Contents

Executive Summary

Forests in the Northeast form the foundation of many valuable ecological, cultural and economic services, such as providing habitat, creating recreational opportunities and producing timber.

Criteria 1 stands, establish permanent continuous forest inventory plots for the entire Park, and/or pursuing opportunities to use Pisgah State Park as a test case in various carbon mapping and assessment efforts.

Key Findings

In comparing various forest inventory data sources, there is no one inventory that is fully sufficient for estimating carbon storage and sequestration for Pisgah State Park as a whole, but useful datasets are available

Based on data from all harvests in the Park between 2008 and 2020, an average of 54.3 acres are harvested per year and the annual rate of sequestration is seven times the average annual rate of removal of harvested wood products.

Based on the intensity of those harvests, sequestration of carbon in unharvested forests will exceed the carbon removed in wood products if less than ~400 acres per year are harvested at similar levels.

In evaluating detailed information from a single sale over two years, the combination of emissions from transporting harvested wood to mills and the carbon stored in the harvested wood was nine percent of the estimated carbon sequestered on the remainder of the Park.

Introduction

Forests play a significant ecological, economic and social role in the fabric of the northeastern US. Following large scale clearing for grazing and timber through the 1800's, much of the region's forests have regrown. Active forest management, including timber harvesting, has continued on state, federal, tribal and privately owned lands. As efforts to meet the challenges presented by climate change in the region grow, there has been a growing focus on the role of northeastern forests in countering the accumulations of greenhouse gases in the atmosphere through sequestration and storage of carbon, and how timber harvesting intersects with that role.

Figure1.

Jenkins et al. (2003) combined with species-specific coefficients t_0 and t_1 provided by FIA (Burrill et al. 2018) to compute megagrams of carbon per acre from diameter and species for each tree using the following equation:

$$Carbon = exp(t_0 + t_1 * ln(DBH * 2.54)) * 2.2046$$

These tree-level estimates were then scaled to the stand, compartment and managed areas based on the number of survey points to produce total estimates at each scale.

ESTIMATED CARBON REMOVED THROUGH HARVESTING

New Hampshire DFL has collected data on removals through harvesting on the PSP from 2008 to 2020, capturing the date, location of sale, species or species group of harvested material, and the harvested volume in either thousands of board feet (MBF) or tons (NHDFL 2021c). In addition, spatial data delineating the sale areas was provided, and this data included the harvestable areas that were not entered during the harvest, allowing us to calculate a per-acre removal value. Note that the year of sale refers to the fiscal year it was sold, not the year(s) it was harvested, and for ease of presentation, we use the year of sale for reporting data over time.

Carbon content of all harvested material reported in MBF was estimated using conversion factors developed by Birdsey (1996) for estimating the carbon content from volume for northeastern forest types. Carbon content of harvested hardwood and softwood material reported in tons was estimated using the ratio of carbon to mass (Birdsey 1992). To utilize these conversion ratios, species were grouped into the forest types in which they generally occur, and the corresponding conversion factor used (Table 2). For the general “hardwood” category, the average of the maple-beech-birch and oak-hickory hardwood conversion factors were used, as these are the predominant hardwood forest types. For hemlock, we used the average of the maple-beech-birch softwoods, oak-hickory softwoods, and pine conversion factors, as there was no forest type available for hemlock in Birdsey (1996).

Results

The results of the analysis at various scales and from various data sources are summarized in the table below (Table 3).

Table 3. Summary of results for carbon sequestration, storage and removals using various data sources and methods.

CARBON STORAGE AND SEQUESTRATION ESTIMATES

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Carbon storage and sequestration in the landscape surrounding the Park

Using FIA's EVALidator tool for all plots within 25 miles of the PSP center, carbon storage was calculated to be 35.66 ± 1.91 Mg C per acre. This translates into an estimate of 378,116 Mg C stored in the entire PSP. Utilizing IA.5

estimates for the roughly 263 acres of land that has been harvested in the last 10 years, due to modeling constraints.

We can apply this yearly rate of sequestration to the areas that have not been harvested in the last 10 years on a yearly basis using information about when timber sales and the amount soled for harvest. This analysis shows that yearly sequestration across the park drops from 10,154 ± 401 Mg C to 9,681 ± 382Mg C (Table 4). However, this does not capture the sequestration occurring on harvested sites post-harvest, which can be much higher than older6[(h)-0[

Figure 4. Comparison of carbon removed from harvesting, emissions of carbon from transportation of harvested material, and sequestration by the remaining areas of the Park not harvested in the last 10 years.

Outcomes and Findings

Based on the data and analyses presented here, we can consider several questions posed by FEMC partners about carbon on the Pisgah State Park. However, while these analyses made the best use of available data, there are limitations including an inability to account for the emissions or storage loss from material harvested but not moved off the site, emissions from the operation of logging equipment on the site, the final fate of wood products, and a lack of sufficient data to calculate Park-specific sequestration rates. Therefore, these results should be interpreted as general comparisons, and not a full carbon accounting for the Park; specific limitations are noted below.

What is the best estimate of carbon storage and sequestration for the Pisgah State Park? Carbon storage on managed areas (45.0 ± 0.4 Mg C/acre) is similar to median carbon storage estimates for similar forest types in the larger landscape 25 miles around the PSP (44.5 ± 1.8 Mg C/acre), especially when taking into account that the allometric equations used to estimate carbon in managed areas from only diameter and species likely overestimate carTD [(ol- (o)-6d6 (n)2.2D [(p)-0.2 Tc der)3.ogoant ileu diaet are a ageima the arora9-6.6 (n)nd-1.9 (

Estimate heights during timber cruises The estimates of carbon storage in managed areas provides a precise estimate, but the lack of height data forces a reliance on less accurate biomass estimation equations. Adding

References

Birdsey, R.A. 1992. Carbon storage and accumulation in U.S. forest ecosystems. USDA Forest Service General Technical Report WO-59.

Birdsey, R.A. 1996. Carbon storage for major forest types and regions in the coterminous United States. In: Sampson, N., Hair, D., eds. Forests and global change. Volume 2: forest management opportunities for mitigating carbon emissions. Washington, DC: American Forests: 1tsr:e1nagtdd4e:9pd3pd1. reL4-gadre2. (:9p)y3 (gg)2=

Appendix 1. Carbon storage summaries for managed areas

Data from on timber cruises within demarcated stands of the PSP designated for active management (Criteria 2 and Criteria 3) was providing by New Hampshire Division of Forest and Lands. Large basal area factor cruise data were collected with an 80-factor prism and recorded diameter at breast height (1.47m, DBH), species, number of sawlogs and a product rating for each tally tree within the variable-radius plot. There are 10 compartments comprised of 162 stands with 3,999 points where data was collected. From this, we estimated carbon at various scales, including the compartment scale (Table 6).

Table 6. Summary of biomass and carbon for compartments with Criteria 2 (uneven-aged) and Criteria 3 (even-aged) management areas on the Pisgah State Park.

Criteria	Compartment	# of stems	# of points	Total biomass (kg)	Total carbon (kg)	Biomass by area

Appendix 3. FIA EVALidator queries

The USDA Forest Inventory and Analysis EVALidator service was used to generate carbon storage estimates for the area 25 miles surrounding the Pisgah State Park's geographic center (42.839793 -72.436584)

The REST endpoint to access this query is:

https://apps.fs.usda.gov/Evalidator/rest/Evalidator/fullreport?reptype=Circle&lat=42.839793&lon=-72.436584&radius=25&snum=Aboveground carbon in live trees (at least 1 inch d.b.h./d.r.c), in short tons, on forest land&sdenom=Area of forest land, in acres&wc=252019,332019,502019&pselected=None&rselected=All live stocking&cselected=All live stocking&ptime=Current&rtime=Current&ctime=Current&wf=&wnum=&wnumdenom=&FIAo

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p.lat>42.461005121212125 and p.lat<43.218580878787876 and p.lon<-71.2461078095238
and p.lon>-73.62706019047619 and SDO_GEOM.SDO_DISTANCE(SDO_GEOMETRY(2001,
8265,SDO_POINT_TY-PE(
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Nonstocked' when 1 then '`0006 Unavailable' else '`0007 Other' end) tmpyyy group by cube(pagestr,rowstr,colstr)) tmptable GROUP BY pagestr, rowstr, colstr) tmp2table group by pagestr, rowstr, colstr order by pagestr, rowstr, colstr

Providing the information needed to understand, manage, and protect the region's forested ecosystems in a changing global environment