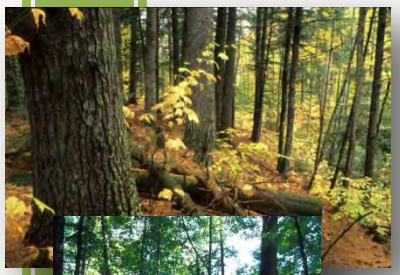
Old Growth Characteristics in Wisconsin's Forests



Old growth forests are natural stands that have developed over a period of time, generally at least 120 years, without experiencing a stand-replacing disturbance. Typical traits of old growth in Wisconsin include:

- Advanced stand age
- Diversity of tree sizes from saplings to large sawtimber
- Presence of very old and large trees
- Presence of large, standing dead trees
- Increased amounts of dead stumps and coarse woody debris
- Pit and mound topography and presence of canopy gaps

Several of these characteristics are measured in the Forest Inventory and Analysis database and can be used to identify forests with old growth characteristics. In this report, we present one methodology for estimating old growth acreage across several inventories.

- Advanced stand age
- Diversity of tree sizes from sapling to large sawtimber
- Presence of very old and large trees
- Presence of large standing dead trees
- Increased amounts of dead stumps and coarse woody debris
- An estimation of "old growth" acres in Wisconsin
- "Old growth" compared to "old stands"

Division of Forestry
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Advanced Stand Age

Wisconsin's forests are aging as almost half of all timberland is over 60 years of age (Figure 1). The amount of very old forest (over 120 years) is far less than what it was in 1983, but has increased 60% in the last decade.

In 1983, over 4% of timberland was at least 120 years of age, and 80% of this was in the oak / hickory or maple / beech / birch forest types (Figure 2). Thirty years later, in 2013, only 1.2% of timberland is this old and less than 50% is in either oak / hickory or maple / beech / birch type.

Forest Inventory and Analysis (FIA) approximates stand age by weighting the cored age of several canopy trees of differing sizes by the proportion of that size class in the canopy. This procedure may underestimate the age of very old stands that have trees in many size classes.

In this analysis, we will see that many stands with old growth characteristics do not have an advanced stand age in the FIA inventory and many stands with advanced ages do not have typical features of old growth.

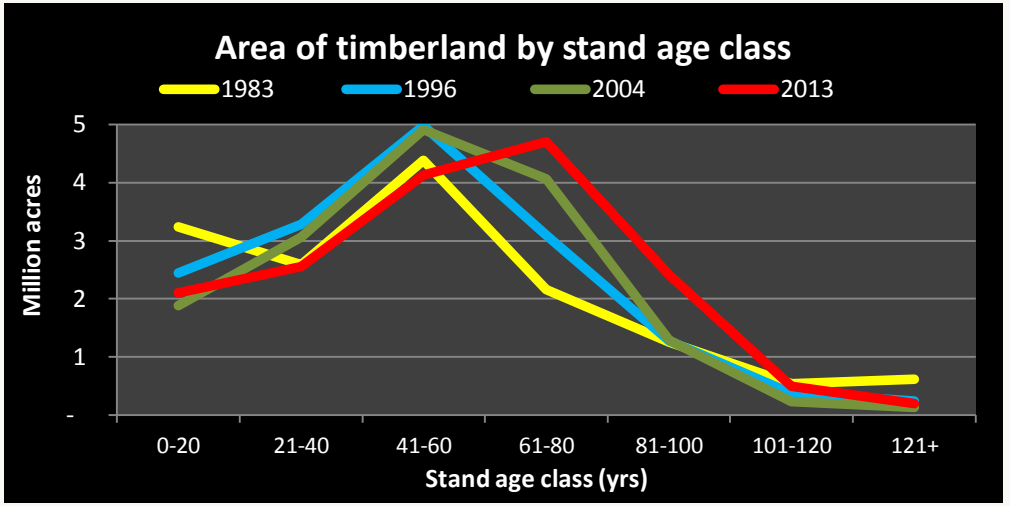

Figure 1. Area of timberland by stand age class (Forest Inventory and Analysis).

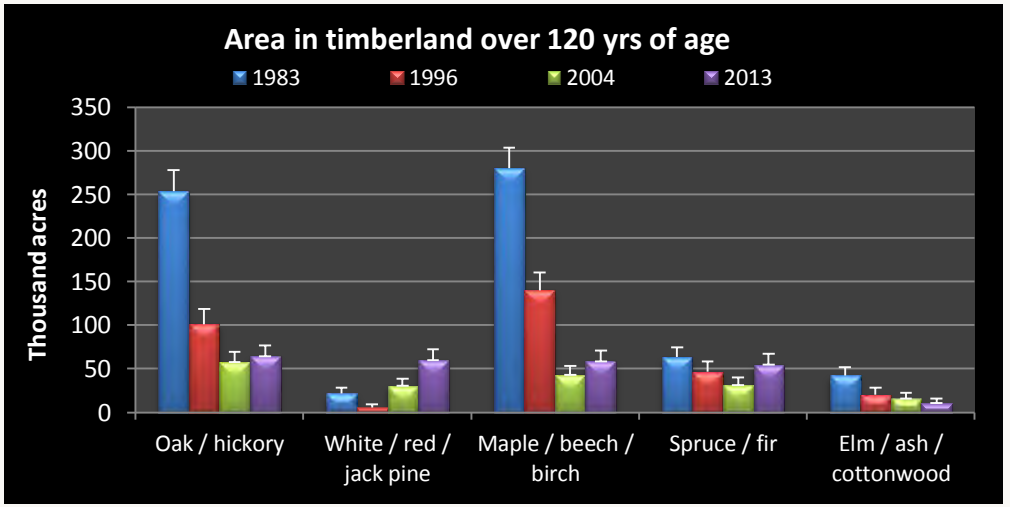

Figure 2. Acreage of timberland over 120 years old by forest type group (forest Inventory and Analysis).

Diversity of tree sizes from sapling to large sawtimber

As a forest ages, large trees die and fall over. They open canopy gaps for saplings and poles to fill in and the stand becomes a mix of trees of various sizes and ages creating a layered canopy.

In the FIA database, tree ages are not measured but tree diameters are and in general correlate well with tree age. One measure of the evenness of distribution of tree diameters is the Shannon's index of diversity*. The index increases when the number of trees in each diameter class up to 21+ inches is more evenly distributed. As stands age, the distribution becomes flatter and the value of the diversity index increases (Figure 3).

As mentioned, the diversity index increases with age (Figure 4). Between 1996 and 2013, however, the average value of the index decreased in all age classes.

The forest types with the highest average diversity index are maple/beech/birch, oak/hickory and white /red/jack pine. These types have higher numbers of large diameter trees in old stands.

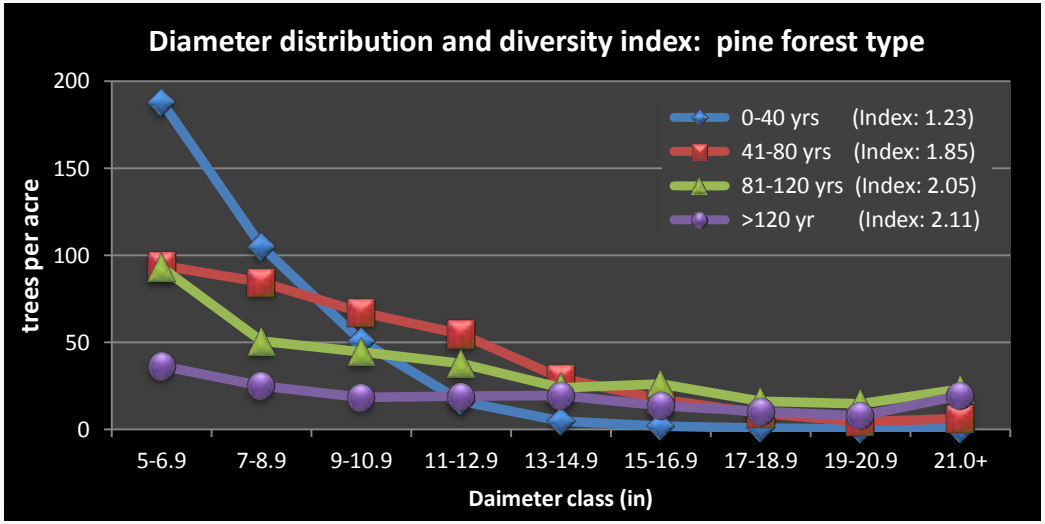

Figure 3. The relationship between diameter distribution and diversity index (Forest Inventory and Analysis, 2013).

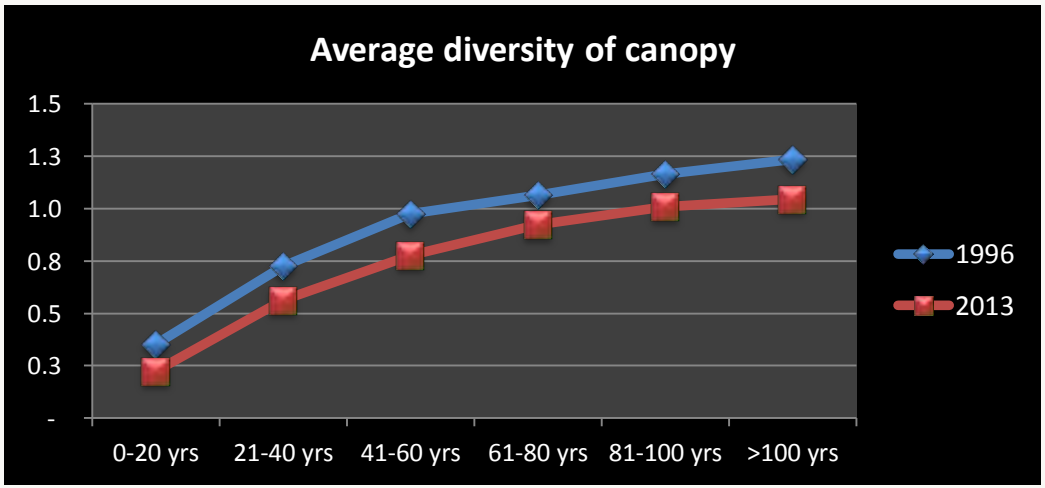

Figure 4. Average value of Shannon's index of diversity by stand age, 1996 and 2013 (Forest Inventory and Analysis).

*For an explanation see: http://en.wikipedia.org/wiki/Diversity_index

Presence of very old and large trees

Large and very old trees not only provide structural diversity and a layered canopy but also genetic diversity. Trees that have survived challenges from abiotic forces, disease and insects over decades may harbor important genes for survival.

The number of large sawtimber trees has increased steadily since 1996, 50% for trees 17 to 20.9 inches in diameter and 23% for trees 21 inches and greater (Figure 5).

The density of trees (trees per acre) over 21 inches in diameter increases significantly with stand age (Figure 6).

The density of these large trees in stands younger than 80 years is very low. Over 50% of all large trees are in younger stands (<80 yrs) but at a very low density. The density of large trees is 8 times higher in stands over 120 years of age compared to forests younger than 80 years old.

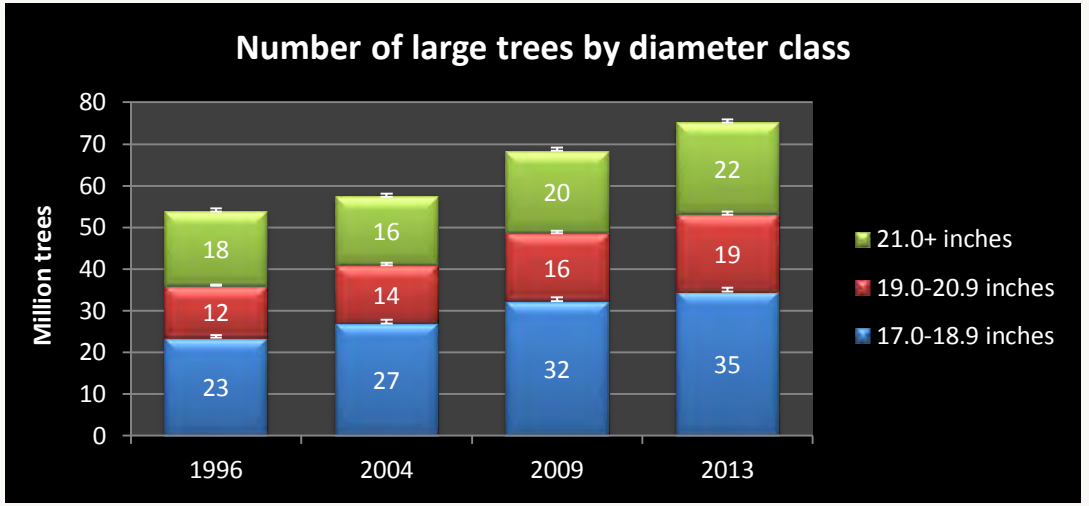

Figure 5. Trends in the number of trees greater than 17 inches (Forest Inventory and Analysis).

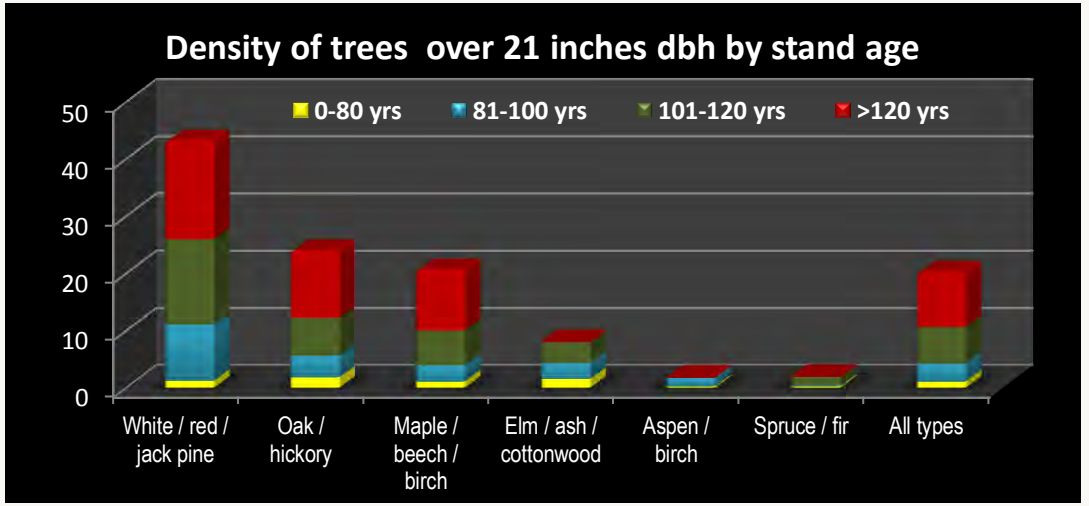

Figure 6. The density of large trees (over 21 inches dbh) by forest type group (Forest Inventory and Analysis).

Presence of large standing dead trees

Large standing dead trees or snags provide vital nesting, foraging and denning sites for many species of forest birds and mammals.

The density of large standing dead trees (over 17 inches dbh) increases dramatically after a stand age of 100 years (Figure 7). Snag density decreased between 1996 and 2013 for stands less than 120 years of age.

The highest density of large standing dead trees occurs on the white / red / jack pine types which also has the highest density of large living trees.

The major species of large snags in the database were red oaks and eastern white pine.

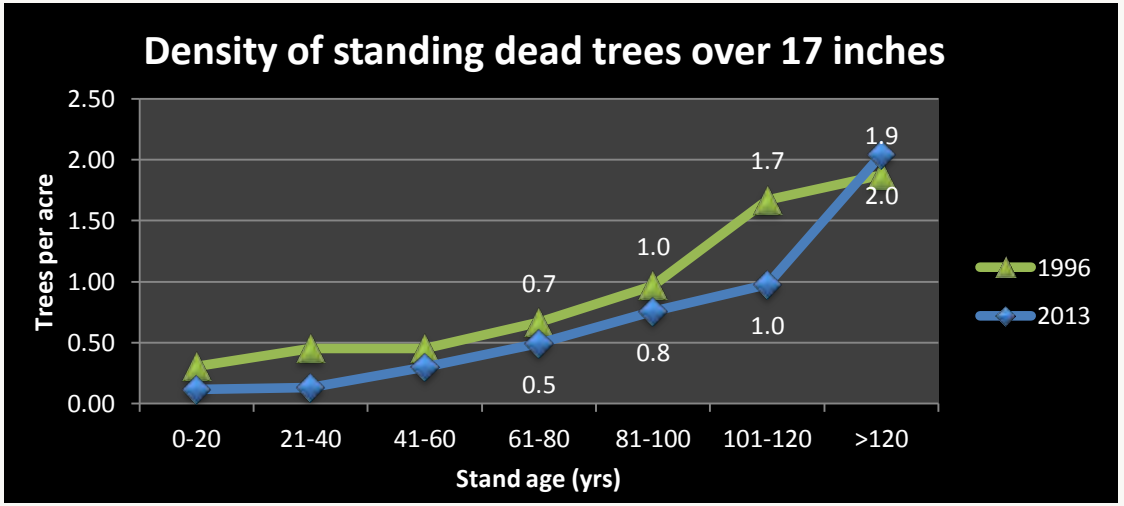

Figure 7. The density of large standing dead trees (Forest Inventory and Analysis, 2013).

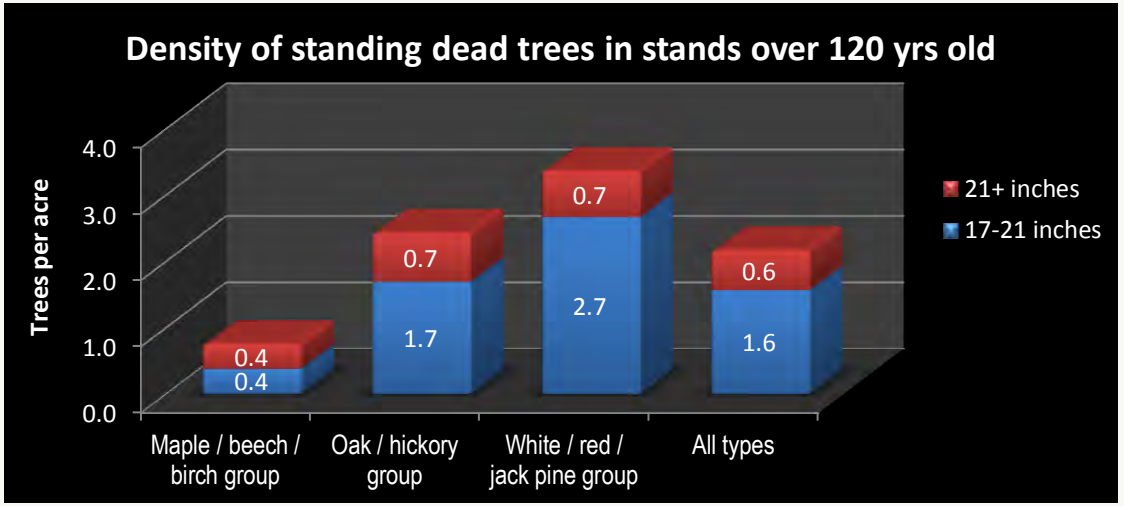

Figure 8. The density of large standing dead trees in stands over 120 yrs old by forest type group (Forest Inventory and Analysis, 2013).

Increased amounts of dead stumps and coarse woody debris

Without intervention as stands become older they accumulate greater amounts of carbon in non-living material such as coarse woody debris (CWD), standing dead trees, stumps and litter. These components are a major contributor to old growth ecosystems not only serving as a reservoir of stored carbon but also supporting a diversity of species.

Carbon in dead material accumulates steadily with age and then levels off after about stand age 140 due to a decrease in litter density in older stands (Figure 9). Carbon, however, continues to accumulate in stumps, coarse woody debris and standing dead trees past 180 years (sampling error is extremely high as there are only five stands in the database older than 180 years).

The forest type group which has the greatest density of carbon is spruce / fir due to the large amount of litter (Figure 10). The white / red / jack pine type has the highest density of carbon in coarse woody debris and stumps.

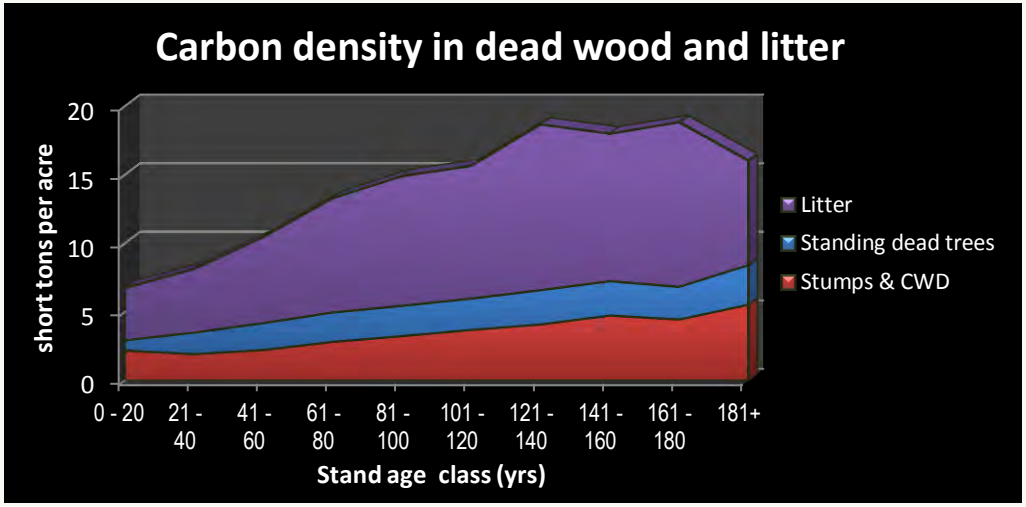

Figure 9. The density of carbon in coarse woody debris, stumps and litter (Forest Inventory and Analysis, 2013).

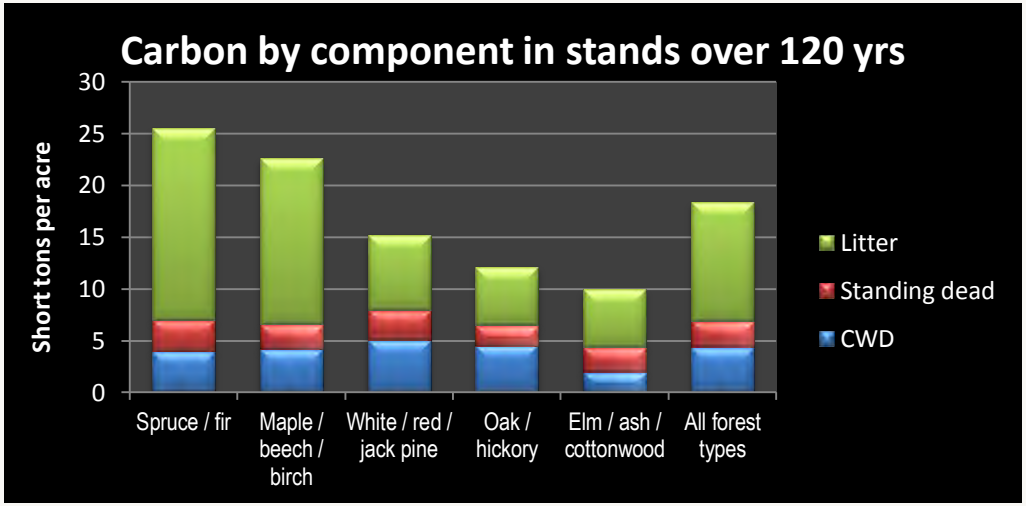

Figure 10. The density of carbon by forest type in stands over 120 years of age (Forest Inventory and Analysis, 2013).

An estimation of "old growth" acres in Wisconsin

In order to define old growth forests, stand age alone is not very helpful since many very old stands have been harvested or disturbed multiple times. For this reason "old growth" status is not solely a function of stand age. A given stand must meet several criteria such as the presence of many large trees (at least 21 inches dbh) plus a few very large trees (at least 30 inches dbh), the presence of large standing dead trees (at least 17 inches dbh), a diversity of canopy tree sizes ranging from sapling to large sawtimber (high diversity index) and a large amount of coarse woody debris.

In order to approximate the acreage of forest having these old growth characteristics, in this analysis we used the average value from the FIA database for all stands over 120 years of age as a minimum criterion for these five features. By summing the acreage of stands which met four of the five criteria, we were able to estimate the acreage in old growth as follows: 60,330 acres in 1996, 60,811 in 2004 and 77,205 acres in 2013 (Figure 11). Interestingly, 40% of old growth acreage is located in southern Wisconsin. Whereas only 2% of all forest in the state is on Native American land, 15% of old growth acreage is in Menominee County, presumably on reservation land.

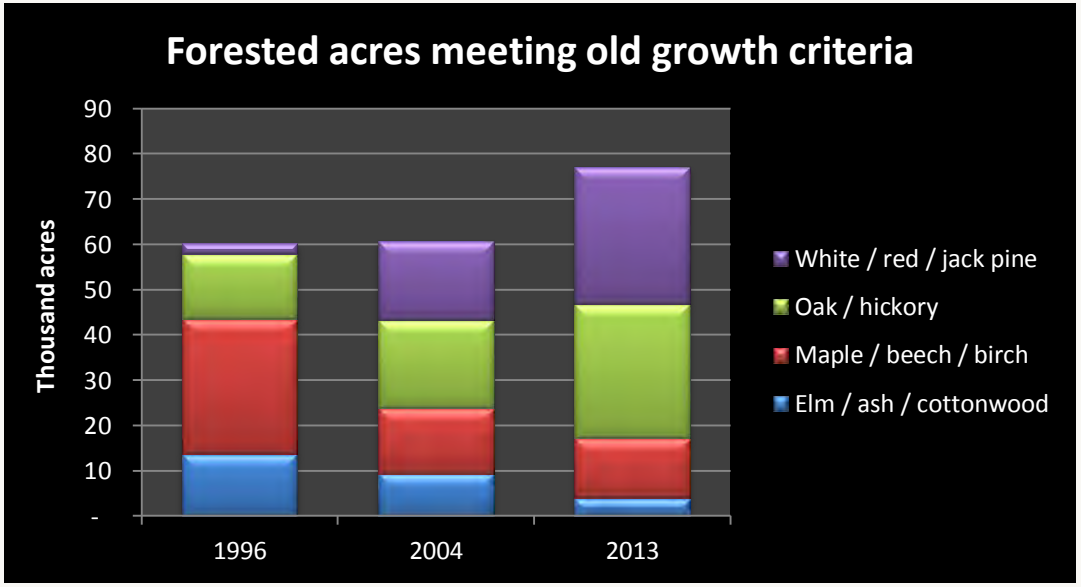

Figure 11. An estimation of forested acreage meeting old growth criteria.

This is only an estimate based on undocumented criteria but the estimate for 1996, 60,330 acres, is very close to the approximation of 57,000 acres by Frelich and Reich (1996*). Based on this analysis, old growth forests, as opposed to old forests may actually have increased since 1996. One of the reasons is the large increase in trees over 17 inches (Figure 5).

* Frelich, Lee and Reich, Peter. 1996. Eastern Old Growth Forests: Prospects for Rediscovery and Recovery. Island Press. Chapter 11 pg 24.

Old growth compared to old stands

The charts on this page (Figure 12) show the difference between old stands (at least 120 years old in the FIA inventory) and "old growth" as estimated in this analysis. The number of large trees is 2 ½ times higher on old growth. The number of very large trees is over five times higher and the number of large snags is almost three times higher on old growth stands compared to stands which are over 120 years old. Many of these old growth stands are not listed as having an advanced stand age in the FIA inventory: almost 50% of "old growth" stands have a designated stand age of less than 100 years.

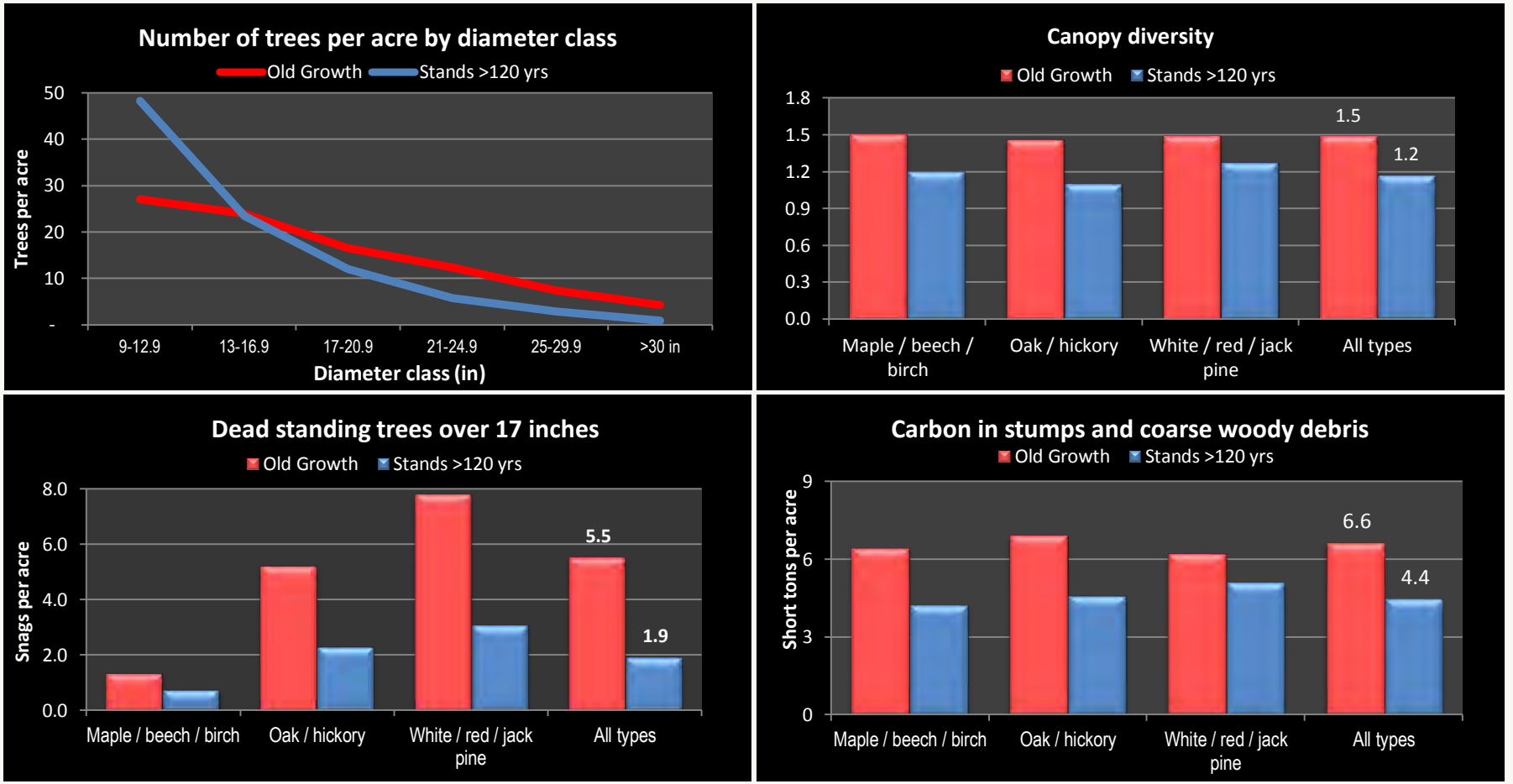

Figure 12. Diameter distribution (top left), canopy diversity (top right), density of standing dead trees (bottom left) and carbon density in CWD (bottom right) on estimated old growth vs. stands which are over 120 years of age in the FIA database.