DRAFT Maine 2018 - Forest Ecosystem Services

Carbon, Growing Stock & Sawtimber Attributes, Timber Products, and Northern White-Cedar

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Forest Carbon

Among terrestrial ecosystems, forests contain the largest reserves of sequestered carbon. The accumulation of carbon in forests helps to mitigate emissions of carbon dioxide to the atmosphere from sources such as wild fires or the burning of fossil fuels. Carbon accumulates in growing trees via the photosynthetically driven production of structural and energy-containing organic (carbon) compounds that primarily accumulate in trees as wood; approximately 50 percent of tree biomass is carbon (based on dry weight). Over time, this stored carbon also accumulates in standing dead trees, down woody materials, litter, and forest soils. The FIA program uses a combination of field measurements and models to estimate forest carbon stocks. Procedures for the estimation of carbon are detailed in the Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2017 (U.S. Environmental Protection Agency 2019). Forest carbon is often broken down into storage pools. The carbon pools and their components discussed here are defined as: live biomass (live trees at least 1 inch d.b.h. and live understory vegetation), dead wood (standing dead trees at least 1 inch d.b.h. and down dead wood), forest floor litter, and soil organic matter estimated to a depth of 1 meter (39 inches).

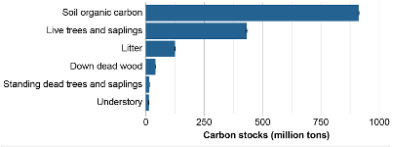


Figure 35 - Carbon stocks on forest land by component, Maine, 2018. Error bars represent a 68 percent confidence interval around each estimate.

What we found

Total forest ecosystem carbon stocks in Maine are an estimated 1.5 billion tons. This represents an increase of less than one percent over 2013, despite a decrease in the area of forest land. Carbon density is an estimated 88 tons per acre of forest land. Soil organic carbon and live trees are the largest components; combined, these account for 87 percent of forest carbon stocks.

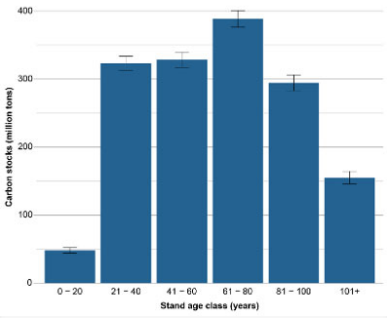


Figure 36 - Carbon stocks by stand-age class, Maine, 2018. Error bars represent a 68 percent confidence interval around each estimate.

Most of Maine's forest carbon stocks are in stands between 21 and 100 years old (87 percent of total forest carbon), with stocks being almost evenly distributed among stand age classes within that range. Much less carbon is found in stands older than 100 years (10 percent) and younger than 21 years (3 percent).

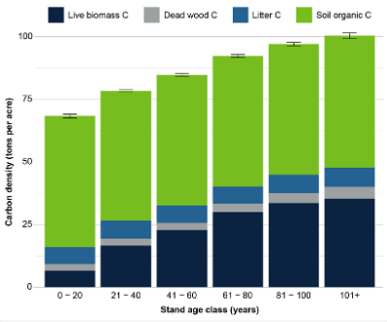


Figure 37 - Carbon density by stand-age class and carbon pool, Maine, 2018. Error bars represent a 68 percent confidence interval around the total density estimate (all pools).

As stands age, total carbon density generally increases, driven in large part by net carbon accumulation in live biomass. The live biomass pool rises from being only 10 percent of total density in the 0 – 20 years stand age class to a high of 35 percent of the total density in the over 100 years class.

Carbon density can vary among forest-type groups with the live biomass pool being most affected by tree species composition (e.g., forest-type groups dominated by long-lived species can have a higher proportion of live biomass carbon). Among the forest-type groups that account for at least 1 percent of Maine's forest carbon, both total density (100 tons per acre) and live biomass density (38 tons per acre) was highest in the oak/hickory forest-type group. The maple/beech/birch forest-type group covered the most forest area and therefore contributed most to total carbon stocks in the state (648 million tons; 42 percent of the total), followed by the spruce/fir group with 509 million tons (33 percent).

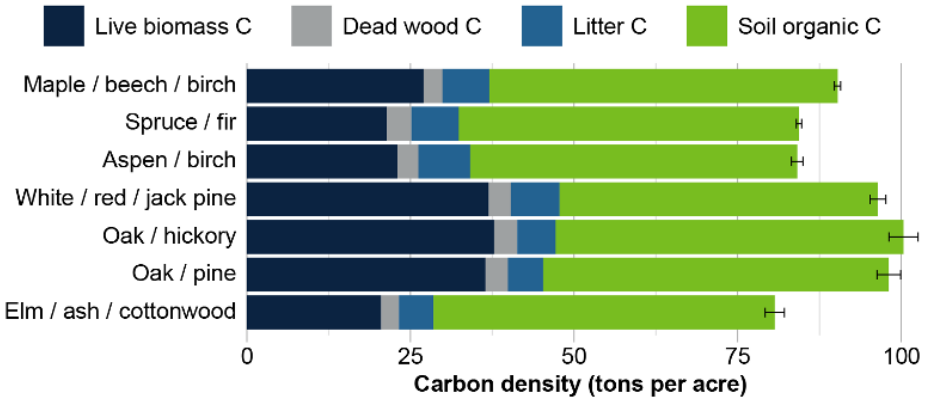


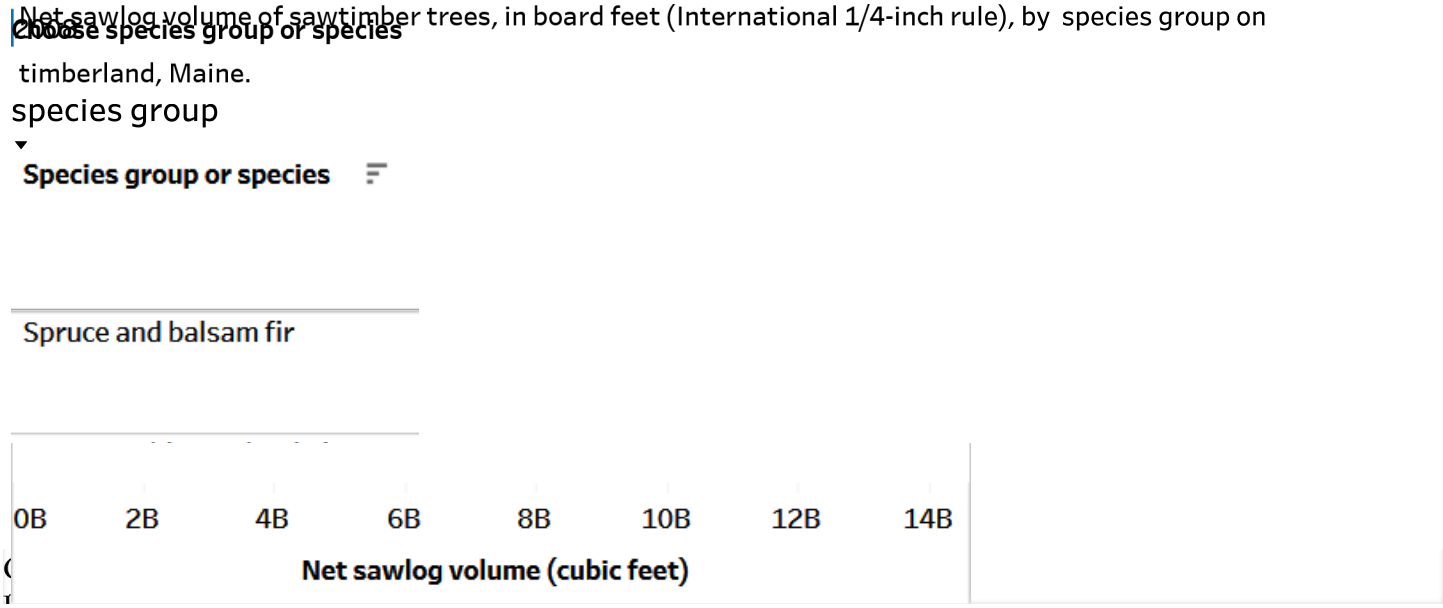
Figure 38 - Carbon density by forest-type group and carbon pool, Maine, 2018. Error bars represent a 68 percent confidence interval around the total carbon density estimate (all pools).

What this means

While forest ecosystem carbon stocks have remained relatively stable in Maine, density has risen slightly as a result of maturing stands accumulating carbon in the live biomass pool coinciding with a loss of forest land area. Soil organic carbon stocks represent the largest pool in Maine and are important to long-term carbon storage. The carbon stocks in live biomass also represent a substantial amount of the total carbon and there are opportunities to increase carbon stocks in the near term, as this pool is most affected by forest management. However, one of the greatest threats to the carbon stocks of Maine forests is loss of forest land. As mitigating U.S. greenhouse gas emissions becomes increasingly important, an understanding of trends in carbon sequestration in the face of land use change will be an essential tool for forest managers.

Growing Stock & Sawtimber Attributes

The attributes of sawtimber and growing stock on timberland across Maine is an important foundation of rural economies and provisioning of ecosystem services from Maine's dominant land use. Trends in the amount of sawtimber are a basic metric of sustainable forest utilization. Beyond the absolute quantity of sawtimber, the size distribution within sawtimber stands can indicate stages of stand development and rates of past utilization. Finally, the quantity of growing stock versus cull volumes in addition to sawtimber quality define the merchantability and economic worth of timber when considering the diverse array of species and stand structures across the swath of Maine's timberland.



Interactive Figure 36 - Interactive Tableau dashboard of net sawlog volume of sawtimber trees by species group on timberland, Maine.

What we found

Since 1959, sawtimber on Maine's timberland has increased over 75% to over 56 billion board feet in 2018 although the rates of increase have stabilized since the early 2000's despite reductions in timberland area. Red spruce and eastern white pine dominate the sawtimber volume across Maine. By diameter class, the largest-sized trees (20.9 + inches d.b.h.) have increased almost 150 percent in terms of net sawtimber volume while the smallest sized trees (9 to 12.9 inches) have increased the least (approximately 57 percent).

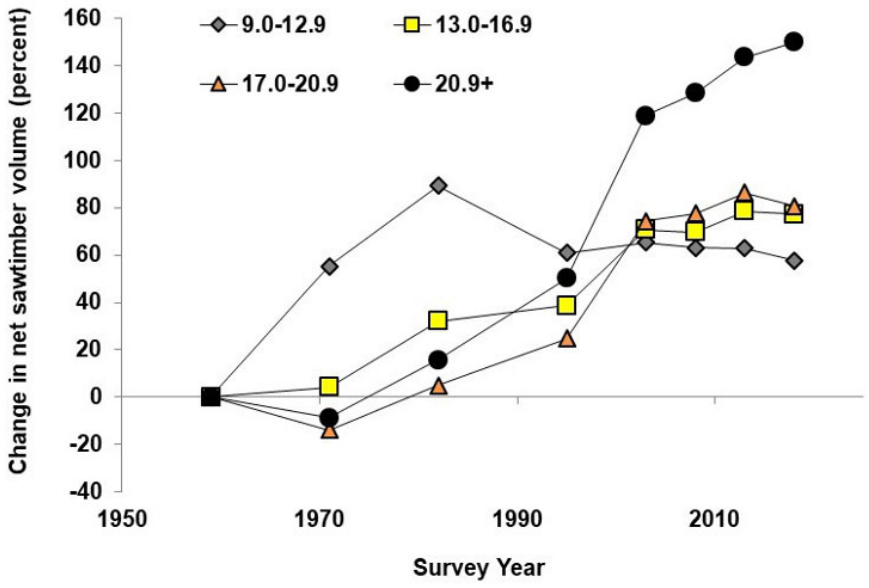
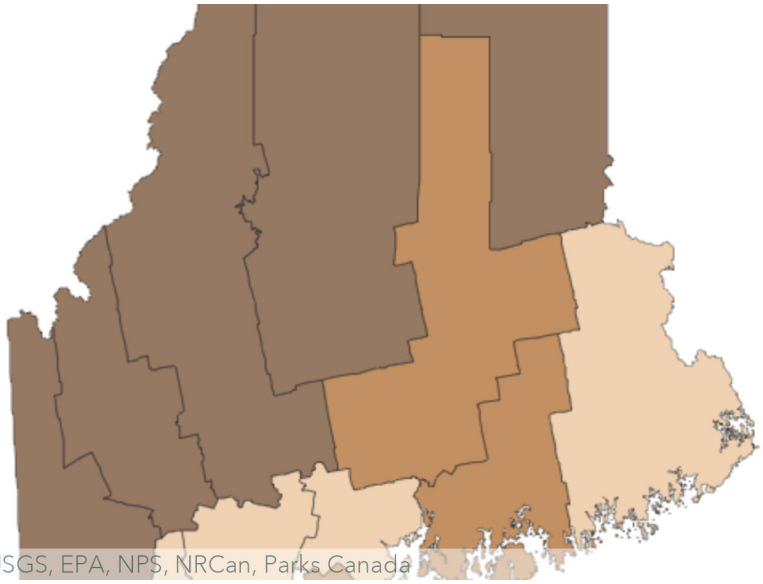


Figure 39 - Percent change in net sawtimber volume on timberland by diameter class (inches) and inventory year since 1959.



Interactive Figure 37 - Interactive map of volume in live softwood trees considered growing stock, rough and rotten cull.

The trends in mid- to large-sized sawtimber tree volume accretion have been increasing steadily in a somewhat positively linear fashion since 1959. Approximately 94 percent of volume in live softwood trees greater than 5 inches in diameter on timberland are considered growing stock while the remaining volume is considered rough and rotten cull.

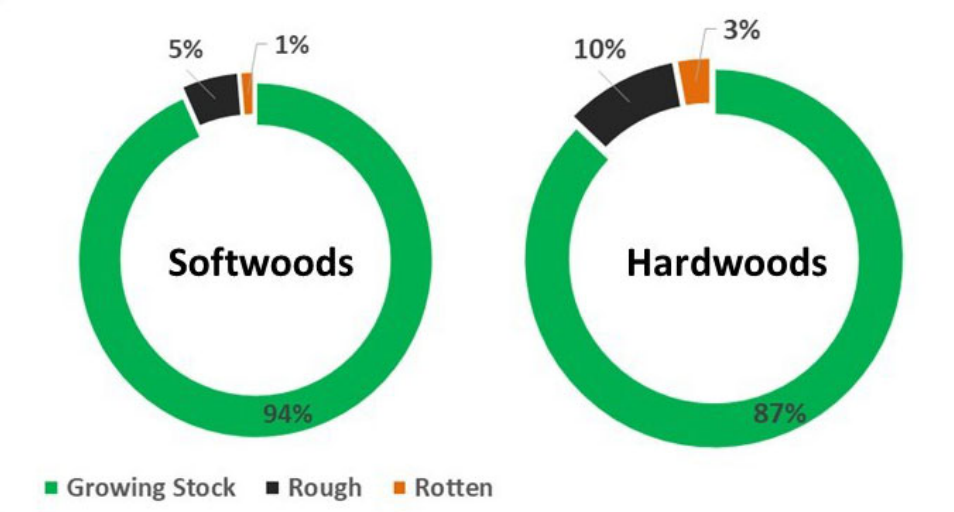


Figure 40 - Percentage of growing stock and rough/rotten cull live tree volume on timberland for trees 5 inches or greater in diameter by softwood and hardwood species groups, Maine 2018.

Interactive Figure 38 - Interactive map of percentage of softwood sawtimber considered grade 1.

In comparison, 87 percent of hardwood volumes are considered growing stock. In terms of the quality of sawtimber on Maine's timberland, a large percentage of softwood sawtimber is considered of the highest quality, grade one. Conversely, only 14 percent of Maine's hardwoods are considered grade one. However, only 13 percent of Maine's hardwood sawtimber is considered below grade three or lacking any gradable log.

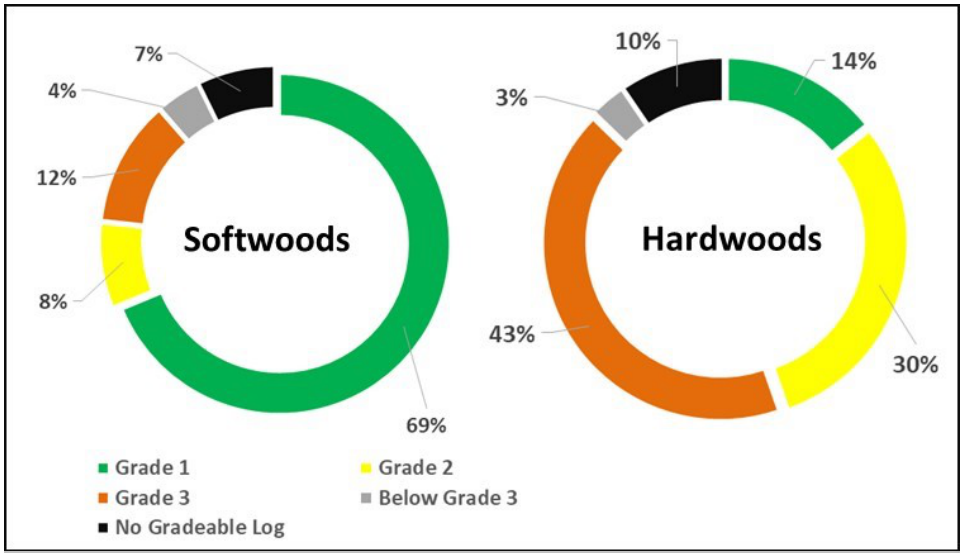


Figure 41 - Percentage of net sawtimber volume by tree quality grade on timberland by softwood and hardwood species groups, Maine 2018.

What this means

Despite the somewhat declining acreage of timberland across Maine over the past decade the quantity of merchantable tree volume (growing stock and sawtimber) have increased over the long run. Coupled with this trend is the relative diminishment of the smallest-sized sawtimber while the largest-sized sawtimber trees have greatly increased since 1959. Such a trend is indicative of a somewhat maturing resource. Coupled with these volume trends, the softwood tree species have maintained their high quality status remaining an important economic driver. Given the relatively poor quality of the hardwood species across Maine, the maintenance of low value timber markets (i.e., pulp and biomass) will be important to enable continued forest management activities especially in the face of insects and diseases such as beech bark disease and emerald ash borer that should continue to induce future tree mortality among hardwood components.

Timber Products

The harvesting and processing of timber products produces a stream of income shared by landowners, managers, marketers, loggers, truckers, and processors. A 2016 economic impact analysis of Maine forest products industry estimated a total statewide economic impact of $8.5 billion, 33,538 supported full- or part-time jobs, $1.8 billion in labor income and an estimated $278.4 million in state and local taxes (Maine Forest Products Council 2016). Each year, the Maine Forest Service surveys the primary wood using industries of the state to determine the species, amounts and locations where timber has been harvested (Maine Forest Service 2018) as part of an effort to better understand how wood flows maintain and might improve the state's forest economy. In 2018 MFS received a total of 403 wood processor reports from a mix of primary processing mills (118), portable saw mills (43), firewood dealers (91), loggers and brokers exporting wood (118), concentration yards (25), and mills that burn wood for energy (8).

What we found

In 2018 Maine harvested a total of 12.1 million green tons of wood which is down 15% when compared to the 14.3 million green tons harvested in 2013). Compared to 2013, sawlog (including sawlogs, studwood, pallet logs, boltwood, and veneer logs) harvest levels increased 11% and pulpwood harvest levels decreased 29%. However, pulpwood continues to represent the largest product class by tonnage with 44% of the harvest going to pulpwood; 35% of the harvest going to sawlogs; 18% of the harvest going to biomass chips; and 2% going to firewood and pellets. Out of the total harvest, 10.1 million green tons were processed in Maine and 2.0 million green tons were exported from Maine without processing. An additional 2.9 million green tons were imported from out of state.

At least in recent years, Maine has been a net exporter of sawlogs and net importer of pulpwood. In 2018, Maine continued that trend exporting slightly more sawlogs than it imported (1.1: 0.8 million green tons) with the majority of the movement happening between the US and Canada. Maine imported nearly 3 times as much pulpwood as it exported (1.7:0.6 million green tons) with a combined total of over 0.8 million green tons coming from New Hampshire and Vermont. The total 13.0 million green tons of wood that is processed in Maine, is down 13.3% from the 15.0 million green tons processed in 2013. Of the total wood processed, 31% is sawlog material, 50% is pulpwood, 17% is in biomass chips, and 2% is in firewood pellets. By species (groups), a mix of hardwood species contribute the majority (4.9 million tons) of the pulpwood processed. Of the 4.0 million green tons (0.9 million MBF) of the sawlog volume processed, spruce-fir (0.4 million MBF), pine (0.2 million MBF proc), and aspen (0.1 million MBF) represent the majority with birch, maple, beech, oak, ash, cedar, hemlock and other species contributing.

Using methods described in Smith (1991), the processing of the sawn lumber generated an estimated 2.3 million green tons of sawmill residues: roughly 44% was further utilized as fuel; 26% went towards manufacturing fiber/composite products; 19% transferred to the agriculture sector; and 11% was further processed into paper products. Less than 1% went to the landfill. The harvesting of timber for processing in the State's sawmills and pulp and paper mills resulted in 5.1 million green tons of harvest residues being left in the wood. Only 20 percent of the harvest residues were comprised of growing-stock material (considered useable by FIA standards of merchantability). The rest is tops, limbs, cull sections, or other unusable material. Eighty-seven percent of the wood material that was shipped to mills for processing came from growing-stock sources, while the rest was from cull or dead trees, limbwood, tops, or sapling.

What this means

Estimates of Maine's total forest economy vary, but apparently remained fairly stable between 2011 and 2016 (Maine's Forest Economy 2016). The steady decline in pulpwood harvesting over the past 5 years, may hint that there will be some challenges in maintaining pulpwood demand in upcoming years. The excess sawlog volume exported without processing may represent an opportunity for Maine to develop capacity for higher valued sawlog products including cross-laminated timber. With COVID-19, while we may see increased demand in tissue (at least in the short term) and packaging products, demand for paper may decrease especially if schools remain closed and people continue to work from home (Kingsley 2020). Sawlog harvest volumes increased slightly over the past 5 years, but with a recession threatening, the demand for building materials may decline and prices soften. Housing starts have started to decline since the COVID-19 (Kingsley 2020; Alderman XXXX).

Maine's Northern White-Cedar

Northern white-cedar is an iconic tree species across Maine's forest landscape in terms of cultural heritage, ecology, aesthetics, and role in the shingle and specialty wood products industries. Despite being an integral component of Maine's forest, it is neither a forest management priority nor the primary focus of conservation efforts. Recently, concern has arisen regarding the perpetuation of this species in the northern forest due to browsing by white-tailed deer, altered hydrologic regimes, lack of management guidance, and levels of harvest utilization.

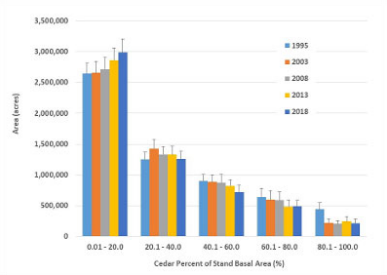


Figure 42 - Maine forest land area by the percent of a forest stands live tree basal area occupied by northern white-cedar since 1995. Error bars represent a 68 percent confidence interval around the population estimate.

What we found

Approximately three quarters of a million acres of Maine's forest are currently dominated by northern white-cedar (live tree basal area greater than or equal to 60% of total stand basal area). Since the 1995 inventory, cedar has lost its dominance in terms of live tree basal in stands where it is present across Maine's forest. The number of acres where cedar basal area is less than or equal to 20 percent of total stand basal area has increased nearly 13 percent while conversely stands with more than 80 percent cedar basal area have decreased 52 percent.

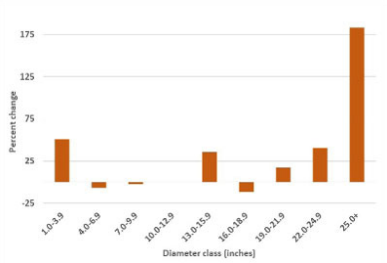


Figure 43 - Percentage change in abundance of northern white-cedar from 2003 to 2018 in Maine forest stands where 60 percent or more of the live tree basal was occupied by northern white-cedar.

This trend may also be reflected in cedar diameter distributions in cedar-dominated stands, with the number of cedar trees with a d.b.h. in excess of 25 inches increasing over 175 percent since 2003 while the number of cedar trees with a d.b.h. between 4 and 13 inches slightly decreased.

Average annual net growth of cedar in cedar-dominated stands decreased sequentially across the past 3 inventories reaching approximately 4.5 million cubic feet per year in 2018, a 60 percent reduction since 2008. This loss of net growth can be attributed to substantial reductions in gross growth coupled with rather stable levels of tree mortality and harvest removals. Such reductions in gross growth might be attributed to diminished growth of survivor trees and newly recruited cedars. Over the course of the inventories no cedar-dominated stands were categorized as non-harvest removals, which would have indicated land-use conversion or inclusion in a protected status.

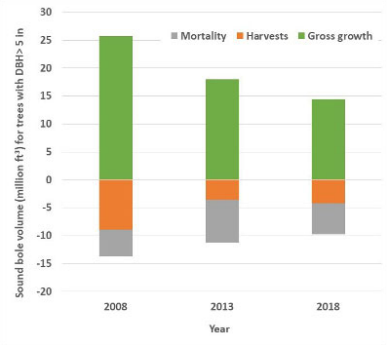


Figure 44 - Average annual northern white-cedar gross growth, mortality, and harvest removals for northern white-cedar dominated stands (60% or more of live tree basal area occupied by northern white-cedar) in Maine for the 2008, 2013, and 2018 inventories.

What this means

Despite its iconic status across Maine's forests, northern white-cedar appears to be losing its dominance in forest stands, perhaps becoming a subordinate component in upland sites and experiencing recruitment failures in stands where it once thrived. In other words, cedar may senescing, with a cedar understory unable to be recruited into the mid-story in many current cedar stands. Although there have been reductions in cedar growth and recruitment into pole and/or sawtimber sizes in cedar-dominated stands, its collective annual mortality and harvest removals have been stable leading to substantial reductions in net growth. If current trends persist in combination with emerging global change issues such as changing precipitation patterns or increased browsing then one would expect a substantial loss of Maine's cedar stands in coming decades.

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