NRCS Final Grant Report

Project Title: Dogwood Alliance's Carbon Canopy Project

Grant Number: CIG 69-3A75-13-207

Project Manager: Andrew Goldberg

Current Contact: Tyson Miller (tyson@dogwoodalliance.org)

Timeline: 2013-2016

Report Submission Date: November 23, 2016

Deliverables: Completed forest carbon offset project; lessons learned report

Table of Contents

Executive Summary

NRCS Priorities

This project addresses the NRCS's priority to prepare agricultural producers, including EQIP eligible forest landowners, for participation in greenhouse gas markets in order to increase the nation's capacity for land-based carbon sequestration and use carbon markets to keep small landholders from converting to non-agricultural land uses. The round of CIG grants for which we applied had a focus on technical assistance for small forest landowners to prepare them for being able to access forest carbon offset markets.

Purpose

The purpose of the project was to demonstrate a market-based approach to funding forestland conservation and stewardship practices through the creation and sale of high quality forest carbon offsets and Forest Stewardship Council (FSC) certified timber management. The intent of this innovative model of forest conservation and management was to provide a viable funding mechanism from revenue produced from forest –based carbon offsets under the California carbon cap and trade program to enable this landowner and ultimately other private landowners to expand protection, restoration and conservation of their forests under certified forest management practices to the high standards of FSC certification.

Developing forest carbon offset projects in the highly variable mixed hardwood forests of the Eastern U.S. is challenging and requires some amount of trial and error due to the difficulty in accurately predicting starting carbon stocks in the absence full inventory data. In addition, predicting whether there will be adequate growth to sustain a carbon project while also producing commercial timber is also difficult on limited data. In the absence of sufficient experimentation and pilot project development, it is difficult to standardize the process and provide information to non-industrial landowners who may be able to take advantage of the combination of income from carbon offset projects and the sale of FSC timber.

Background

For too long, the forest economy of the US South has been based almost exclusively on resource extraction at the expense of other forest values such as carbon sequestration, water quality and biodiversity. Across the South, the economic and cultural reach of industrial forestry runs deep. While there has been some progress in recent years, natural forests are still converted to pine plantations and more than five million acres are clear-cut for forest products annually. Further, outdated government subsidies still drive unsustainable resource extraction through tax breaks and cost-sharing, while funding for conservation suffers. The traditional model of land conservation requires significant funding from state and federal sources amounting to thousands of dollars per acre conserved.

Getting private forests into FSC certification can help drive a move towards more sustainable management that provide vital ecosystem services in addition to wood products. The area in FSC-certified forests in the United States has grown, from 9 million to 35 million acres in the past ten years, but only 16 percent of this is in the South—just under 4 million acres or 2 percent of the southern forests. This low penetration is largely due to the fact that many southern landowners lack access to viable tools or sufficient economic incentives to help them conserve, restore, manage and certify working forests to a high environmental standard. In addition, there are real and ongoing costs associated with forest certification. And often times, FSC forest management plan calls for less harvest volume than legally permissible, so there is less timber revenue for the landowner. Put simply, under the current paradigm, it just doesn't pay to improve forest management practices though the climate, water and biodiversity benefits of well-managed forests are significant. Taken together these factors represent a significant barrier to entry for certification.

Creating alternative markets for small forest landowners assists with their economic viability and ability to stay on the land in the long-term. Timber and pulp markets can be volatile, and non-industrial owners oftentimes harvest only once or twice during their tenure. Providing a source of more frequent payments for ecosystem services produced through sustainable management can allow forests to be a reliable source of income for landowners and prevent the need either for episodic unsustainable harvest or to sell the land for development.

Accomplishments

While this project did not achieve its intended goal of bringing a forest carbon offset project under the California regulatory protocol to market, it did accomplish two important things that assist in the advancement of carbon markets for small forest landowners:

1) We achieved a high accuracy carbon inventory that met the standards of the California protocol and can pass on that technical knowledge to other landowners.
2) We assessed the financial conditions under which a forest carbon project would be viable for a non-industrial landowner for low productivity forests in the southern Appalachians.

Barriers to Completion

The main barrier to completing full carbon project development was the lower than expected revenue potential of the carbon offset revenue stream compared to timber revenue for this particular non-industrial forest landowner. After completion of the full carbon inventory and preliminary financial analysis, the landowner decided not to move ahead with a full project development. The landowner's decision not to move forward with the project revolved around three major factors. The first was uncertainty about the future of the carbon market. The second is the high expense of project development and maintenance compared to credit yield and credit value at this stage of maturity of the carbon market and given productivity conditions of the project site. The third is the higher certainty and value that revenue for timber harvest provides compared to managing with a higher emphasis on carbon sequestration.

While the starting carbon stocks on the property were much higher than the Common Practice Indicator, and a baseline scenario in which all available merchantable timber could have easily been shown to be financially feasible (therefore additionality of the carbon credits would have been valid), the low site quality and therefore low future growth rates of the forest made it so future carbon credit accumulation would be low. High project maintenance costs would not have been sufficiently balanced by carbon revenue to make the risks of low prices and high costs worth the commitment. Neither the regulated carbon market in California nor demand from voluntary corporate buyers is sufficiently certain to be able make a 100 year commitment to monitoring and verifying carbon stocks associated with the initial sale of credits after the first verification, as is required by the California protocol and its associated regulations.

In the two years since this project started development, political uncertainty continues to plague California's cap and trade system, despite the program's success at delivering emissions reductions at reasonable cost, and meeting legal requirements. The State of California passed new legislation in 2016, SB 32, which gave legal force to a 2030 emission reduction goal. This legislation did not however explicitly re-authorize the use of cap and trade to reach those emission reduction requirements and on-going litigation over the use of a permit auction has made the system's future uncertain. In the face of such uncertainty, it is difficult to have confidence in price projections or whether to make long-term commitments based on future income.

Forests in the southern Appalachians tend to have slow growth rates. While this in and of itself should not prevent a payment system for net accumulation of carbon stocks, given the value of land-based mitigation strategies for meeting our nation's commitments to reduce CO_2 emissions in the Paris accords. However, the overall price dynamics of the California carbon market combined with the currently high costs of collecting inventory data and conducting project verification provide too small a margin of comfort for future income when compared to the relatively predictable income one can receive from harvesting timber. In addition, once harvests are complete, there are few legal obligations to take into account when making future decisions about one's property, compared to the 100 year obligation after selling carbon credits.

Finally, slow growth rates create conditions such that even relatively low levels of harvests could create temporary reversals of emission gains, or reduce carbon credit yield to the point where the project would have to be financially subsidized by timber revenue. It is not surprising that landowners would chose not to enter into carbon offset projects under these conditions.

While Dr. Argow is very committed to seeing carbon markets play a role in helping non-industrial forest landowners conduct sustainable management, this particular set of circumstances did not fit his goals of being able to manage for both timber and improved carbon stocks.

Project Completion Timeline and Grant Beneficiaries

The project did not run over its anticipated timeline. This was however due to the landowner's decision not to complete the project due to financial considerations.

Beneficiaries of this grant are other non-industrial landowners considering entering the California forest carbon offset market. Information we generated from assessing the viability of this project, in addition to other projects as part of the larger Carbon Canopy program, assists other landowners in determining whether their lands and their management goals are a fit for the market as it currently stands, and where it might go in the future.

Budget

We invoiced $28,778 out of the total $45,000 grant award. That we spent less than the total grant award reflects the fact that we did not take forest carbon offset project development to its completion. Funds were spent as expected for the forest carbon inventory, analysis of inventory data and translating of that data into carbon stocks, determining the Common Practice Indicator for the project area, and conducting the preliminary financial analysis.

Alternative Technologies

No alternative physical technologies were employed in this project. Use of carbon markets were however considered an alternative and innovative financial approach to keeping non-industrial forest landowners on the landscape and allowing them to improve the ecological health of their lands and the economic performance of their assets.

Results

<u>Inventory</u>

A total of 219 plots were installed over 2,255 acres. Height, diameter, species, and defect were measured/recorded on each plot for standing live and dead trees.

The statistical accuracy of the carbon plots measurements are required to be at a standard error of less than +/- 5% at a 90% confidence interval in order to not have carbon stocks discounted for measurement uncertainty. The accuracy of this inventory exercise was +/- 2.2% at the 90% confidence level, and so met the highest expectations of the protocol.

Starting Carbon Stocks

The starting carbon stocks were determined to be above the Common Practice Indicator (CPI). This is a value that is based on average carbon stocking for non-federal lands by eco-region and is the major determinant for carbon project baselines in the ARB protocol. In general, projects which have starting carbon stocks above the CPI have a higher chance of being financially viable than projects which start at or below this value.

The Common Practice Indicator for the project area was 85.6 metric tons of above ground live CO2e per acre. Starting stocks for the project area were 108.8 above ground live metric tons of CO_2e per acre.

This surplus of 23.2 metric tons of CO_2e per acre based on the inventory data but prior to full baseline modeling that carbon offsets indicated that the project had high potential to be financially viable, and attractive to the landowner.

Preliminary Financial Analysis

Based on the starting stocks, and prior to full modeling, a preliminary financial analysis of project viability was conducted in order to assess the likelihood that the carbon project would provide a net profit to the landowner. This analysis involved making assumptions about the growth rate of the forest on project lands, and the amount of harvested wood products to be produced under both the baseline and project scenarios. Costs of project maintenance are known. A sensitivity analysis was run varying prices of carbon offsets over the life of the project. The landowner then had the option to decide whether to move forward based on preliminary projected financial returns.

The results of the preliminary financial analysis showed a spread in projected income from the project of a net revenue over 30 years of $707,000 to a worst case scenario of low prices and high costs of a net loss of $195,000 over 30 years. The more optimistic scenario was within the bounds of existing experience and conservative price projections. However, we also felt that it was important to understand what might happen financially if prices became and stayed depressed, and if the ARB review process became even more cautious and legalistic than it is currently, which could drive up verification expenses significantly.

We also think that progress in technology for gathering and verifying inventory data could reduce project costs significantly in the future. We however did not project any reduced costs into the future, and based our analysis solely on existing technology and costs.

The estimate which received a net positive revenue assumed prices started at $12/credit for the first two years of sales, went to $15/credit from 2017-2022, went to $20/credit from 2022 to 2032 and topped out at $25/credit for the remainder of the analysis period. The pessimistic scenario started at $9/credit, dipped to $7 per credit, and stayed there for the duration of the analysis period.

For comparison, California Air Resources Board Offset Credits (ARBOCs) are selling for approximately $10 to regulated buyers. We have transacted credits to voluntary corporate buyers in the $12-$15 range. We have also completed verifications for $45,000, which is less than the cost used in the more optimistic scenario. The high cost scenario reflects the potential for unforeseen circumstances to arise during either the field or desk review processes.

While a formal pro forma analysis was not done on timber revenue, a timber cruise was conducted. The cruisers and our timber mill partner in Carbon Canopy, estimated the stumpage value of available harvestable volume to be $914,000 at 2014 prices.

Even with the more optimistic scenario for the carbon project, in which the first two years with of income was nearly $570,000, timber revenue was still 1.6 times higher over the same time period. While harvesting all merchantable timber at one time was not the landowner's intent, this is still a significant difference in potential near-term income.

Recommendations

Carbon markets, especially the one established through California's cap and trade system, still retain potential, three things need to occur in order to drive change in private forest management:

1) Political uncertainty involving the use of cap and trade to meet California's 2030 goals should be resolved;
2) Prices need to increase to above $15/credit
3) Costs associated with project development and maintenance need to be reduced, either through technological advances, or streamlining of the project approval process, or both.
4) Other non-offset approaches to financing forest carbon gains should be explored.

There have been ongoing discussions about extending the cap and trade program to at least 2030, if not 2050. California Governor Jerry Brown issued an executive order in 2015 that calls for reductions of GHG emissions to 40% below 1990 levels by 2030. The California State legislature passed SB 32 in the summer of 2016 to institutionalize this goal into law. This legislation did not however explicitly re-authorize cap and trade. As of the writing of this report, discussions are on-going about the best way to ensure legal stability of the market post 2020. ARB is also in the process of updating its scoping plan (the official plan by which it meets its overall GHG reduction goals, including all relevant mechanisms, including cap and trade) and just released a new discussion draft of regulations to extend the market to 2050 (http://www.arb.ca.gov/cc/capandtrade/draft-ct-reg_071216.pdf).

If these goals are incorporated into a formal regulatory cap, the demand for offsets should increase significantly, and the price should rise accordingly. If this state of affairs comes to pass, the feasibility of using California's carbon market to drive sustainable forestry in the southern Appalachians and throughout the country should increase from where it is today.

Market participation would also improve if project development became somewhat less burdensome and unpredictable from a regulatory perspective. In addition, if the use of remote-sensing techniques such as LIDAR and drone technology to measure carbon stocks eventually replaced on-the-ground plot measurements, project development and long-term maintenance costs would decrease significantly, making what are now marginal or inadvisable projects much more attractive.

If prices stay below $20/credit, other non-market mechanisms should be developed to incentivize non-industrial landowners to manage for retention or improvement of forest carbon stocks. Some suggestions are detailed in the full report, but include use of term payments and permanent conservation easements that are funded through programs that recognize the cost of emitting greenhouse gases, but use in a complementary manner to those emissions, rather than as a substitute as is in done with the offset mechanism.

Introduction

Purpose and Objective of the Project

The purpose of the project was to demonstrate a market-based approach to funding forestland conservation and stewardship practices through the creation and sale of high quality forest carbon offsets and Forest Stewardship Council (FSC) certified timber management. The intent of this innovative model of forest conservation and management was to provide a viable funding mechanism from revenue produced from forest –based carbon offsets under the California carbon cap and trade program to enable this landowner and ultimately other private landowners to expand protection, restoration and conservation of their forests under certified forest management practices to the high standards of FSC certification.

The Crummie's Creek project must be viewed in the broader context of the Carbon Canopy program's 5 year strategic plan adopted by the partners in 2012. Our goals were focused on expanding the number and acreage of FSC-certified, ARB-compliant carbon projects in the Southern Appalachian region to build the foundation for a achieving our long-term goal of catalyzing the sustainable stewardship of an additional 20 percent of southern forests or 40 million acres over the next 20 years. The five year goal was to move 100,000 acres of ARB-compliant, FSC-certified projects forward in the Southern Appalachian region. This project was one of a suite of projects we were attempting to move through the project development and verification process, part of a shorter-term goal to complete projects on 20,000 acres over a two-year period. The initial projects were intended to test feasibility and approaches with differently sized projects, develop templates (e.g., terms sheets) reduce transaction costs and create replicable procedures to make scale-up feasible in subsequent years.

Developing forest carbon offset projects in the highly variable mixed hardwood forests of the Eastern U.S. is challenging and requires some amount of trial and error due to the difficulty in accurately predicting starting carbon stocks in the absence full inventory data. In addition, predicting whether there will be adequate growth to sustain a carbon project while also producing commercial timber is also difficult on limited data. In the absence of sufficient experimentation and pilot project development, it is difficult to standardize the process and provide information to non-industrial landowners who may be able to take advantage of the combination of income from carbon offset projects and the sale of FSC timber. We intended to use this project to serve as an important vehicle for learning and dissemination of that learning to other non-industrial owners. Dr. Argow is both the President and CEO of the National Woodlands Association, he is publisher of the National Woodland magazine. The goal was to use the magazine to describe the characteristics of projects that can be successful for this type of landowner.

Project Location

The proposed project area was located on several tracts of forest totaling approximately 2,000 acres in Calhoun, Gilmer, Roane, Randolf and Tucker Counties in West Virginia. During project development, we also added a 790 acre parcel also owned by Dr. Argow from southwestern Virginia.

County	Tract	Est. Acreage	Forested Acreage
Calhoun	Crummies	760	725
	Groundhog	225	225
	Mule Knob	215	175
	Rush Run	165	160
Gilmer	Indian Fork	351	339
	Steer Creek	96	96
Roane	Poca	72	71
	Stringtown	65	65
Randolph	Cheat Mt.	85	84
Tucker	St. George	46	46
		2,080	total approximate acreage

Project Personnel and Qualifications

Key project personnel were:

Andrew Goldberg, was Director of Corporate Engagement at the Dogwood Alliance during this project. Mr. Goldberg lead the Carbon Canopy project for four years and oversaw all aspects of the partnership including planning, fundraising and recruitment. In addition, as Director of Corporate Engagement for Dogwood Alliance, Andrew Goldberg also managed relationships with major corporations as well as other key stakeholders in the industrial wood products supply chain to foster continuous improvement in industrial forestry practices and advance Dogwood Alliance's forest conservation objectives. He lead Dogwood's work in implementing Memoranda of Understanding around supply chain sourcing improvements with Bowater now known as Resolute Forest Products, Georgia-Pacific and International Paper. In addition, he serves on the Forest Stewardship Council U.S. Controlled Wood Working Group and SE Regional Steering Committee 2012. He currently works for the Rainforest Alliance. Prior to joining Dogwood Alliance, Mr. Goldberg was the Program Coordinator for Environmental and Natural and was a Visiting Professor, College of Business and College at the University. He has a B.A. in history from Tufts University and a J.D. and Certificate in Environmental and Natural Resources Law from Northwestern School of Law, Lewis & Clark College, where he was a Natural Resources Scholar.

Jon Shaffer, was technical forestry consultant with Forest Stewards. Mr. Shaffer has worked as a consulting forester for Forest Stewards and taught forestry for Western Carolina University. He provided consulting forestry services to private landowners and municipalities, as well as being involved in prescribed fire research on state and federal lands. He has comprehensive experience in forest stewardship planning, forest inventory design and implementation, timber sale planning and administration, forest growth modeling, controlled burning, and geospatial analysis. He has a Masters in Forestry from Duke University. Jon has recently moved to New Hampshire to work for EcoForesters in New Hampshire and conducts verifications for carbon offset projects.

Dr. Paula Swedeen of Swedeen Consulting managed overall project development. She has worked on forest conservation issues for 27 years. Her primary focus over the past 10 years has been the development of policies and programs to create ecosystem service payments and markets involving carbon, wildlife, and water. She is a member of the Washington State Forest Practices Board, which regulates forest harvest on 10 million acres of state and private lands. She has provided key input to the Climate Action Reserve and the California Air Resources Board on forest carbon protocols and cap and trade regulations. She has managed the development and implementation of forest carbon projects in multiple locations around the country, including a program that joins forest carbon credits with FSC certification in the U.S. South (Carbon Canopy). She was project lead for the only forest carbon offset project so far to be developed in the Pacific Northwest under the ARB protocol. She has also successfully developed a payment for watershed services project in the Nisqually Watershed around the City of Olympia's wellhead protection area, and currently is working to expand the use of water as a driver for payments for ecologically based forest management. She currently works on these issues for the Washington Environmental Council. Prior to this, Dr. Swedeen worked for the State of Washington (DNR and WDFW) for 12 years as a wildlife biologist and policy analyst on endangered species conservation in forests. She has a B.S. in Biology from Indiana University, a Masters of Environmental Studies and Political Science from Western Washington University, and a Ph.D. in Interdisciplinary Studies with an emphasis on Ecological Economics from the Union Institute.

Project Funding

The overall Carbon Canopy program was funded through a combination of foundation grants and philanthropic gifts from co-operating companies. This funding allowed technology transfer from west coast experts in carbon project development to local technical consultants to become trained in carbon project specific inventory and carbon stock calculation methods. This particular project was however funded entirely through this CIG grant.

Project Background

For too long, the forest economy of the US South has been based almost exclusively on resource extraction at the expense of other forest values such as carbon sequestration, water quality and biodiversity. Across the South, the economic and cultural reach of industrial forestry runs deep. While there has been some progress in recent years, natural forests are still converted to pine plantations and more than five million acres are clear-cut for forest products annually. Further, outdated government subsidies still drive unsustainable resource extraction through tax breaks and cost-sharing, while funding for conservation suffers. The traditional model of land conservation requires significant funding from state and federal sources amounting to thousands of dollars per acre conserved.

Forests are indisputably essential to the health of the planet, yet globally face intense pressure. They not only provide everyday products such as timber and paper, but also other critical ecosystem services including protection of biodiversity, water filtration and provision, and flood attenuation. In addition, conservation, restoration and responsible management of forests are critical in the global effort to address climate change because they remove and store significant amounts of carbon from the atmosphere.

The Southern US is home to the most biologically diverse forests in North America, yet this one region produces more paper and wood products than any other country in the world. Although they comprise just 2 percent of the planet's total forest cover, southern forests produce 25 percent of the world's pulpwood for paper and paper-related products and 18 percent of the its industrial timber.

Pressure from the intense demand for paper and wood products has led to large scale clear-cutting and the conversion of natural forests to plantations – practices that significantly degrade forests and threaten many important ecosystem services provided by forests including carbon storage and biodiversity protection. Changes in forest ownership exacerbate these pressures. Eighty-seven percent of the forests in the South are privately held, with one-third of this owned by companies and the rest by individuals and families. Recent divestitures of expansive tracts of forestland by large paper companies pose the risk of further forest fragmentation and parceling.

In addition, non-industrial owners are ageing and survey data indicates that many younger members of these families are not likely to maintain ownership. This generational turn-over can and does result in conversion of forests to other types of land uses.

Over the past decade, large corporate consumers of paper and wood products originating from southern forests have committed to increase the amount of products they purchase that are certified by the Forest Stewardship Council (FSC), the most robust certification system for sustainable forest management in existence today. This shift in the marketplace has prompted large paper producers to begin improving their fiber sourcing to meet customer demand for FSC products. This, in turn, has resulted in the growth of FSC-certified forests across North America.

Yet, while FSC-certified forests in the United States have grown, from 9 million to 35 million acres in the past ten years, only 16 percent of this is in the South—just under 4 million acres or 2 percent of the southern forests. This low penetration is largely due to the fact that many southern landowners lack access to viable tools or sufficient economic incentives to help them conserve, restore, manage and certify working forests to a high environmental standard. In addition, there are real and ongoing costs associated with forest certification. And often times, FSC forest management plan calls for less harvest volume than legally permissible, so there is less timber revenue for the landowner. Put simply, under the current paradigm, it just doesn't pay to improve forest management practices though the climate, water and biodiversity benefits of well-managed forests are significant. Taken together these factors represent a significant barrier to entry for certification.

Creating alternative markets for small forest landowners assists with their economic viability and ability to stay on the land in the long-term. Timber and pulp markets can be volatile, and non-industrial owners oftentimes harvest only once or twice during their tenure. Providing a source of more frequent payments for ecosystem services produced through sustainable management can allow forests to be a reliable source of income for landowners and prevent the need either for episodic unsustainable harvest or to sell the land for development. Getting properties into FSC certification with accompanying management plans can also improve long-term productivity for high-quality timber products, such as veneers for plywood used in value-added cabinet and furniture production.

Review of Methods

Methods to develop a forest carbon offset project under the California Air Resources Board protocol and using Carbon Canopy's business relationships for the Crummies Creek properties included the following steps:

Inventory Design: A full project carbon inventory was designed based on the vegetation types present on the property. This design included stratification (i.e., distributing plots by vegetation type rather than treating the property as a uniform type), which reduced the total number of plots required to reach desired statistical accuracy, and therefore cost.

A total of 219 plots were installed over 2,255 acres. Height, diameter, species, and defect were measured/recorded on each plot for standing live and dead trees.

Data Collection: Plots were measured and data formatted for modeling in the Forest Vegetation Simulator, which is a forest growth and yield model used to project both baseline and project management scenarios. Data was collected during leaf-off in order to improve height accuracy.

The statistical accuracy of the carbon plots measurements are required to be at a standard error of less than +/- 5% at a 90% confidence interval in order to not have carbon stocks discounted for measurement uncertainty. The accuracy of this inventory exercise was +/- 2.2% at the 90% confidence level, and so met the highest expectations of the protocol.

Carbon Stock Calculations: Starting carbon stocks were calculated according to the Component Ratio Method as described in the California Air Resources Board protocol methods. A fuller description of these methods is included in the Technical Appendix.

The starting carbon stocks were determined to be above the Common Practice Indicator (CPI). This is a value that is based on average carbon stocking for non-federal lands by eco-region and is the major determinant for carbon project baselines in the ARB protocol. In general, projects which have starting carbon stocks above the CPI have a higher chance of being financially viable than projects which start at or below this value.

The Common Practice Indicator for the project area was 85.6 metric tons of above ground live CO2e per acre. Starting stocks for the project area were 108.8 above ground live metric tons of CO_2e per acre.

This surplus of 23.2 metric tons of CO_2e per acre based on the inventory data but prior to full baseline modeling that carbon offsets indicated that the project had high potential to be financially viable, and attractive to the landowner.

Preliminary Financial Analysis: Based on the starting stocks, and prior to full modeling, a preliminary financial analysis of project viability was conducted in order to assess the likelihood that the carbon project would provide a net profit to the landowner. This analysis involved making assumptions about the growth rate of the forest on project lands, and the amount of harvested wood products to be produced under both the baseline and project scenarios. Costs of project maintenance are known. A sensitivity analysis was run varying prices of carbon offsets over the life of the project. The landowner then had the option to decide whether to move forward based on preliminary projected financial returns.

The results of the preliminary financial analysis showed a spread in projected income from the project of a net revenue over 30 years of $707,000 to a worst case scenario of low prices and high costs of a net loss of $195,000 over 30 years. The more optimistic scenario was within the bounds of existing experience and conservative price projections. However, we also felt that it was important to understand what might happen financially if prices became and stayed depressed, and if the ARB review process became even more cautious and legalistic than it is currently, which could drive up verification expenses significantly.

We also think that progress in technology for gathering and verifying inventory data could reduce project costs significantly in the future. We however did not project any reduced costs into the future, and based our analysis solely on existing technology and costs.

The estimate which received a net positive revenue assumed prices started at $12/credit for the first two years of sales, went to $15/credit from 2017-2022, went to $20/credit from 2022 to 2032 and topped out at $25/credit for the remainder of the analysis period. The pessimistic scenario started at $9/credit, dipped to $7 per credit, and stayed there for the duration of the analysis period.

For comparison, California Air Resources Board Offset Credits (ARBOCs) are selling for approximately $10 to regulated buyers. We have transacted credits to voluntary corporate buyers in the $12-$15 range. We have also completed verifications for $45,000, which is less than the cost used in the more optimistic scenario. The high cost scenario reflects the potential for unforeseen circumstances to arise during either the field or desk review processes.

While a formal pro forma analysis was not done on timber revenue, a timber cruise was conducted. The cruisers and our timber mill partner in Carbon Canopy, Columbia Forest Products, estimated the stumpage value of available harvestable volume to be $914,000 at 2014 prices.

Even with the more optimistic scenario for the carbon project, in which the first two years with of income was nearly $570,000, timber revenue was still 1.6 times higher over the same time period. While harvesting all merchantable timber at one time was not the landowner's intent, this is still a significant difference in potential near-term income.

The financial analysis spreadsheet is attached as an appendix.

The remainder of the steps below, as described in the original grant application, were not completed because the landowner decided not to move ahead with the project after the results of the preliminary financial analysis. A discussion of the factors that lead to this decision, and why this was not foreseen prior to commencing project development are discussed below.

[Full Modeling: Inventory data will then be used to model out a baseline scenario (harvest regimes under a "no project" situation) over 100 years to demonstrate that carbon stocks can be reduced to the minimum baseline level, (the Common Practice Indicator for the ecological assessment area) in a financially feasible manner that also takes into account any legal restrictions on the property. In addition, several project management scenarios will be modeled in order to help the landowner understand the range of management flexibility that he will have under a carbon project to produce timber as well as carbon credits. These project scenarios are also helpful for calculating how carbon stored in wood products affect the final credit calculations.

Credit Calculations: Based on the results of the full modeling, calculation of the amount of credits available for registration and sale will be conducted according to the methods described in the ARB protocol. This involves taking into account any discounts for less than full accuracy of inventory data, if any (this can be an issue for highly diverse stands in which it may be less expensive to take a discount rather than put the full number of inventory plots required to reach =/-5 % accuracy at a 90% confidence interval); buffer pool contribution; and primary and secondary effects of the project on storage of carbon in wood products.

Final Financial Analysis: After full modeling and credit calculations, a more accurate projection of financial prospects for the project is possible. The preliminary pro forma conducted in 4) will be updated to reflect modeled credit generation over time. If the project still looks attractive to the landowner, the formal submission process will begin.

Listing: The project team will fill out listing information and submit the paperwork to the Climate Action Reserve, which is an accredited project Registry for California Air Resources Board compliance offset projects. Information generated from the inventory and modeling steps above are required for the listing form.

Verification: While the Climate Action Reserve is reviewing the project for eligibility, the project team will assemble the full Project Design Document and prepare for Third Party Verification. Once notification of acceptance of listing is

received, the project team in cooperation with Dr. Argow will schedule and conduct project verification with an ARB accredited third-party verifier.
Registration: once verification is complete, the project team will complete the final administrative steps according the ARB regulations for project registration. This includes having the ARB review the "registry" project – this is a final review stage after the Climate Action Reserve has approved the project as meeting all protocol and regulatory guidelines.

Sale of credits to Carbon Canopy Buyers: We will work out template contract language for both the landowner and corporate voluntary buyers of ARB offset credits and execute the first sale of credits.]

Quality Assurance

The main component of quality assurance for the parts of the project that were completed involve inventory data collection and the preliminary financial analysis. The inventory data collection process was check-cruised – i.e., an independent forester visited a random selection of plots to ensure that cruiser instructions were followed and measurement results were the same. If more than 5 percent of plots had any discrepancies, the overall inventory process would have been re-examined. The check cruise passed with all sampled plots.

Assumptions of the sensitivity analysis were examined by all team members and an outside carbon project developer.

Had the project gone through full development, quality assurance is built in through the third party verification process. In addition, the offset regulations require that both the third part project registry and the Air Resources Board review project documentation and the verification report. This process results in three levels of review prior to credit issuance. On other projects we have worked on that have gone through the full process, all of these steps were undertaken with a high level of scrutiny by the parties involved. The credit issuance process often takes several months after the third party verification has been successfully completed.

A copy of the inventory sampling plan is included here. Maps of inventory plot layout are included in the appendix.

2014 Inventory Sampling Summary for the Argow Properties in West Virginia

Inventory sampling has multiple goals on the Argow properties. Beyond tracking inventory changes over time, specific objectives include:

- Establishing required confidence in inventory sample
- Validating modeling assumptions
- Updating inventory for increased confidence prior to harvest
- Providing basis for estimates of forest carbon stocks

Sampling Procedure

The cruiser shall establish points (plot centers) on a fixed grid pattern evenly spaced in each cover type along cardinal bearings. Plots will be variable radius plots with a 10 BAF in all cover types. Number of plots and plot spacing will be pre-determined for each cover type and the cruiser will establish plot locations on the map prior to beginning the cruise. Points (plot centers) will be located on a UTM Grid that overlays each cover type.

Plot numbers will be established on the plot map. The cruiser shall locate points using GPS, pacing, or chaining. Plot locations will be referenced by flagging and painting trees facing the plot center. Plot centers shall be marked using a painted piece of rebar with flagging. Notes on the flag should include the plot number, the initials of the cruiser(s) and the date of the sample. GPS coordinates will be averaged and recorded at each plot center.

The cruiser will be provided with both contour maps and aerial imagery of each cover type designated for sampling along with relevant cover type information.

Data Collection at Plots

1) Plot Data: At each plot, slope (percent), aspect (azimuth in degrees from north), and topographic position (1 = bottom, 2 = lower slope, 3 = mid-slope, 4 = upper slope, 5 = ridge top) will be recorded.

2) Trees: All trees greater than or equal to 4.6 inches in diameter at breast height are measured if they fall within the 10 BAF variable radius plots in all cover types. Record NT if no live trees are recorded on the plot. All trees measured in the variable radius plots will be marked with paint on the side of the tree facing plot center.

3) *S*pecies: Record species using codes in **Table 1**.

4) Species Group: For variable radius plots assign a group code for live trees, and snags. Group codes are shown in **Table 2.**

5) Diameter at Breast Height (DBH): For all trees measured in each plot, diameters will be recorded (using a diameter tape) to the nearest tenth of an inch at a point 4.5 feet above the ground level or root collar on the uphill side of the tree. In the case of irregularities in DBH, such as swelling, bumps, depressions, branches, etc., diameters are measured immediately above the irregularity at the place where it ceases to affect the normal stem form.

6) Height: Total height measurements will be taken for all trees measured in all plots. For trees in all plots with broken, missing, or dead tops, include a measurement of tree height to the point of top-kill (HtTopK). Height measurements will be determined by using a rangefinder to measure the horizontal distance from the tree and a clinometer to measure the percent angle above and below the horizontal.

7) Live Crown Ratio: This is the ratio of total height of the crown divided by total height of the tree. Irregular crowns must be visually balanced. The measurement is taken on every tree greater than or equal to 4.6" in diameter at breast height that falls in a 10 BAF variable radius plot in all cover types. It is recorded as a percent value (eg: 1-100).

8) Damage: Record damage for each tree based on codes in **Table 3.**

9) Defect: For each tree greater than or equal to 4.6" DBH in diameter at breast height in each variable radius plot, record defect (rotten or missing cull) as a percentage of standing volume from a 1-foot stump to a minimum 4-inch top diameter outside bark or to where the central stem breaks into limbs all of which are less than 4.0 inches diameter outside of bark. Each tree with a defect > 0 should receive a Damage code of 26 in the data table. Record defect as a percent value (1-99) in Severity column of data table (see **Table 3**).

10) Snags: All snags greater than or equal to 4.6" DBH are measured in each plot. Record Species, DBH, Height to break (recorded in Taper Height column), top diameter (recorded in Taper Diameter column), and decay class (in Status column). Record a group code of "SN" for all snags. Decay class codes (recorded in Status column of data table) are detailed in **Table 4.**

    Top diameter (0 if top is not missing) is based on an ocular estimate. If splitting, hollow cores, burned portions or other physical defects have resulted in a significant reduction in bole volume (>5%) at DBH such that the original bole dimensions cannot be accurately measured (e.g.: bole is a 'semi-circle') then estimate and record original DBH prior to damage and record percent defect for total bole. If damage affects bole above DBH, record percent defect based on percent of bole material missing for the total height of the snag. Minimum height for snag measurement is =15'.

11) Regeneration: Trees >4.5' in height and less than 4.6" DBH are tallied on every plot. The sample area measured for regeneration is a fixed 1/100th acre plot. Record species, height (by 5 foot classes: 5,10,15 etc) and diameter (by 0.5" class). All regeneration recorded must be, in cruiser's opinion, vigorous enough to survive for one year following measurement.

12) Road Plots: Area of cover types in the inventory is net of mapped road acreage. Any plot center that falls on a mapped haul road should be recorded as a 'road plot' and skipped. Plots that fall on secondary, unmapped roads, landings and skid trails should be installed where they fall.

13) Edge Trees: Sample points located near cover type edges, typed out roads or property lines will employ the "Walkthrough Method" for sampling features near boundaries.

    a) For any plot that falls near a cover type, road or property boundary, measure the distance from the sample point to the measured object (distance *x*), then measure the distance from the object to the boundary (distance *y*) following the same bearing.

b) If the distance to the boundary from the object (distance *y*) is less than the distance from the sample point to the object (distance *x*) then tally the object twice. If it is a measure tree, record it as two measurements.

c) Assign the second record of the object a Status code of 22

14) Offsets: Plots that fall in unmapped water features or other areas that are inaccessible or hazardous may be offset by 30 meters in direction of travel. Measure distance to the next plot from the original location of the plot, not the offset location.

Table 1: Codes

(All codes are entered in data Table)

Key to Species Codes		
Species Code	**Common Name**	**Scientific Name**
FR	fir species	*Abies spp.*
JU	redcedar species	*Juniperus spp.*
PI	spruce species	*Picea spp.*
PU	sand pine	*Pinus clausa*
SP	shortleaf pine	*Pinus echinata*
SA	slash pine	*Pinus elliottii*
SR	spruce pine	*Pinus glabra*
LL	longleaf pine	*Pinus palustris*
TM	table mountain pine	*Pinus pungens*
PP	pitch pine	*Pinus rigida*
PD	pond pine	*Pinus serotina*
WP	eastern white pine	*Pinus strobus*
LP	loblolly pine	*Pinus taeda*
VP	Virginia pine	*Pinus viginiana*
BY	baldcypress	*Taxodium distichum*
PC	pondcypress	*Taxodium ascendens*
HM	hemlock species	*Tsuga spp.*
FM	Florida maple	*Acer barbatum*
BE	boxelder	*Acer negundo*
RM	red maple	*Acer rubrum*
SV	silver maple	*Acer saccharinum*
SM	sugar maple	*Acer saccharum*
BU	buckeye, horsechestnut species	*Aesculus spp.*
BB	birch species	*Betula spp.*
SB	sweet birch/black birch	*Betula lenta*
AH	American hornbeam	*Carpinus caroliniana*
HI	hickory species	*Carya spp.*
CA	Catalpa	*Catalpa spp.*
HB	hackberry species	*Celtis spp.*
RD	eastern redbud	*Cercis canadensis*
DW	flowering dogwood	*Cornus florida*
PS	common persimmon	*Diospyros virginiana*
AB	American beech	*Fagus grandifolia*
AS	ash species	*Fraxinus spp.*
WA	white ash	*Fraxinus americana*
BA	black ash	*Fraxinus nigra*
GA	green ash	*Fraxinus pennsylvanica*
HL	honeylocust	*Gleditsia triacanthos*

LB	loblolly-bay	*Gordonia lasianthus*
HA	silverbell	*Halesia spp.*
HY	American holly	*Ilex opaca*
BN	butternut	*Juglans cinerea*
WN	black walnut	*Juglans nigra*
SU	sweetgum	*Liquidamber styraciflua*
YP	yellow-poplar	*Liriodendron tulipifera*
MG	magnolia species	*Magnolia spp.*
CT	cucumbertree	*Magnolia acuminata*
MS	southern magnolia	*Magnolia grandiflora*
MV	sweetbay	*Magnolia virginiana*
ML	bigleaf magnolia	*Magnolia macrophylla*
AP	apple species	*Malus spp.*
MB	mulberry species	*Morus spp.*
WT	water tupelo	*Nyssa aquatica*
BG	blackgum, black tupelo	*Nyssa sylvatica*
TS	swamp tupelo	*Nyssa biflora*
HH	eastern hophornbeam,	*Ostrya virginiana*
SD	sourwood	*Oxydendrum arboreum*
RA	redbay	*Persea borbonia*
SY	sycamore	*Platanus occidentalis*
CW	cottonwood species	*Populus spp.*
BT	bigtooth aspen	*Populus grandidentata*
BC	black cherry	*Prunus serotina*
WO	white oak	*Quercus alba*
SO	scarlet oak	*Quercus coccinea*
SK	southern red oak	*Quercus falcata*
CB	cherrybark oak	*Quercus pagoda*
TO	turkey oak	*Quercus laevis*
LK	laurel oak	*Quercus laurifolia*
OV	overcup oak	*Quercus lyrata*
BJ	blackjack oak	*Quercus marilandica*
SN	swamp chestnut oak	*Quercus michauxii*
CK	chinkapin oak	*Quercus muehlenbergii*
WK	water oak	*Quercus nigra*
CO	chestnut oak	*Quercus prinus*
RO	northern red oak	*Quercus rubra*
QS	Shumard oak	*Quercus shumardii*
PO	post oak	*Quercus stellata*
BO	black oak	*Quercus velutina*
LO	live oak	*Quercus virginiana*
BK	black locust	*Robinia pseudoacacia*
WI	willow species	*Salix spp.*
SS	sassafras	*Sassafras albidum*
BW	basswood species	*Tilia spp.*
EL	elm species	*Ulmus spp.*
WE	winged elm	*Ulmus alata*

AE	American elm	*Ulmus americana*
RL	slippery elm	*Ulmus rubra*
OS	other softwood species	
OH	other hardwood species	
OT	other species	

Table 2: Group Codes

Group Codes	
Code	**Group**
..	Default- Live tree with normal form
SN	Snag

Table 3: Damage and Severity Codes

Damage and Severity Codes		
Damage Code	**Severity Code**	**Description**
26	1-99	Percent Defect
96	N/A	Broken/missing top
97	N/A	Dead top

Table 4: Decay Class Codes

Status Codes	
Code	**Description**
1	Decay Class 1
2	Decay Class 2
3	Decay Class 3
4	Decay Class 4
5	Decay Class 5
22	Walkthrough record

Snag Decay Classes	
Decay Class (Recorded in Status Code Column of PLOTS table)	**Description**
1	All limbs and branches are present; the top of the crown is still present; all bark remains; sapwood is intact, with minimal decay; heartwood is sound and hard
2	There are a few limbs and no fine branches; the top may be broken; a variable amount of bark remains; sapwood is sloughing with advanced decay; heartwood is sound at base but beginning to decay in the outer part of the upper bole
3	Only limb stubs exist; the top is broken; a variable amount of bark remains; sapwood is sloughing; heartwood has advanced decay in upper bole and is beginning at the base
4	Few or no limb stubs remain; the top is broken; a variable amount of bark remains; sapwood is sloughing; heartwood has advanced decay at the base and is sloughing in the upper bole
5	No evidence of branches remains; the top is broken; less than 20% of the bark remains; sapwood is gone; heartwood is sloughing throughout

Findings

The main finding of this project is that the use of third-party verified carbon offsets, especially under California's regulatory system, are not at this point in time a sufficient driver of payments to small forestland owners in the southern Appalachians who are trying to mix sustainable timber harvest with maintenance and increase of carbon stocks.

While preliminary financial analysis found a net profit for the landowner under reasonable scenarios, the magnitude of the potential profit was not sufficient to either justify spending more money to fully develop the project, and get higher certainties on the financial projections, but it was also not nearly high enough to justify the long-term commitment compared to potential income from timber harvest revenue. Not entering into a carbon project allowed the landowner to retain more options for the future.

The landowner's decision not to move forward with the project revolved around three major factors. The first was uncertainty about the future of the carbon market. The second is the high expense of project development and maintenance compared to credit yield and credit value at this stage of maturity of the carbon market. The third is the higher certainty and value that revenue for timber harvest provides compared to managing with a higher emphasis on carbon sequestration.

While the starting carbon stocks on the property were much higher than the Common Practice Indicator, and a baseline scenario in which all available merchantable timber could have easily been shown to be financially feasible (therefore additionality of the carbon credits would have been valid), the low site quality and therefore low future growth rates of the forest made it so future carbon credit accumulation would be low. High project maintenance costs would not have been sufficiently balanced by carbon revenue to make the risks of low prices and high costs worth the commitment. Neither the regulated carbon market in California nor demand from voluntary corporate buyers is sufficiently certain to be able make a 100 year commitment to monitoring and verifying carbon stocks associated with the initial sale of credits after the first verification, as is required by the California protocol and its associated regulations.

In the two years since this project started development, political uncertainty continues to plague California's cap and trade system, despite the program's success at delivering emissions reductions at reasonable cost, and meeting legal requirements. The State of California passed new legislation in September 2016, SB 32, which gave legal force to a 2030 emission reduction goal. This legislation did not however explicitly re-authorize the use of cap and trade to reach those emission reduction requirements and on-going litigation over the use of a permit auction has made the system's future uncertain. In the face of such uncertainty, it is difficult to have confidence in price projections or whether to make long-term commitments based on future income.

Forests in the southern Appalachians tend to have slow growth rates. While this in and of itself should not prevent a payment system for net accumulation of carbon stocks, given the value of land-based mitigation strategies for meeting our nation's commitments to reduce CO_2 emissions in the Paris accords. However, the overall price dynamics of the California carbon market combined with the currently high costs of collecting inventory data and conducting project verification provide too small a margin of comfort for future income when compared to the relatively predictable income one can receive from harvesting timber. In addition, once harvests are complete, there are few legal obligations to take into account when making future decisions about one's property, compared to the 100 year obligation after selling carbon credits.

Finally, slow growth rates create conditions such that even relatively low levels of harvests could create temporary reversals of emission gains, or reduce carbon credit yield to the point where the project would have to be financially subsidized by timber revenue. It is not surprising that landowners would chose not to enter into carbon offset projects under these conditions.

While Dr. Argow is very committed to seeing carbon markets play a role in helping small forest landowners conduct sustainable management, this particular set of circumstances did not fit his goals of being able to manage for both timber and improved carbon stocks.

Conclusions and Recommendations

Carbon markets, especially the one established through California's cap and trade system, still retain potential, three things need to occur in order to drive change in private forest management:

1) Political uncertainty involving the use of cap and trade to meet California's 2030 goals should be resolved;
2) Prices need to increase to above $15/credit;
3) Costs associated with project development and maintenance need to be reduced, either through technological advances, or streamlining the project approval process, or both.

There have been ongoing discussions about extending the cap and trade program to at least 2030, if not 2050. California Governor Jerry Brown issued an executive order in 2015 that calls for reductions of GHG emissions to 40% below 1990 levels by 2030. The California State legislature passed SB 32 in the summer of 2016 to institutionalize this goal into law. This legislation did not however explicitly re-authorize cap and trade. As of the writing of this report, discussions are on-going about the best way to ensure legal stability of the market post 2020. ARB is also in the process of updating its scoping plan (the official plan by which it meets its overall GHG reduction goals, including all relevant mechanisms, including cap and trade) and just released a new discussion draft of regulations to extend the market to 2050 (http://www.arb.ca.gov/cc/capandtrade/draft-ct-reg_071216.pdf).

If these goals are incorporated into a formal regulatory cap, the demand for offsets should increase significantly, and the price should rise accordingly. If this state of affairs comes to pass, the feasibility of using California's carbon market to drive sustainable forestry in the southern Appalachians and throughout the country should increase from where it is today.

Market participation would also improve if project development became somewhat less burdensome and unpredictable from a regulatory perspective. In addition, if the use of remote-sensing techniques such as LIDAR and drone technology to measure carbon stocks eventually replaced on-the-ground plot measurements, project development and long-term maintenance costs would decrease significantly, making what are now marginal or inadvisable projects much more attractive.

If prices stay below $20/offset credit, and the complexity of project development and verification stay as they currently are, it will likely be necessary to create other mechanisms to incentivize forest landowners, especially smaller non-industrial owners, to undertake long-term commitments to ecologically sustainable forestry at scale. Such mechanisms could include federal programs through USDA that reward landowners for increasing carbon stocks but do not rely on offsetting, so that a 100-year commitment was not necessary to start, though these long time commitments should be retained for landowners willing to do so. The long commitment periods are important when some portion of fossil fuel reductions is being replaced with forest offsets, because carbon dioxide can be re-emitted from biological systems. If benefits were trying to be achieved outside of a regulatory cap, then commitments of 40 or 50 years would be more appropriate and might appeal to a larger number of landowners. While accountability would still be important, the need for the level of rigor in inventory data collection and verification would not be as stringent and should cost less, thus smaller owners could participate.

Financing new federal and state programs is difficult. However, justifications can be made for allocating funds to forest conservation and carbon stock enhancement through looking at the social cost of carbon, which is the amount of damages to society per ton of CO_2 pollution. These are costs that are currently externalized in the absence of a nationwide cap and trade program or carbon tax. Until such time as a national carbon price exists, the federal government can still justify spending money to reduce CO_2 levels if the cost of doing so is equal to or less than the damages caused by GHG emissions. The same is true at the state level. Alternatively, smaller incremental steps, such as a tax per barrel of oil or fees on forest conversion, could be a revenue source to cover forest conservation programs.

Another approach would be to create state-based working-forest conservation easement programs, or fee-acquisition programs for land trusts and community forests, that have carbon performance standards. Such a programs require a stable, predictable pool of state-based funding for purchase of easements and a land trust community willing to steward easements or hold lands in outright ownership that have more complicated forest management requirements than are typical. The funding could come from several sources, including any eventual price on carbon, fees on conversion of forest to non-forest land uses, and/or a partnership with federal agencies and programs. The Forest Legacy program could be adjusted to allow carbon sequestration as both a ranking criteria, and as part required easement terms.

An example of an easement requirement that would result in carbon gains over time would be to limit harvest to some percentage less than annual biomass accumulation. Area-based limits could also be used. In addition, other elements important to conservation, and in line with FSC standards, including FSC standards themselves, can also be incorporated into easement terms to protect biological diversity and water quality.

The advantage of using easements rather than carbon offsets for securing carbon sequestration long-term would be the lower transaction and carrying costs of projects. Monitoring would still be important, but as with the federal program example above, if the program is structured in a manner to complement rather than substitute for fossil fuel reductions, the need for the level of precision and rigor in terms of quantifying the tons of CO_2e on an annual basis would be lower. Gains in forest carbon could therefore be made at a lower cost overtime. The use of a conservation easement would secure these gains, or at least the land base on which they can be made (in the event of unintentional natural forest loss) permanently.