Forest Carbon Evaluation for the OM Sanctuary's Property Asheville, Buncombe County, NC

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Introduction

In March and April of 2017 EcoForesters conducted a Carbon Evaluation to estimate the total amount of carbon stored in the 41.5 acres of forestland on the OM Sanctuary property overlooking the French Broad River in Asheville, NC. This forestland has been placed under conservation easement, forever protecting its cove, oak, and low mountain pine forest from development and conserving its wildlife habitat, water quality, and forest carbon stocks. Consistent with its embracement of sustainability, the OM Sanctuary is concerned about the organization's carbon footprint. This Carbon Evaluation of the property provides an accurate estimate of the current forest carbon stocks, allowing the OM Sanctuary to quantify the contribution of conserving the forestland. Additionally, forest carbon stock growth over the next 10 years is modeled to estimate the annual carbon sequestration on the forestland under three different management options.

Methods

EcoForesters installed and measured 20 permanent forest inventory plots randomly chosen on a 50-meter grid overlaying the property (Figure 1). The following forest inventory data was collected at each plot:

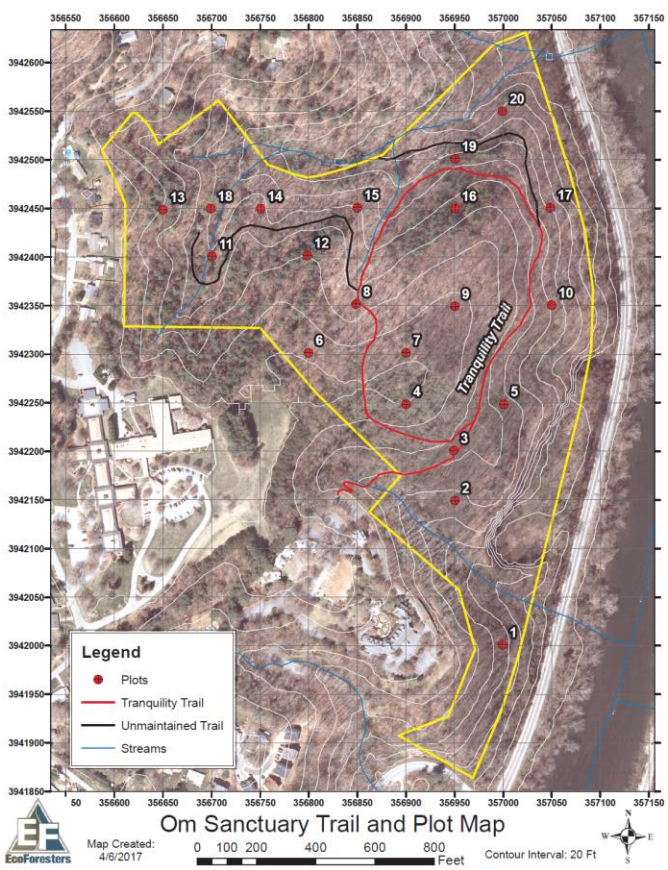


Figure 1. Inventory Plot Locations

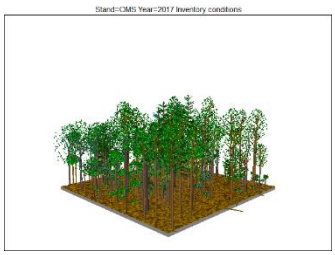
- For each 1/10th acre fixed radius plot, all trees >=5.0" in diameter at breast height (DBH) were inventoried. For each tree: species, DBH (to nearest 0.1 inch), total height, live crown ratio, and tree health (1= <50% live, 2= 50-90% live, 3 =>90% live) were recorded.
- For each plot, nested around plot center, a 1/100th acre fixed radius subplot of all advanced tree regeneration (1"-5" DBH) was also inventoried. Again, species, DBH (to nearest 0.5 inch), total height (to nearest 5'), and tree health (1, 2, 3) were recorded.
- Percent cover (by species to nearest 5%) of invasive exotic plant species and/or native shrubs in the 1/10th ac plot were also recorded. Notes on other significant forest issues (e.g. native vines) or other spots of severe infestations were taken.

Carbon stocks were calculated for the six forest ecosystem carbon pools - live tree, standing dead tree, understory, down dead wood, forest floor, and soil organic carbon (Figure 2).

Figure 2. Forest Ecosystem Carbon Pools

From the forest inventory data, live tree and standing dead tree carbon stocks (both above and below ground) were calculated using a methodology developed for California Air Resources Board's (CARB) Compliance Offset Protocol for US Forest Projects. This methodology is one of the most rigorous available. The Protocol has approved specific volume and biomass equations developed by the United States Forest Service Forest Inventory and Analysis National Program (FIA) using a procedure known as the Component Ratio Method.

The forest inventory data were entered into the Southern variant of the Forest Vegetation Simulator (FVS) to estimate understory, down dead wood, and forest floor carbon stocks from the FVS Carbon Report model output. The Forest Vegetation Simulator (FVS) is an individual-tree, distance-independent, growth and yield model developed by the US Forest Service and is recognized as one of the most useful forest growth models in the Southern Appalachian region.



To estimate soil organic carbon, the soils of the OMS conservation easement property were first mapped with the USDA Natural Resources Conservation Service's soil survey database (SSURGO). Then an estimate of soil organic carbon for each soil type was obtained from the gSSURGO Value Added Look Up Table Database. A weighted average of soil organic carbon was then calculated based upon the acreage in each soil type.

Forest carbon stock growth over the next 10 years was modeled to estimate the annual carbon sequestration on the OMS conservation easement property under the following three different management scenarios:

1. Minimal Management: The forest is allowed to grow with little active management. Little control of invasive exotic plant (IEP) species is undertaken.
2. Active IEP Treatment: An active program for the control of invasive exotic plant species is undertaken through mechanical, biological, and/or chemical means especially focusing on efforts to control invasive vines that threaten to smother trees. Aside from these treatments, the forest is allowed to grow undisturbed.
3. Active IEP Treatment and Prescribed Fire: An active program for the control of invasive exotic plant species is undertaken through mechanical, biological, and/or chemical means especially focusing on efforts to control invasive vines that threaten to smother trees. A series of controlled burns are also carried out to increase wildlife habitat, biological diversity, and forest structural complexity.

The Forest Vegetation Simulator (FVS) was used to model forest growth for each of these scenarios. While FVS is likely the best approximation that we have for modeling forest growth in the region, it is important to note that many variables remain uncaptured by the model given the complexities of Southern Appalachian forests. Model accuracy is thus limited by the constraints of information and unpredictability of future events.

Carbon stocks for each scenario over the 10-year period were then estimated from the modeled data using the same methodology detailed above for estimating 2017 carbon stocks. An average annual carbon sequestration rate was then calculated for each scenario over the 10-year period.

Results

The OM Sanctuary's 41.5 acre permanently conserved forest currently (beginning of 2017) is estimated to be stocked with 13,346 metric tons of carbon dioxide equivalent (mT CO2e) or 321 mT CO2e per acre. The majority of the carbon in the forest is locked up in live trees (8,180 mT CO2e). A summary of all carbon pools can be found in Table 1 below:

Table 1. OMS Forest Carbon Stocking in 2017

Carbon Pool	Stocks per Acre (mT CO2e/acre)	Total Stocks (mT CO2e)
Live Tree	196.7	8,180
Standing Dead Tree	7.0	292
Downed Dead Wood	8.8	366
Forest Floor	12.5	519
Understory	3.3	137
Soil Organic Cabon	92.6	3,853
Total Forest Carbon	**320.9**	**13,346**

Under all three modeled management scenarios, forest carbon stocks on the OMS conservation easement property increase over the next 10 years (Figure 3). In the scenario with minimal management, total stocks increase the most. However live tree carbon stocks increase the most under the management scenario with Active IEP Treatment (Figure 4).

Figure 3. Modeled Total Forest Carbon Stocks 2017 to 2027

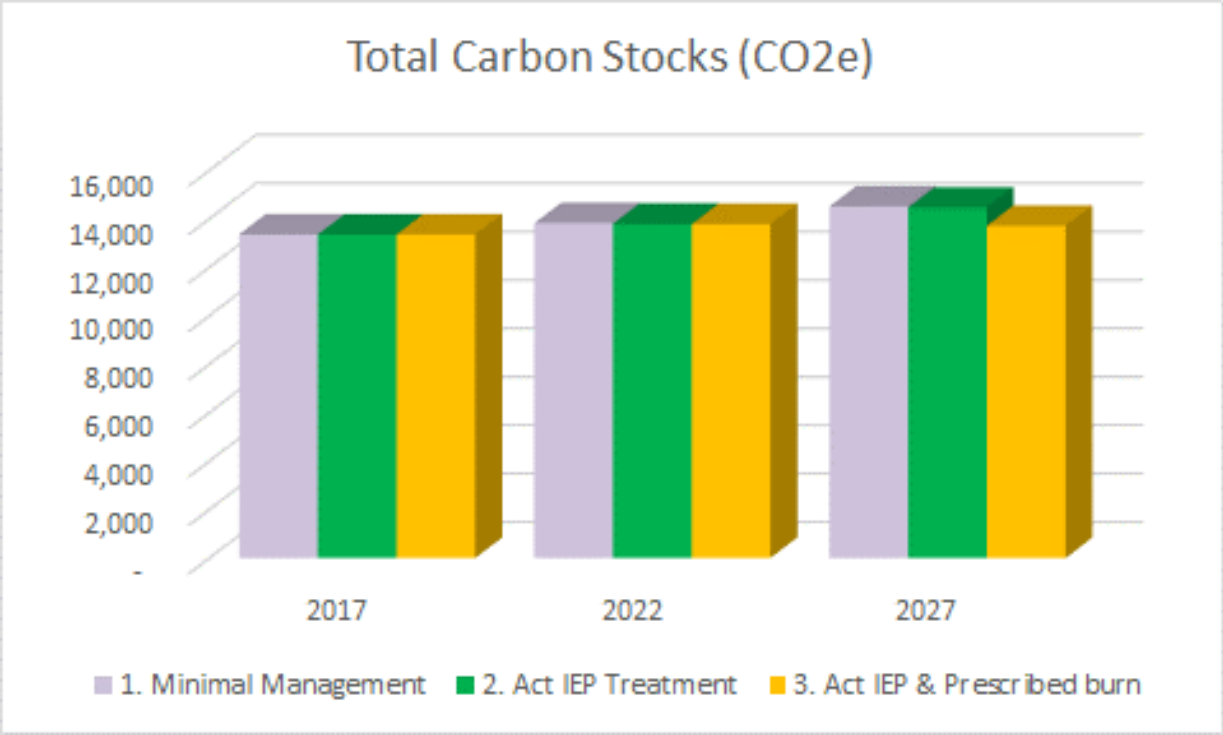
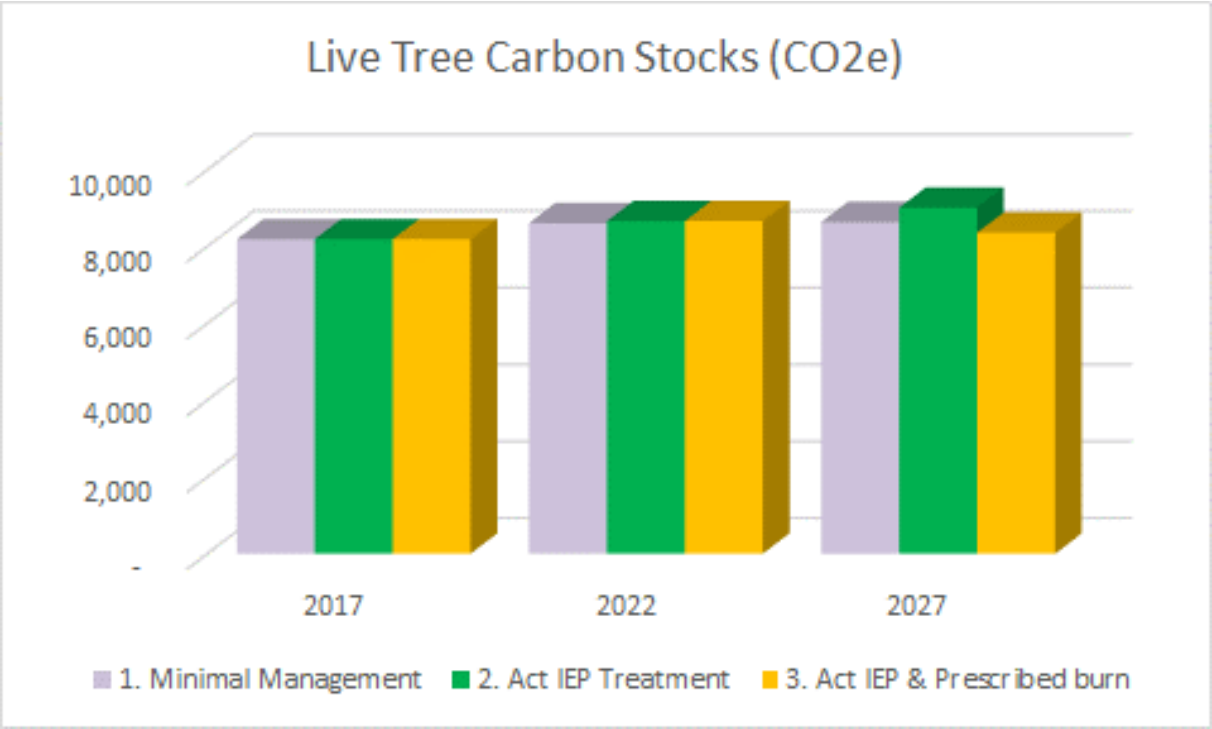


Figure 4. Modeled Live Tree Carbon Stocks 2017 to 2027



Under the Active IEP Treatment and Prescribed Fire management scenario, average annual carbon sequestration in both total forest carbon stocks and live tree stocks was lowest (Table 2.)

Table 2. Average Annual Growth of OMS Carbon Stocks 2017-2027

Management Scenario	Total Stocks (mT CO2e/year)	Live Tree Stocks (mT CO2e/year)
1. Minimal Management	116	45
2. Act IEP Treatment	110	82
3. Act IEP & Prescribed burn	35	17

Discussion

The OM Sanctuary's conserved forest is currently well stocked with 13,346 mT CO2e of total forest carbon. It's aboveground tree stocks of carbon of 163 mT CO2e per acre are much higher than the Blue Ridge Mountains Ecoregion averages of 73 to 135 mT CO2e (based on forest type) calculated from FIA data. The conservation of this property ensures continued high levels of storage of this carbon and avoids the release of a significant amount of carbon dioxide by conversion through development.

The property should continue to see additional annual sequestration of carbon over the next 10 years under all management scenarios. Though the treatment of invasive exotic plant species on the property is not likely to increase the total amount of carbon sequestered on the property over the next ten years, it may increase the survival and regeneration of trees in both the near term and well into the future. Stocks of live tree carbon have a much larger impact on future carbon stocks than any other carbon pool. Therefore, the treatment of invasive exotic plant species now is likely to have a much more favorable effect on future (10 + years from now) carbon stocks than it is in the near term.

The introduction of regular prescribed fire to the property would likely result in lower carbon stocks than with its exclusion, both in the near and the longer term. This results from fire temporarily decreasing the amount of carbon stored in the forest floor and understory carbon pools when leaf litter, duff, twigs, and shrubs are consumed, and from repeated fire causing some tree mortality. From an ecological perspective, this tree mortality can be beneficial by opening up the forest midstory and canopy to allow light into the understory, creating structural and biological diversity. However, from a carbon stocking perspective, this tree mortality does not allow the forest to reach its maximum potential for carbon storage. That being said, the ecological benefits of fire often outweigh the relatively small lost potential in carbon storage.