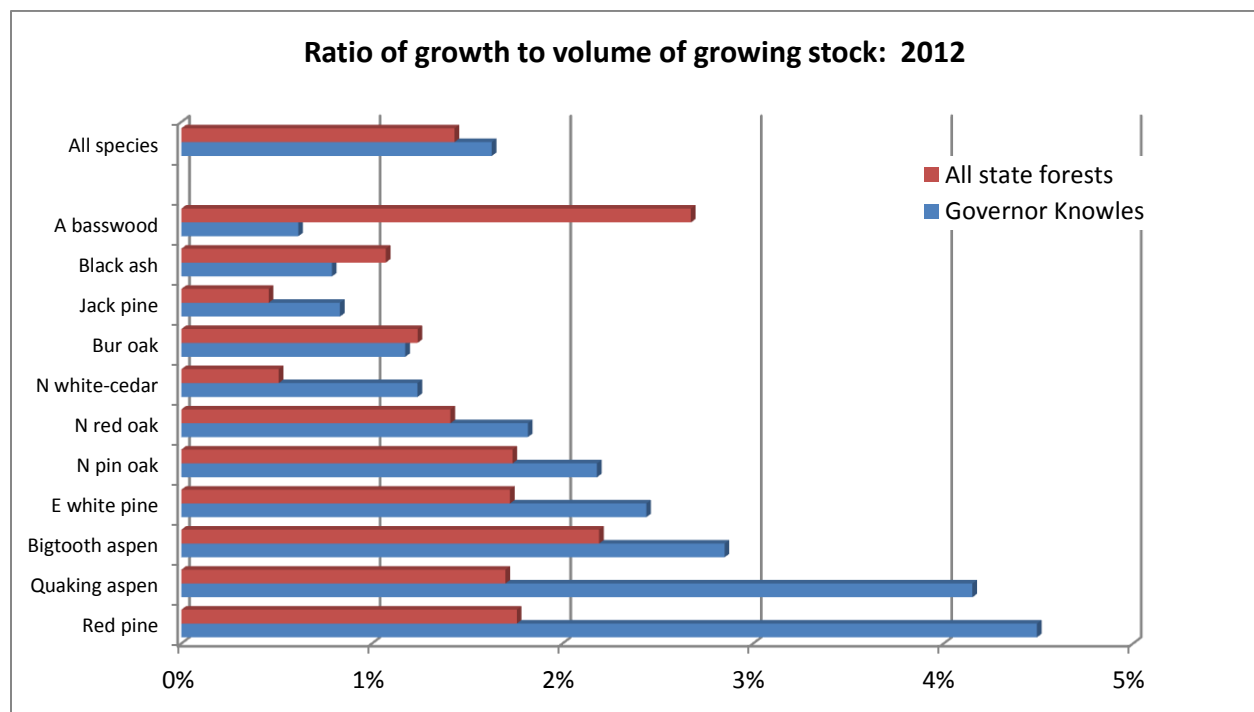
Eastern white pine and northern pin oak make up 36% of growth. Species with higher than average growth to volume ratios include red pine, quaking aspen, bigtooth aspen, eastern white pine and northern pin oak.

Species with growth to volume ratios that are lower than the average for all state forests include black ash, American basswood and red maple. The average growth rate on the Governor Knowles State Forest is about 14% higher than for all state forest properties.

Annual net growth (cft/yr) and growth/ volume ratio for the Governor Knowles State Forest and all state forests combined.

Species*	Average annual net growth	Growth / volume ratio	
		Governor Knowles State Forest	All state forests
Red pine	26,723	4.5%	1.8%
Quaking aspen	32,279	4.2%	1.7%
Bigtooth aspen	19,344	2.9%	2.2%
E white pine	54,109	2.4%	1.7%
N red oak	12,468	1.8%	1.4%
N white-cedar	24,127	1.2%	0.5%
Bur oak	9,726	1.2%	1.2%
Jack pine	5,735	0.8%	0.5%
Black ash	16,314	0.8%	1.1%
A basswood	5,878	0.6%	2.7%
Red maple	6,598	0.6%	1.0%
All species	280,175	1.6%	1.4%

*Figures in red have a sampling error of over 50% and must be used with caution.



Ratio of mortality to gross growth

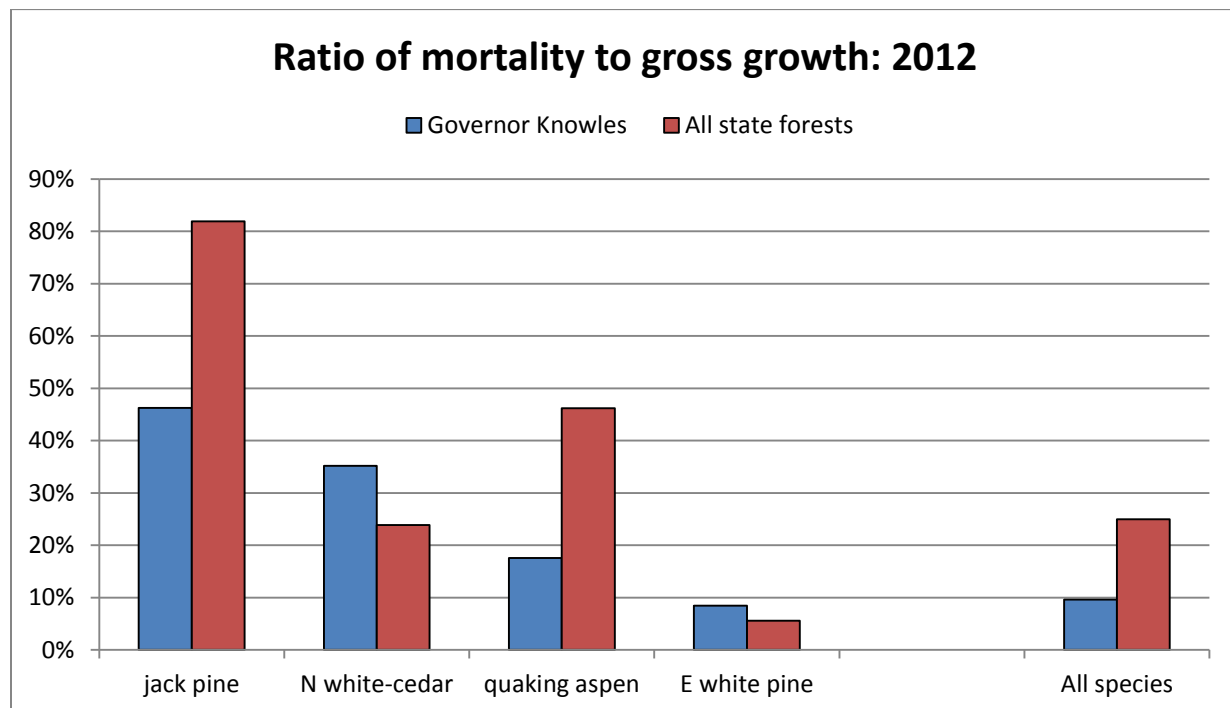
The species with the highest mortality to gross growth ratio for the Governor Knowles State Forest are jack pine and northern white-cedar. Both jack pine and quaking aspen have ratios that are much lower than the average for all state forest. The overall mortality ratio, 9.7%, is much lower on Governor Knowles State Forest compared to all properties combine, 25%.

The annual percentage of trees dying is also lower on Governor Knowles State Forest compared to all properties combined.

Mortality to gross growth ratio of growing stock and for all state forests combined.

Species	Governor Knowles State Forest				All state forests			
	Mortality of growing stock (cft/yr)	Gross growth (cft/yr)	Mortality / gross growth	Percent trees dying per year*	Mortality of growing stock (cft/yr)	Gross growth (cft/yr)	Mortality / gross growth	Percent trees dying per year*
N white-cedar	13,088	37,215	0.35	4.42%	16,931	70,945	0.24	0.27%
quaking aspen	6,893	39,172	0.18	0.55%	761,316	1,647,117	0.46	0.43%
E white pine	5,024	59,133	0.08	0.40%	105,319	1,880,658	0.06	0.07%
jack pine	4,934	10,669	0.46	0.13%	194,865	237,779	0.82	0.44%
All species	29,938	310,113	0.10	0.16%	2,767,937	11,082,704	0.25	0.20%

* Number of trees (at least 1 inch dbh) that died in one year divided by number of all trees, live and dead. Figures in red represent a sampling error of greater than 50% and should be used with caution.

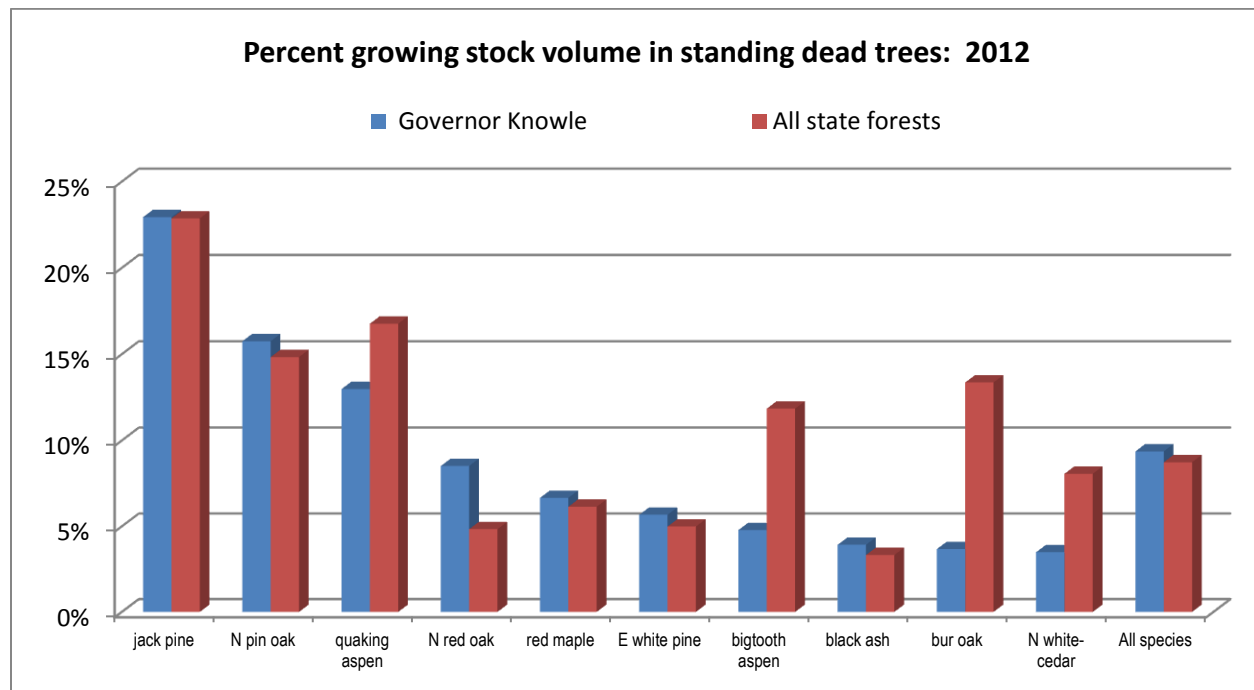


Percent standing dead trees and volume by species

The percentage of standing dead trees and volume in dead trees over 5 inches dbh is higher on the Governor Knowles State Forest than on all state forests combined. Three major species, eastern white pine, northern pin oak and black ash have a higher volume of standing dead trees on the Governor Knowles State Forest than on all state forests combined. Northern white-cedar and American basswood have a lower percentage of volume in standing dead trees compared to all properties combined.

Percent of all trees and all volume in trees >5 inches dbh that are standing dead.

Species*	Percent of trees that are standing dead		Percent of volume in standing dead trees	
	Governor Knowles SF	All state forests	Governor Knowles SF	All state forests
jack pine	5.0%	5.9%	22.9%	22.9%
N pin oak	2.7%	3.3%	15.7%	14.8%
quaking aspen	4.8%	4.8%	13.0%	16.8%
N red oak	20.0%	2.1%	8.5%	4.8%
red maple	0.9%	1.2%	6.7%	6.1%
E white pine	4.1%	1.8%	5.7%	5.0%
bigtooth aspen	3.1%	2.6%	4.8%	11.8%
black ash	1.5%	1.2%	3.9%	3.3%
bur oak	2.6%	3.0%	3.7%	13.4%
N white-cedar	5.0%	5.6%	3.5%	8.1%
red pine	0.5%	1.4%	2.3%	1.1%
A basswood	2.2%	1.1%	0.2%	2.4%
silver maple	0.0%	8.1%	0.0%	3.1%
All species	3.1%	2.8%	9.4%	8.7%



Crown dieback and transparency

The major species with the highest values for dieback on the Governor Knowles State Forest are eastern white pine, red maple, bur oak and black ash. These values are all much higher than for all forests combined for these species.

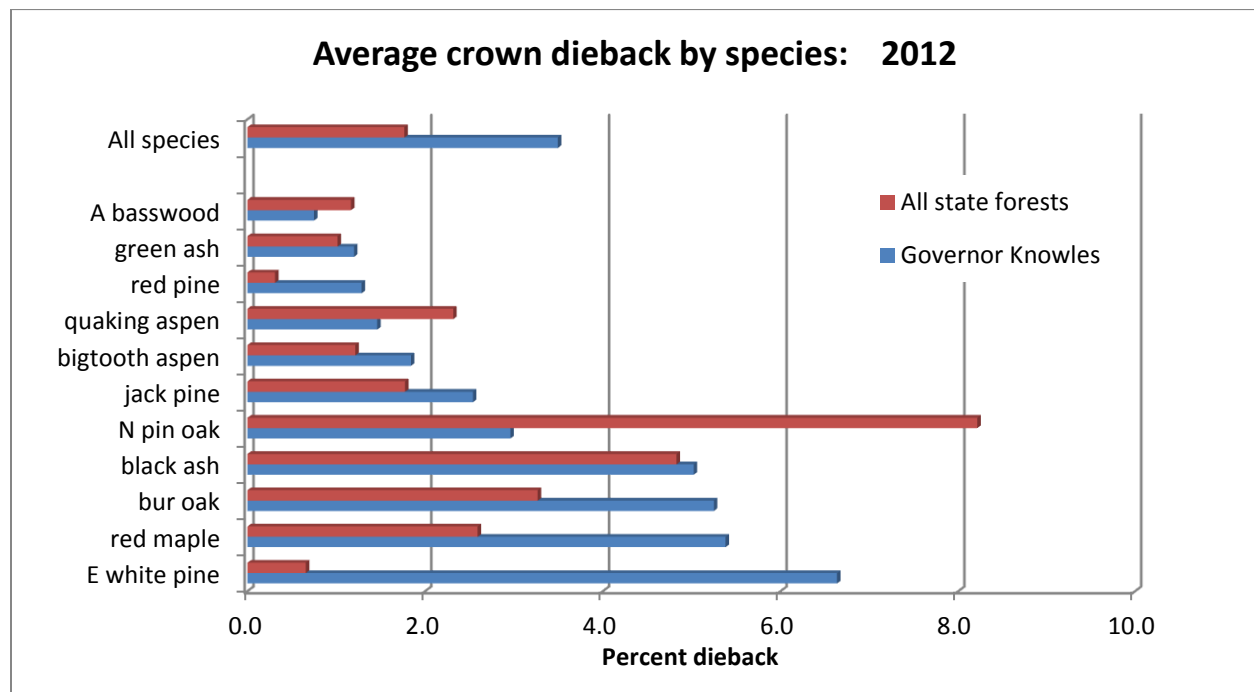
The species with the highest values for crown transparency are quaking aspen, red pine, black ash and bur oak.

In general, dieback is almost twice as high on the Governor Knowles State Forest and transparency is slightly higher than for all state forests combined.

Average crown dieback and transparency for the Governor Knowles State Forest compared to all state forests combined.

Species*	Average crown dieback		Average crown transparency	
	Governor Knowles State Forest	All state forests	Governor Knowles State Forest	All state forests
E white pine	6.6	0.7	18.6	16.5
red maple	5.4	2.6	11.2	17.0
bur oak	5.2	3.3	22.7	17.8
black ash	5.0	4.8	22.8	20.3
N pin oak	3.0	8.2	21.5	22.0
jack pine	2.5	1.8	20.8	21.4
bigtooth aspen	1.8	1.2	16.5	17.9
quaking aspen	1.5	2.3	26.4	19.3
red pine	1.3	0.3	23.8	20.1
green ash	1.2	1.0	14.4	13.6
A basswood	0.8	1.2	20.0	22.1
yellow birch	6.0	2.5	21.3	17.7
paper birch	1.5	2.9	18.0	18.8
balsam fir	0.7	0.9	11.7	13.6
sugar maple	0.7	1.7	18.0	15.8
white oak	0.7	1.9	21.7	18.3
All Species	3.5	1.8	20.9	17.1

* Red indicates species which make up less than 3% of total volume and have high sampling error.



Trends

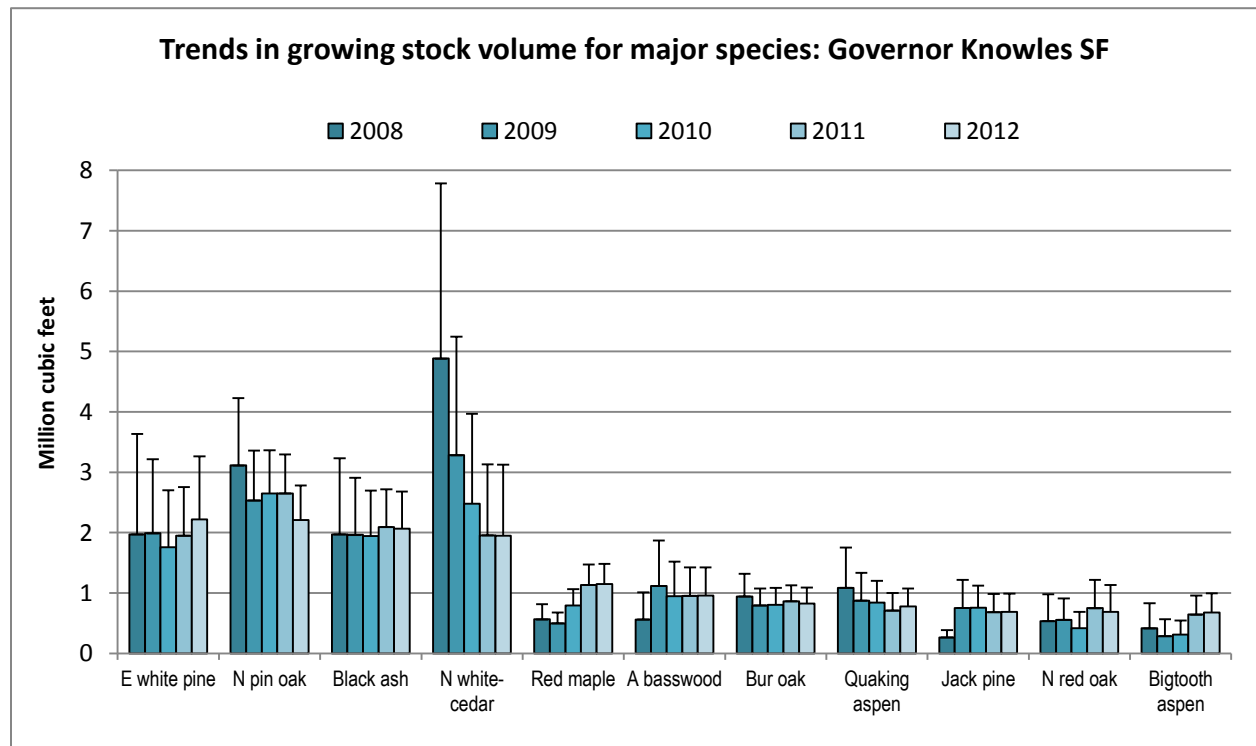
Growing stock volume

There appear to be trends in species volume which cannot be verified statistically since the data is highly auto-correlated. Future re-measurements may help to reduce this correlation.

Growing stock volume (thousand cubic feet) by major species and year

Species	2008*	2009	2010	2011	2012	Change 2008 to 2012
E white pine	1,971	1,989	1,761	1,951	2,217	13%
N pin oak	3,113	2,535	2,647	2,649	2,209	-29%
Black ash	1,971	1,963	1,942	2,092	2,064	5%
N white-cedar	4,884	3,283	2,479	1,955	1,946	-60%
Red maple	563	496	794	1,134	1,148	104%
A basswood	559	1,120	946	954	957	71%
Bur oak	945	794	804	861	827	-12%
Quaking aspen	1,084	872	840	711	778	-28%
Jack pine	265	753	755	681	689	160%
N red oak	534	554	418	749	686	28%
Bigtooth aspen	415	286	313	643	678	64%
All species	17,981	17,333	16,736	17,290	17,196	-4%

* Each year contains previous years' data, i.e. 2010 includes 2008, 2009 and 2010 data.



Definition of Terms

Average net annual growth of growing stock --The annual change in cubic foot volume of sound wood in live sawtimber and poletimber trees, and the total volume of trees entering these classes through ingrowth, less volume losses resulting from natural causes. Average net annual growing stock is the average for the years between inventories.

Forest type-WisCFI. - A tract of forest land characterized by the predominance of one or more key species which make up 50 percent or more of the basal area of saw-timber and pole-timber stands, or of the number of trees in seedling and sapling stands. Forest land less than 10 percent stocked with commercial tree species is classified as upland brush, grass or lowland brush.

Aspen--Aspen comprises 50% or more of the basal area in saw-timber and pole-timber stands, or 50% or more of the stems in sapling and seedling stands.

Bottomland hardwoods --Any combination of silver maple, green ash, swamp white oak, American elm, river birch, and cottonwood comprises 50% or more of the basal area in saw-timber and pole-timber stands, or 50% or more of the stems in sapling and seedling stands. Hardwood dominated forests occurring on floodplains and some terraces.

White birch --White Birch comprises 50% or more of the basal area in saw-timber and pole-timber stands, or 50% or more of the stems in sapling and seedling stands.

White cedar --White cedar comprises 50% or more of the basal area in saw-timber and pole-timber stands, or 50% or more of the stems in sapling and seedling stands. In mixed swamp conifer stands, white cedar is predominant.

Central hardwoods --Any combination of oaks, hickories, elms, black cherry, hackberry, red maple, white ash, green ash, basswood, and sugar maple, which does not satisfy the defining criteria for NH, MR, or O cover types. The CH type occurs only on uplands within and south of the Tension Zone (southern Wisconsin).

Balsam Fir --Balsam fir comprises 50% or more of the basal area in saw-timber and pole-timber stands, or 50% or more of the stems in sapling and seedling stands. In mixed swamp conifer stands, balsam fir is predominant.

Hemlock --Hemlock comprises 50% or more of the basal area in saw-timber and pole-timber stands, or 50% or more of the stems in sapling and seedling stands.

Miscellaneous Conifers --Conifer forests dominated by uncommon or exotic species; e.g. Eastern red cedar, Scotch pine, Norway spruce, European Larch.

Miscellaneous Deciduous --Hardwood forests dominated by uncommon or exotic species; e.g. box elder, honey locust, black locust, Norway maple.

Red Maple --Red Maple comprises 50% or more of the basal area in saw-timber and pole-timber stands, or 50% or more of the stems in sapling and seedling stands. If soil is poorly drained, then swamp hardwood.

Northern hardwoods --Any combination of sugar maple, beech, basswood, white ash, and yellow birch comprises 50% or more of the basal area in saw-timber and pole-timber stands, or 50% or more of the stems in sapling and seedling stands.

Oak --Oak comprises 50% or more of the basal area in saw-timber and pole-timber stands, or 50% or more of the stems in saplings and seedling stands.

Scrub oak --More than 50% of the basal area in saw-timber and pole-timber stands, or 50% or more of the stems in sapling and seedling stands is comprised of oak with site indices ≤ 50 . Typical forest products include only fuelwood and fiber.

Red pine --Red pine comprises 50% or more of the basal area in saw-timber and pole-timber stands, or 50% or more of the stems in sapling and seedling stands. In mixed pine stands, red pine is predominant.

White pine --White pine comprises 50% or more of the basal area in saw-timber and pole-timber stands, or 50% or more of the stems in sapling and seedling stands. In mixed pine stands, eastern white pine is predominant.

Jack pine --Jack pine comprises 50% or more of the basal area in saw-timber and pole-timber stands, or 50% or more of the stems in sapling and seedling stands. In mixed pine stands, jack pine is predominant.

Black spruce --Black spruce comprises 50% or more of the basal area in saw-timber and pole-timber stands, or 50% or more of the stems in sapling and seedling stands. In mixed swamp conifer stands, black spruce is predominant.

Swamp hardwoods --Any combination of black ash, green ash, red maple, silver maple, swamp white oak, and American elm that comprises 50% or more of the basal area in saw-timber and pole-timber stands, or 50% or more of the stems in sapling and seedling stands. This type occurs on wetlands characterized by periodic inundation (fluctuating water table near or above the soil surface) and nearly permanent subsurface water flow.

White Spruce --White spruce comprises 50% or more of the basal area in saw-timber and pole-timber stands, or 50% or more of the stems in sapling and seedling stands.

Tamarack --Tamarack comprises 50% or more of the basal area in saw-timber and pole-timber stands, or 50% or more of the stems in sapling and seedling stands. In mixed swamp conifer stands, tamarack is predominant.

Black Walnut --Black walnut comprises 50% or more of the basal area in saw-timber and pole-timber stands, or 50% or more of the stems in sapling and seedling stands.

Growing-stock tree.--A live timberland tree of commercial species that meets specified standards of size, quality, and merchantability. (Note: Excludes rough, rotten, and dead trees.)

Growing-stock volume.--Net volume in cubic feet of growing-stock trees 5.0 inches d.b.h. and over, from 1 foot above the ground to a minimum 4.0- inch top diameter outside bark of the central stem or to the point where the central stem breaks into limbs.

Habitat types and habitat type groups – An aggregation of units of land capable of producing similar plant communities at climax and having similar potential productivity. Habitat type groups are groupings of habitat types with similar soil moisture and nutrient regimes and potential productivity.

Sawtimber tree.--A live tree of commercial species containing at least a 12-foot saw log or two noncontiguous saw logs 8 feet or longer, and meeting regional specifications for freedom from defect. Softwoods must be at least 9.0 inches d. b. h. Hardwoods must be at least 11.0 inches d.b.h.

Sawtimber volume.--Net volume of the saw-log portion of live sawtimber in board feet, International 1/4-inch rule (unless specified otherwise), from stump to a minimum 7.0 inches top d. o. b, for softwoods and a minimum 9.0 inches top d. o. b, for hardwoods.

Site index.--An expression of forest site quality based on the height of a free-growing dominant or codominant tree of a representative species in the forest type at age 50.

Stand-size class.--A classification of stocked (see Stocking) forest land based on the size class of live trees on the area; that is, sawtimber, poletimber, or seedlings and saplings.

Nonstocked - Meeting the definition of accessible forest land, and one of the following applies: (a) less than 10 percent stocked by trees of any size, and not classified as cover trees (see code 6), or (b) for several woodland species where stocking standards are not available, less than 5 percent **crown cover** of trees of any size.

Large saw-timber stands (15+") - Saw-timber stands typed as large saw-timber within the primary cover type based on the basal area size class distribution of saw timber trees 15.0 inches d.b.h. and larger.

Small saw-timber stands (Softwoods 9-14.9", Hardwoods 11-14.9") - Saw-timber stands typed as small saw-timber within the primary cover type based on the basal area size class distribution of saw-timber trees less than 15.0 inches d.b.h.

Pole-timber stands (Softwoods 5-8.9", Hardwoods 5-10.9") - Stands typed as pole-timber within the primary cover type having a minimum net basal area of 10 sq. ft./acre.

Sapling stands (1-4.9") - Forest stands typed as saplings within the primary cover type having a minimum of 200 seedlings per acre.

Seedling stands (<1") - Forest stands typed as seedlings within the primary cover type having a minimum of 200 seedlings per acre.

Stand-age class.--A classification based on age of the main stand. Main stand refers to trees of the dominant forest type and stand-size class.

Timberland.--Forest land that is producing, or is capable of producing, more than 20 cubic feet per acre per year of industrial wood crops under natural conditions, that is not withdrawn from timber utilization, and that is not associated with urban or rural development. Currently inaccessible and inoperable areas are included. (Timberland was formerly called commercial forest land.)

Tree grade.--A classification of the lower 16 feet of the bole of standing trees based on external characteristics as indicators of the quality and quantity of lumber that could be produced from the tree. Tree grade was assigned to a sample of hardwood sawtimber trees during the 1996 inventory. See Wisconsin Dept of Natural Resources Division of Forestry. October 2011. Wisconsin State Forest Continuous Forest Inventory Volume I: Field Data Collection Procedures for Phase 2 Plots- Version 3.0, <http://dnr.wi.gov/topic/ForestPlanning/documents/WisCFlvolumelversion3.pdf>, pp 219-229.

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For more information on the WisCFI database including background, reports, tables and access to the data, please go to the WIDNR Wisconsin's Continuous Forest Inventory website at: <http://dnr.wi.gov/topic/ForestPlanning/forestInventory.html>