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Tree Planting in Maryland - Carbon Offset Feasibility Analysis and Quantification Plan

Image displays the 2024 tree planting at Tuckahoe State Park

Introduction

Maryland has an ambitious tree-planting program and a goal to plant and maintain 5 million trees in the state by 2031, as required by the state's Tree Solutions Now Act of 2021. This law mandates some funding sources for tree planting: $2.5 million per year from the state's Chesapeake and Atlantic Coastal Bays Trust Fund, $2.5 million per year to supplement Maryland Department of Agriculture's (MDA) Conservation Reserve Enhancement Program (CREP) program offerings, and an additional $10 million per year of state general funds to be allocated to the Chesapeake Bay Trust towards tree planting in urban underserved areas. The 5 Million Trees Hub, developed and maintained by Maryland Department of the Environment (MDE), tracks the state's progress toward the goal. While significant progress is being made, it is likely that additional funding will be required for the state to meet the tree planting goal by the law's deadline. The sale of carbon credits has been identified as a possible solution and the Conservation Finance Act of 2022 mandates that Maryland Department of Natural Resources (DNR) develop two carbon offset projects on state lands. This paper presents a plan for the 2024 tree planting at Tuckahoe State Park to serve as one of those projects along with a financial feasibility analysis of utilizing carbon offset sales as a funding mechanism for the 5 Million Trees Initiative in Maryland.

Forests contain the largest amount of stored carbon in the terrestrial landscape and, by some estimates, have the potential to achieve up to a third of the needed carbon removal to meet global greenhouse gas reduction targets set by the International Panel on Climate Change (IPCC) through tree planting and improved forest management practices (Bastin et al. 2019), although other studies have estimated their potential to be lower (Harris 2021, Mo et al. 2023, Roebrock et al. 2023). Sale of carbon credits from tree planting has been suggested as an economically viable alternative to agricultural crops, under some conditions in Maryland (Lamb et al. 2022). While tree planting shows theoretical promise, carbon offsets generated by this practice have drawn criticism due to inappropriate planting locations leading to loss in important grassland ecosystems (Baker et al. 2020, Bardget et al. 2021, Zhu et al. 2021, Li et al. 2023), failed plantings (Coleman et al. 2021, Fleishman et al. 2020), and plantation-style species monocultures that provide less benefits than a more diverse natural system (Heilmeyer et al. 2020, Aguirre-Gutiérrez et al. 2023). Less than 10% of forest carbon offsets are generated through tree planting, with the majority made up by improved forest management. Improved forest management credits are assigned based on the carbon that remains on the landscape, relative to an alternative scenario of business-as-usual management. This approach has also garnered extensive criticism (Thales et al. 2023, Guizar-Coutiño et al. 2022, West et al. 2020) with some claiming that over 90% of this type of carbon credit project have had no actual impact on reducing GHG emissions. The issues faced by forest carbon credits reinforces the need for Maryland to develop a rigorous approach to quantifying carbon on the landscape, in accounting for this carbon in our GHG inventory and planning, and careful consideration of how the state should engage with carbon credit or offset markets. This is in line with the May 2024 Whitehouse statement Voluntary Carbon Markets Joint Policy Statement and Principles, which emphasizes the need for high integrity in every phase of carbon markets and the role of government in enabling and ensuring that integrity.

Climate mitigation through carbon sequestration is only one of the many benefits provided by forests that Maryland seeks to achieve through the 5 Million Trees Initiative. Newly established forests help the state make progress towards the Chesapeake Bay TMDL by taking up nutrients and reducing sediment erosion, provide habitat for wildlife, and help to clean the air and improve human health, among other ecosystem services.

What's the Difference between a Carbon Credit, Offset, and Outcome?

Both a carbon credit of offset represents one metric ton of carbon dioxide (CO_2) or its equivalent measure of a different greenhouse gas

Carbon Credit- generally traded on a compliance market and represents the right to emit the equivalent amount of carbon dioxide. Allows regulated entities to comply with a greenhouse gas cap (i.e. a cap and trade system). Must comply with the protocol requirements of the compliance market.

Carbon Offset- generally traded on a voluntary market, represents an individual, small business or corporation "offsetting" their greenhouse gas emissions through carbon removal in another location. Many different protocols and markets.

Carbon Outcome- carbon that is removed from the atmosphere as the result of an action, that is quantified but not transacted on a market

Compliance Market- carbon credits sold in this marketplace are to meet regulatory compliance requirements. Typically have specific protocols for credit projects.

Voluntary Market- carbon offsets sold in this marketplace are to meet voluntary climate mitigation goals of a corporation or individual. Often a variety of protocols can be applied to projects in order to generate offsets.

Relevant Terms and Definitions

Greenhouse Gas- a gas that contributes to the greenhouse effect by absorbing infrared radiation in the atmosphere
CO2e- carbon dioxide equivalent, often expressed in metric tons. The common unit of carbon offsets.
Carbon Offset Purchaser- individual, small business or corporation that purchases a carbon offset on the voluntary market.
Additionality- the requirement that the carbon represented in a credit or offset be additional to actions that would have occurred in absence of the sale of carbon.
Permanence- the length of time carbon is projected to remain sequestered on the landscape
Verification- The process of ensuring that the carbon credits/offsets are legitimate and that consumers receive value for their money
Monitoring- collection of data on forest growth
Afforestation- planting trees on lands that have not been forested in the recent past
Reforestation- planting trees on lands that were recently forest
Improved Forest Management-forest management practices that increase carbon stocks or reduce greenhouse gas emissions
Carbon Market- venue for the sale and purchase of carbon credits or offsets
Carbon Protocol/Standard- a set of tools and methods for measuring greenhouse gas emissions or removals; provide universal frameworks for reporting, accounting, and verifying carbon, making emissions/removals comparable and credible.
Discount Rate- the interest rate used to calculate the present value of future cash flows from a project or investment. Used to reflect the difference in how people value money they can use today vs. expect to get in the future.
Internal Rate of Return- a discount rate that makes the net present value (NPV) of all cash flows equal to zero in a discounted cash flow analysis, used in financial analysis to estimate the profitability of potential investments
Net Present Value- the difference between the present value of cash inflows and the present value of cash outflows over a period of time. Determined through applying a discount rate to future revenue to estimate the value of the investment today.
Ecosystem Services- benefits to people derived from the natural environment

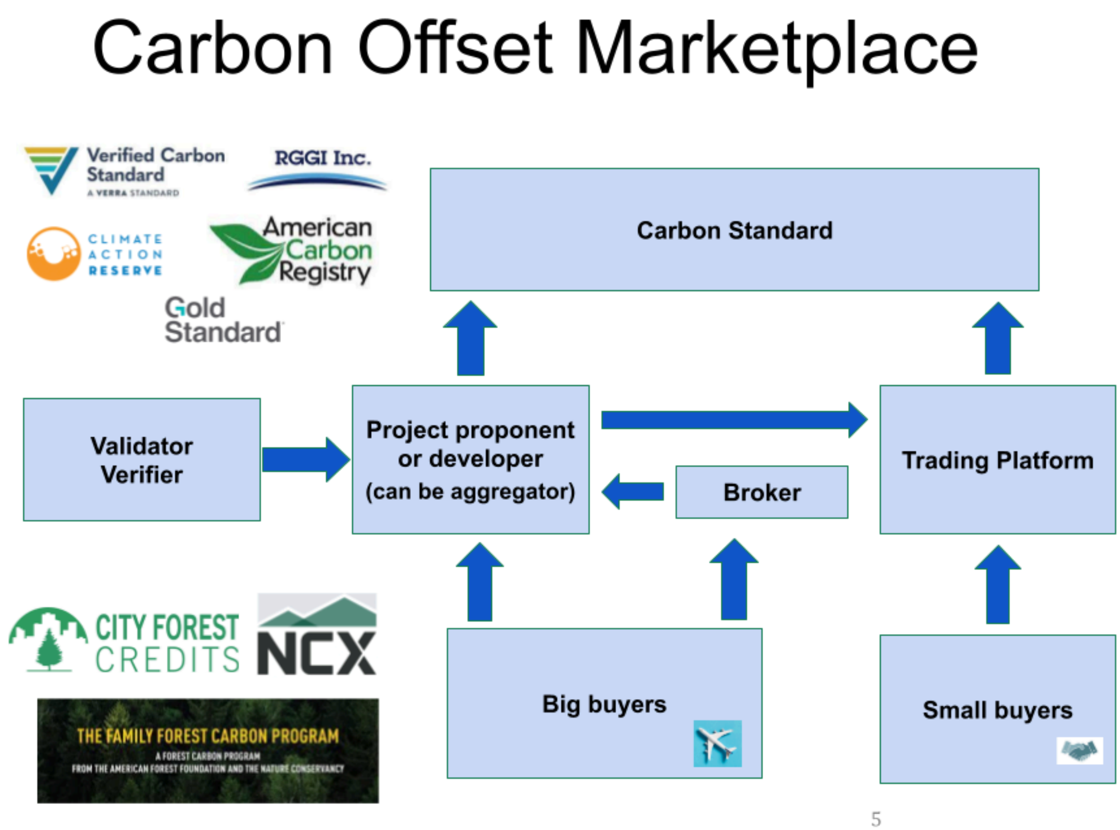

Figure 1. Diagram of a Carbon Offset Marketplace with some examples of carbon standards and validator/verifiers and typical connections between the major components of the system. Source: Final Plan for Growing 5 Million Trees in Maryland.

It is important to note this analysis is done primarily from the perspective of the State of Maryland as the entity producing and selling carbon credits. The results presented here may be informative for private investors, but we leave out some costs they would likely incur when identifying and developing projects. We analyze two carbon crediting cases here, one where the State of Maryland functions as the project developer and another where the state functions as the credit validator and utilizes a low-cost carbon standard based on remote sensing. We also consider the non-market value of carbon sequestration as measured through the social cost of carbon (EPA, 2023) and how that compares to the cost of project implementation.

Methodology

Tuckahoe Tree Planting and Carbon Plan

Project Description: The immense undertaking of planting and maintaining 5 Million Trees is being coordinated by the Maryland Department of the Environment and implemented with leadership from Maryland Forest Service and other state agency partners. To help achieve this goal, the Maryland Park Service has identified areas within state parks that would benefit from large-scale tree plantings.

A total of 118 acres have been planted in spring 2024 in Tuckahoe State Park. The planting sites consist of fallow agricultural fields, working agricultural fields, and mowed open field space (see Figure 1 and Appendix 1). There are three priority planting zones within the total acreage. Plantings will expand existing forested stream buffers and create more wildlife habitat. Plantings are adjacent to wetlands and meadows. There are multiple trails in the State Park that will benefit from the planting, creating additional shade and wildlife viewing opportunities for visitors.

The Maryland Forest Service has created planting plans tailored to the conditions of each site.
Plantings used native tree bare-root seedlings from the John S. Ayton State Tree Nursery. Some seedlings were planted in 5-foot shelters, with bird netting over top and a white oak stake to anchor them. Following planting, the Maryland Forest Service will perform maintenance for the first five years. Maintenance includes biannual mowing; spot-spraying and/or mechanical removal of invasive species; shelter straightening; and stake replacement. At the conclusion of the five-year period, the Maryland Forest Service will coordinate removal of all tubes, nets, and stakes. After which the Maryland Park Service will assume ongoing responsibility for site maintenance.

General Site Conditions: The planting areas mainly consist of upland agricultural fields that have been fallow for one growing season. Predominant soils are Ingleside sandy loam. The grasses and forbs are no more than waist high in the majority of planting areas. A mowed section of trail through a field at the Eveland Road site connects to the Park's trail network. Overall the area is accessible and not completely dominated by impassable walls of invasive species. Surrounding forested areas consist mainly of pine, oak, and poplar. The potential for natural regeneration exists along the borders in several areas. These areas were more sparsely planted to encourage selected species and diversity, while allowing some natural recruitment.

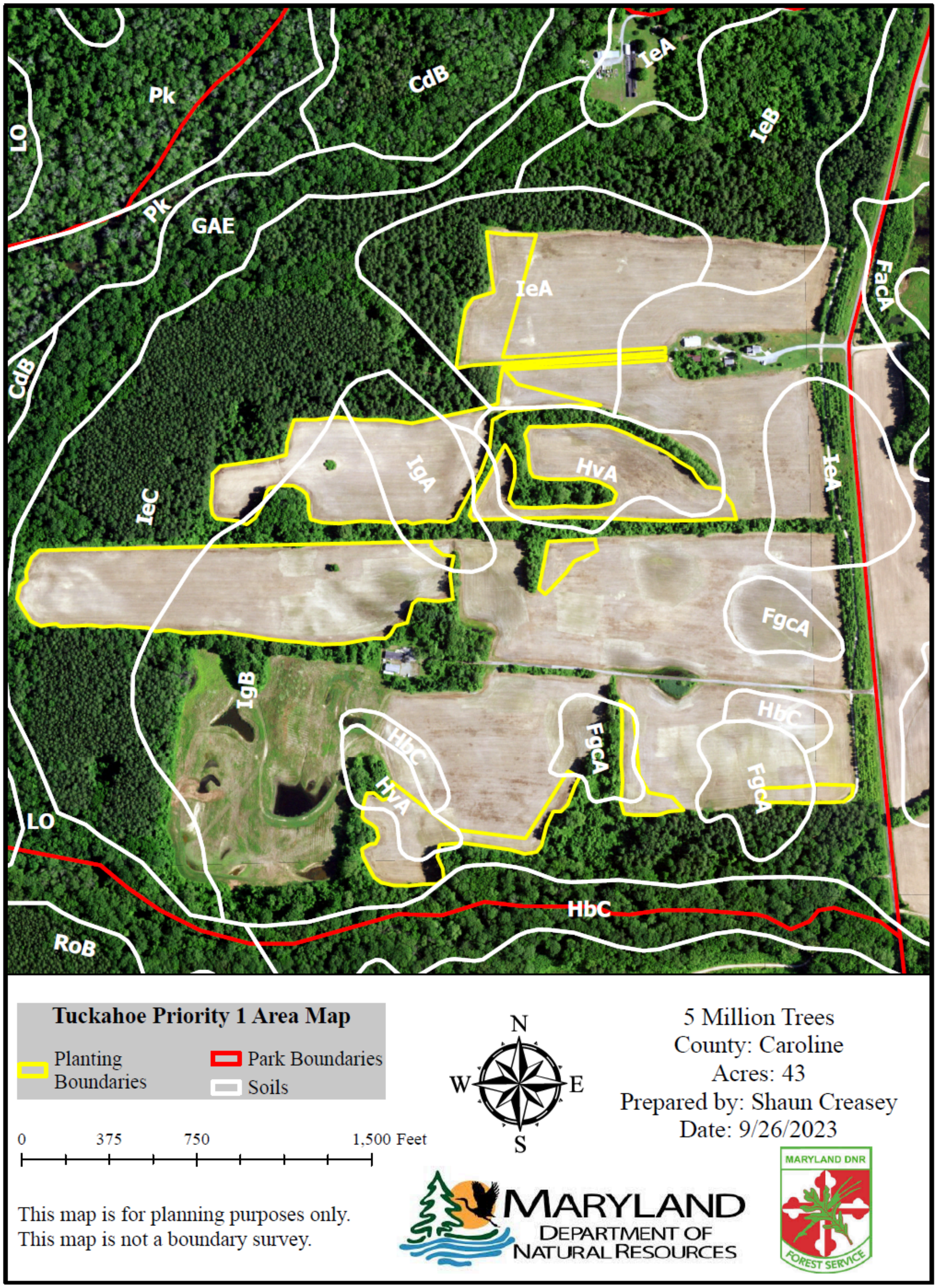

Figure 2. Map of Tuckahoe Priority 1 Planting Area. Remainder of planting area maps included in Appendix 1.

Carbon Quantification Plan

At the conclusion of the five-year maintenance period, and every five years thereafter for a period of 50 years, the Maryland Forest Service in collaboration with Maryland DNR Chesapeake and Coastal Service will evaluate the carbon storage and sequestration across this 118-acre tree planting. This will be accomplished by the following approach:

1. Forest inventory of 25 randomly selected ¼-acre sample locations across the 118 acres of tree plantings. Plot centroids will be randomly selected using a GIS tool. A sample size of 25 was selected based on U.S. Forest Service (USFS) guidance in Pearson et al. 2007 and a desired standard error of 10%. Inventory will follow USFS guidance for Forest Inventory and Analysis (USFS 2023).
2. Collation of collected data, calculation of total ecosystem biomass, conversion of biomass to stored ecosystem carbon for the 118-acre planting site and calculation of basic statistics. This work will follow USFS guidance on calculating tree biomass (Hoover 2023).
3. Comparison of empirical results to modeled/remotely sensed carbon sequestration expectations as reflected in Maryland's Greenhouse Gas (GHG) Inventory, published every three years. Currently the comparison would be to the National Aeronautics and Space Administration (NASA) Carbon Monitoring System's forest carbon monitoring approach, which is currently being used to annually quantify forest carbon fluxes for the state's GHG Inventory.[1]
4. Reassessment of the financial feasibility of carbon offsets or credits given the latest regulatory framework, carbon price, and GHG mitigation goals.

There are many different carbon protocols but this approach was chosen as being consistent with methodology provided by one of the largest offset registries, the Climate Action Reserve, and reliant on publicly available and scientifically vetted methodology provided by the USFS.

Financial Feasibility Assessment

To assess the financial feasibility of generating carbon credits from tree planting projects, a range of carbon outcome scenarios, (e.g., ecosystem carbon, carbon credit prices, discount rates and two alternatives for credit payment schedules) were analyzed. The values chosen are meant to represent the range of outcomes the state or a private investor could expect when doing a carbon offset project in Maryland. The analysis was done on a per-acre basis then scaled for the Tuckahoe planting across 117 acres. The range of ecosystem carbon over time was derived from the University of Maryland's NASA Carbon Monitoring System project, in which the Maryland DNR is a long term partner (Ma et al. 2021, Ma et al. 2022a and b). Three time periods were analyzed to reflect the variability in forest growth over time: 0-15 years, 15-30 years, and 30-50 years. Two growth rate scenarios were selected from the NASA CMS work, one being average growth rate for the Tuckahoe plantings and the other the maximum rate observed for each time period. A third scenario was selected representing average growth rates in the region from the USFS (Hoover et al., 2021).

Carbon accumulation rates for the three growth scenarios over the three time periods are shown in Table 1. The average sequestration rate on a yearly basis is also provided for each growth scenario. Three carbon prices were considered: \$10, \$35, and \$50 per metric tonne (t) CO_2e. These were chosen to represent the current approximate average price for offsets, the current "premium" price for offsets that represent achievement of other co-benefits, and the rate suggested as minimum for triggering significant growth in the sector (IPCC

[1]https://mde.maryland.gov/programs/air/ClimateChange/Documents/VIMAL/MD_ForestCarbon_Flux_Methodology_01.06.23.pdf

2021). Four discount rates were considered (0%, 3%, 7%, and 12%), representing a “climate” discount rate at the suggestion of several economists (Stern et al. 2006, Fleurbaey and Zuber 2013). A 0% or even negative discount is appropriate when calculating the net present value of climate investments, 3% represents the capital value for governments, 7% represents return possibly acceptable for philanthropic finance, and 12% represents the low end of necessary return on investment for traditional finance.

The two payment structures considered were an annual payout based on the carbon projected to be sequestered in that year over 50 years (Table 1) and an upfront payment structure where 20% of the total 50 year projected carbon removal, minus a 20% buffer pool, is paid in year 1 and 80% is paid in year 3 after the planting establishment has been verified (Table 2). An upfront payment structure is sometimes used for tree-planting carbon projects to compensate for the fact that it typically takes 10 years or more for trees to begin to accumulate significant amounts of carbon annually, a long time for investors to wait to begin significant payments. It is assumed that a buffer pool will not be necessary for the annual payment structure because the forest growth will be verified every five years and that a 20% buffer pool will be sufficient for the upfront payment, given the relatively low rate of disturbance in Maryland. The buffer pool is carbon that is expected to be generated by the project but not sold on the market. This is typically required by project certifiers to compensate for potential “reversals,” i.e., events like wildfires where carbon is lost. For the Tuckahoe case study, a fee of $50,000 in year 1 and $100,000 in year 4 was applied to represent the estimated cost of credit verification and marketing. Total costs for implementing the Tuckahoe project were $615,045, $270,485 in year 1 and maintenance costs of $80-$90,000 in years 2 to 5. The total cost of approximately $5,200 per acre is representative of other tree-planting projects the state has funded and similar costs were assumed for the per-acre scenarios, $3,000 in year 1 and $500 in year 2 to 5. In the per-acre scenario the cost of credit verification and marketing were assumed to be spread across the entirety of annual planted lands, approximately 500 acres, and were assumed to be $100 in year 2 and $200 in year 4. A scenario of in-state sale of self-verified credits was also considered without these costs due to the state utilizing a low-cost remote sensing-based verification protocol (scenarios referred to as no credit costs in Table 2). The non-market social cost of carbon value of the carbon sequestered was calculated by entering the sequestration estimates into a spreadsheet provided by the US EPA (US EPA, 2023).

Table 1. Carbon Accumulation Rates in Maryland Forests

	15 years	30 years	50 years	
Carbon Accumulation, Tuckahoe	30.1	68.6	99.2	t CO2e
Carbon Accumulation, High Estimate	62.3	103.9	145.4	t CO2e
Carbon Accumulation USFS*	48.3	72.3	99.7	t CO2e
Average Sequestration, Tuckahoe	2.01	2.29	1.98	t CO2e yr^{-1}
Average Sequestration, High Estimate	4.15	3.46	2.91	t CO2e yr^{-1}
Average Sequestration, USFS*	3.22	2.41	1.99	t CO2e yr^{-1}

* USFS estimates for forests in the Maryland region from Hoover et al. 2021

Results

Project costs exceed revenue from the sale of carbon offsets in most scenarios. Revenue never exceeds costs for the median carbon estimate used in the Tuckahoe planting scenario. The breakeven price for carbon using annual payments was approximately $50 per t CO2e when the net present value of the cash flow was calculated using a 0% discount rate, $90 per t CO2e under a 3% discount rate, $156 per t CO2e for 7% discount rate and $236 per t CO2e under a 12% discount rate (see Table 2).

In an upfront payment scenario, where 20% of the payment is made in year 2 and 80% in year 4, using a 20% buffer pool, revenue exceeds costs in the high carbon scenario at a carbon price of $50 per t CO2e (see Table 3); the breakeven price is $41 under this scenario. The breakeven price for the average carbon scenario is $66 per t CO2e under a 3% discount rate and $63 under a 0% discount rate. The upfront payment scheme is less sensitive to discount rate because the payments are made within the first three years.

Results are presented in Table 1 with column 1 presenting four different discount rates applied to three different carbon price points. Columns 2-7 display the Net Present Value of revenue minus costs over the project lifespan for the Tuckahoe project, carbon expected with average carbon sequestration rates, and carbon expected under maximum growth, all presented either with or without the cost of credit certification. Table 3 presents the same information in column 1 and the same carbon growth projections and all three scenarios include the crediting costs presented in the methods section. Green text represents positive and red represents negative net present value over the lifespan.

Table 2. Net Present Value for Carbon Offset Annual Payments Under Different Price and Discount Rates

Annual Payment Scenarios	Net Present Value (NPV) of Total Project Lifespan (50 years)					
Discount Rate (DR) and Carbon Price	Tuckahoe, State does crediting	Tuckahoe with Credit Costs	1 Acre, Avg. C, No Crediting Costs	1 Acre, Avg. C, with Credit Costs	1 Acre, High C, No Credit Costs	1 Acre, High C, with Crediting Costs
0% DR, $10 per t CO2e	$ (492,208)	$ (641,972)	$ (3,762)	$ (4,056)	$ (3,269)	$(3,561)
0% DR, $35 per t CO2e	$ (185,113)	$ (334,877)	$ (668)	$ (953)	$ 1,058	$ 777
0% DR, $50 per t CO2e	$ (856)	$ (150,856)	$ 1,189	$ 905	$ 3,654	$ 3,375
3% DR, $10 per t CO2e	$ (510,315)	$ (646,065)	$ (4,035)	$ (4,301)	$ (3,780)	$(4,044)
3% DR, $35 per t CO2e	$ (353,053)	$ (488,802)	$ (2,329)	$ (2,588)	$ (1,438)	$(1,693)
3% DR, $50 per t CO2e	$(258,695)	$ (394,674)	$ (1,306)	$(1,564)	$ (33)	$ (287)
7% DR, $10 per t CO2e	$ (492,058)	$ (611,799)	$ (4,000)	$ (4,234)	$ (3,865)	$(4,098)
7% DR, $35 per t CO2e	$ (409,775)	$ (529,516)	$ (3,032)	$ (3,261)	$ (2,562)	$(2,787)
7% DR, $50 per t CO2e	$ (360,405)	$ (480,366)	$ (2,452)	$ (2,680)	$ (1,781)	$(2,005)
12% DR, $10 per t CO2e	$ (455,523)	$ (558,724)	$ (3,798)	$ (4,000)	$ (3,721)	$(3,922)
12% DR, $35 per t CO2e	$ (408,362)	$ (511,563)	$ (3,208)	$ (3,405)	$ (2,938)	$(3,131)
12% DR, $50 per t CO2e	$ (380,066)	$ (483,477)	$ (2,854)	$ (3,050)	$ (2,467)	$(2,661)

Under a high carbon sequestration scenario revenues exceed costs for the price scenarios of $35 and $50 per t CO2e annual payments using a 0% discount rate or $50 per t CO2e for upfront payments.

Table 3. Net Present Value for Carbon Offset Upfront Payments Under Different Price and Discount Rates

Upfront Payment, 20% Year 1, 80% Year 3, 20% buffer pool			
	Net Present Value (NPV) of Revenue		
Discount Rate and Carbon Price	Tuckahoe	1 Acre, Avg. C	1 Acre, High C
0% DR, $10 per t CO2e	$ (516,775)	$ (4,027)	$ (3,640)
0% DR, $35 per t CO2e	$ (271,099)	$ (1,595)	$ (239)
0% DR, $50 per t CO2e	$ (123,694)	$ (135)	$ 1,801
3% DR, $10 per t CO2e	$ (494,203)	$ (3,875)	$ (3,508)
3% DR, $35 per t CO2e	$ (261,240)	$ (1,569)	$ (283)
3% DR, $50 per t CO2e	$ (121,463)	$ (185)	$ 1,651
7% DR, $10 per t CO2e	$ (466,707)	$ (3,689)	$ (3,346)
7% DR, $35 per t CO2e	$ (249,120)	$ (1,535)	$ (334)
7% DR, $50 per t CO2e	$ (118,568)	$ (242)	$ 1,473
12% DR, $10 per t CO2e	$ (435,965)	$ (3,479)	$ (3,163)
12% DR, $35 per t CO2e	$ (235,413)	$ (1,493)	$ (387)
12% DR, $50 per t CO2e	$ (115,082)	$ (302)	$ 1,279

Using the US EPA calculator for social cost of carbon the carbon sequestered by the Tuckahoe tree planting over 50 years has a present value of between $1.53 and $4.63 million dollars, depending on the discount rate. Even the low estimate exceeds the total cost of the project ($615,000) by nearly three times.

Discussion

It is not likely for the sale of carbon credits to fund, or at least to be the sole source of funding, for tree-planting projects in Maryland given the current price for carbon offsets. Carbon offsets would need to trade at $50 per t CO2e for the investment to pay for itself if future revenues were given the same preference as current costs, i.e., if a discount rate is not applied to future revenue, as has been suggested to be appropriate for climate mitigation investments (Stern et al. 2006, Giglio et al. 2013). Private finance is only likely to invest in carbon offsets from Maryland tree planting at a carbon offset rate of approximately $115 to $175 per ton of CO2e, with $115 representing philanthropic finance and $175 representing traditional finance. This is assuming a relatively low risk of the investment. While disturbance rates in Maryland forests have historically been low, climate change is projected to increase forest disturbances (Rustad et al. 2012, Vose 2018), increasing the risk of investing in forest offsets.

Crediting Carbon Towards Maryland's Climate Mitigation Goals

Beyond the rate of return for carbon offsets from afforestation, there are questions regarding the additionality of carbon offsets generated through tree plantings on state or private lands in Maryland. This is not typically due to the alternative land-use prior to tree planting, typically cropland or mowed grass with low rates of carbon sequestration, but due to the fact that the State of Maryland includes carbon removal by natural lands within its GHG inventory, and increases in this removal represents progress towards the states ultimate goal of achieving carbon neutrality by 2045. Maryland separately accounts carbon outcomes via the Greenhouse Gas Inventory from "transactions" in the voluntary market space. Meaning, from an accounting point of view, Maryland is counting all the carbon on the landscape toward climate goals, independent of the funding source (e.g., state or federal grants, voluntary carbon market sales happening independent from the state). For carbon market activities that the state is aware of or participating in, it would want to be sure those outcomes show up as credit on only one account; so if the state is purchasing the outcome, the government buys the carbon and no one else can buy it too. The GHG inventory, however, is where official credit for that project is accounted for, meaning that Maryland doesn't add the credited carbon to the inventory.

It may be that this could be avoided by limiting the sale of offsets to entities within the State of Maryland, if those entities fell under the regulatory authority of the state. If carbon offset revenue was used in a revolving way, where revenue was reinvested in additional afforestation projects, this would also help address questions about the legitimacy of the carbon offset. That said, these results show it is not likely for carbon offset revenue to fully pay for afforestation project costs, so the question of additionality remains.

Transferability of This Work

While this analysis was performed from the perspective of the State of Maryland, the results likely have implications for potential private finance investment in tree plantings on private lands. The state benefits from the larger 5 Million Trees Initiative, where Maryland Forest Service staff and partners engage in landowner outreach and project development and partner with MDE to conduct an awareness campaign and track the plantings over time. A private entity would likely incur significant costs in project design and set-up. Steps including initial feasibility assessment, ground truthing, baseline social and biodiversity assessment, stakeholder consultation, drafting of the plan, legal consultation, carbon validation, and other costs can add hundreds of thousands of dollars to the overall project. A recent estimate from the Climate Action Reserve of these costs was $125,000 to $160,000 per project. The state would incur an extra cost from carbon validation and market transaction costs if they were to bring carbon offsets to market but otherwise most of these costs have already been embedded within the greater tree-planting effort. The costs used here were sourced from actual cost data from the Tuckahoe planting project; we believe this is a conservative estimate of average costs because this project falls on the low end of the average per-acre tree-planting project costs. A private entity may achieve cost savings in the plantings themselves, and possibly in project management, particularly if economies of scale are achieved, but overall it is likely that privately financed tree planting projects in Maryland would be more costly than the state-funded projects analyzed here.

An alternative to direct participation in carbon markets is to use market-based incentives in state programs. For instance, using pay-for-success/pay-for-performance may be a way to invest in carbon outcomes (i.e., functionally invest in long term maintenance to ensure carbon sequestration outcomes) without all of the additional requirements and costs of participating in the voluntary market. The state's approach of verifying outcomes with remote sensing/modeling is low cost, uncertainty is likely within 20%, allowing the annual budget to go farther. Private investors front load the costs of large-scale reforestation/afforestation projects they might not otherwise do and are compensated via the Trust Fund or other MDE funds. The total budget for these investments is still dependent on state funds, but the programs may attract new landowners to the program beyond those who are already engaged in existing grant programs if there was aggregation or other support provided by private finance. A better understanding of carbon outcomes would also aid in the rationale for directing funds from future revenue generating climate compliance programs, potentially like compliance with Maryland's Building Energy Performance Standards. Revenue would be collected from entities needing to pay into a fund to comply with the regulation, but this would not be a 1:1 offset program. The Regional Greenhouse Gas Initiative (RGGI) program functions this way in New Jersey, with 10% of allowance auction proceeds directed towards natural climate solution projects like wetland restoration and tree planting.

Social Cost of Carbon

When taking a holistic look at the economic benefits of removing carbon dioxide and other greenhouse gasses from the atmosphere through calculating the social cost of avoided carbon emissions, the state's investment in tree planting looks favorable. Avoided costs associated with climate change far exceed the project costs in all scenarios presented by the US EPA. A caveat is that the social cost of carbon is based on global damages caused by climate change. Maryland does rank high in terms of vulnerability to climate change (14th in the United States, according to the Climate Vulnerability Index)[2], so it is possible that Maryland would disproportionately benefit from climate mitigation relative to the global estimate.

[2] https://map.climatevulnerabilityindex.org/map/cvi_overall

Carbon as a Co-benefit

Carbon sequestration is the most obviously marketable ecosystem service from tree planting, apart from harvested wood products, and is a key part of the state's strategy to achieve net zero GHG emissions by 2045. However, carbon is not the only or the most important benefit that trees provide. New tree plantings on lands that were previously grass or cropland provides a large benefit for water quality, particularly if the planting occurs alongside a waterbody or land in agriculture. Forests also provide habitat for wildlife, opportunities for outdoor recreation, reduction in flood risk, protection of drinking source water, and removal of pollutants from the air that would otherwise increase risk of human health impacts. Altogether, Maryland DNR's prior work on ecosystem services indicates that the forests of Maryland provide $7.5 billion of non-market economic value to the people of Maryland every year (Campbell et al. 2020). Providing this full suite of benefits is the driving force behind forest conservation and afforestation in the state.

Conclusion

Tree planting is an essential part of Maryland's climate mitigation strategy and the benefits of newly established forests far outweigh the costs of planting them. However, given the current market for voluntary carbon offsets/credits and the uncertainty around how to satisfy the requirement for additionality while also progressing Maryland's climate mitigation goals it is not likely that this mechanism will be a viable option for funding tree planting on state lands.

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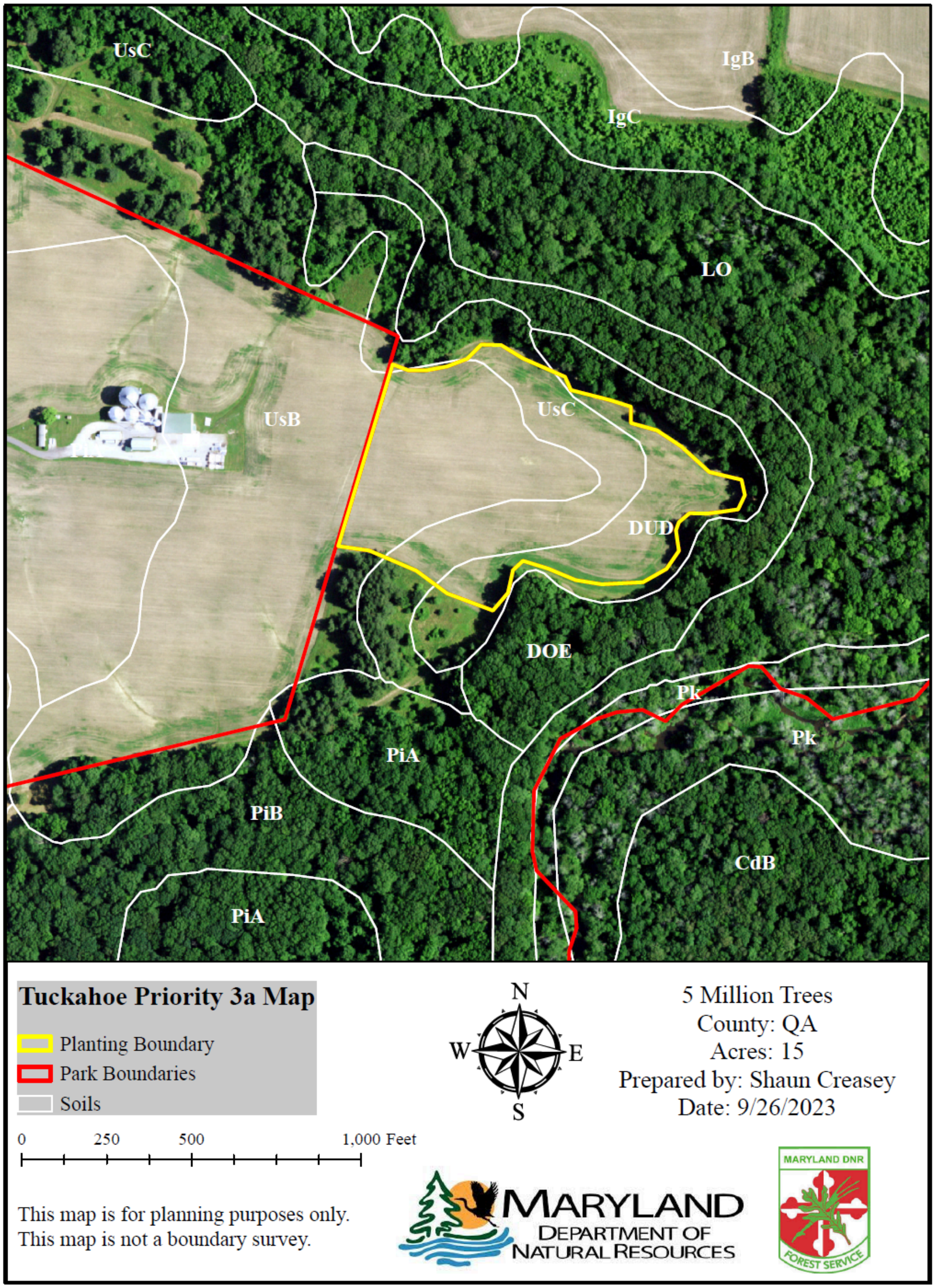
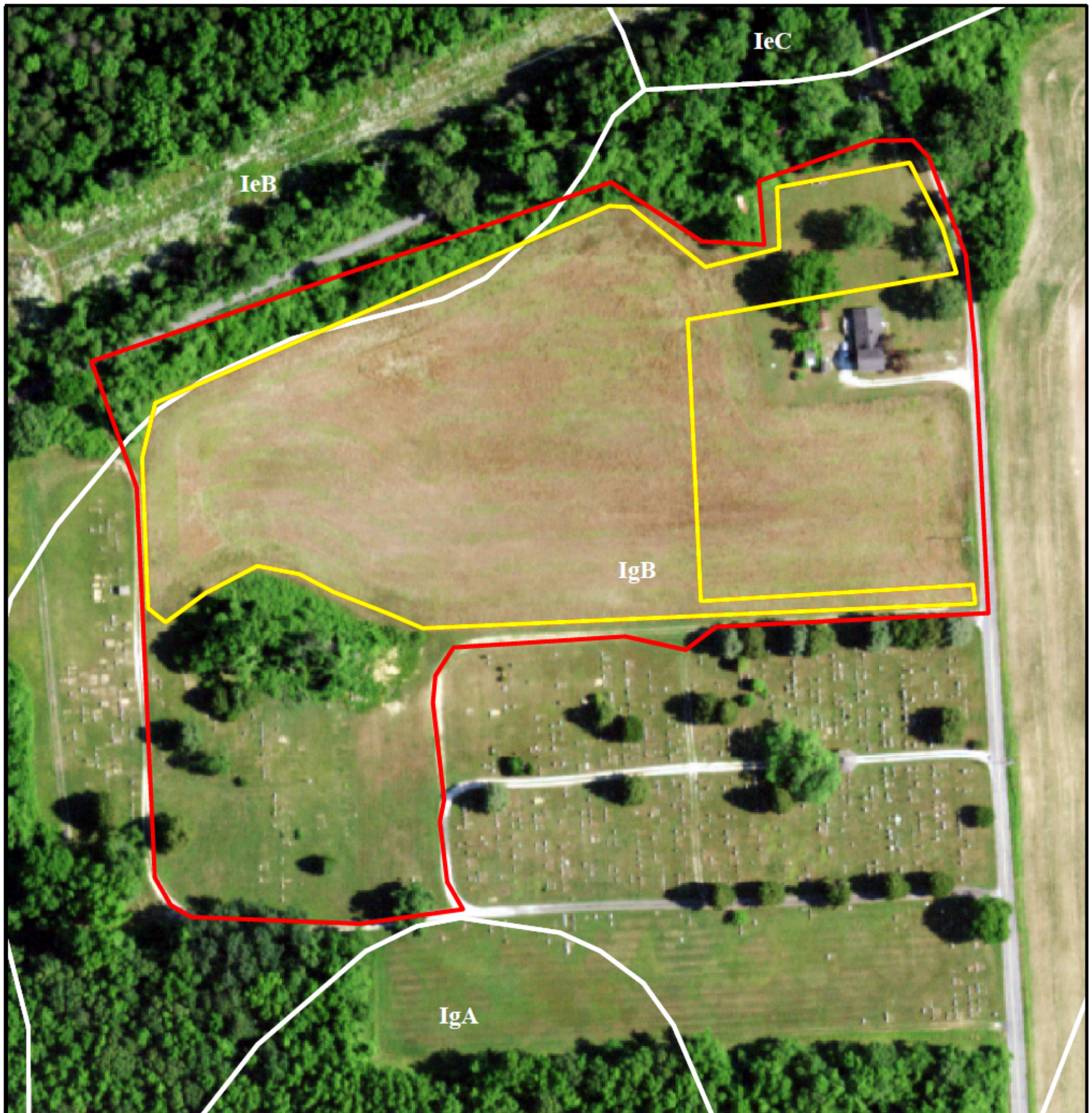
Appendix A: Tuckahoe Planting Maps





Tuckahoe Priority 3b Map

Planting Boundary
Park Boundaries
Soils

N
W
E
S

5 Million Trees
County: Caroline
Acres: 6
Prepared by: Shaun Creasey
Date: 9/26/2023

0 110 220 440 Feet

This map is for planning purposes only.
This map is not a boundary survey.

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