LAND TRUST CARBON CREDIT MARKET PARTICIPATION PLAN

by

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Glossary

Aggregate projects	A type of forest carbon project in which a group of geographically separated smaller projects can register as a group. The goal of aggregate projects is to alleviate transaction costs, enable economies of scale, and help ensure an adequate supply of offsets to the market.
American Tree Farm System	A nonprofit organization that provides a network for small private woodland owners as well as a sustainable forest certification framework.
Avoided conversion	A forest carbon project type in which land use change is presented in a forested area through a conservation easement.
Baseline Harvest Interval	In an Extended Rotation Project, the baseline harvest intervals the timber harvest rotation interval that is used for the project's baseline modeling. The regional common practice rotation interval length is usually used for this value.
Broadcast fertilization	A fertilization method in which the fertilizer is applied broadly and not in spot treatments.
Buffer Pool	Each project is given an individual risk rating that dictates that a certain percentage of credits are to be held in a registry-wide buffer pool. The buffer pool acts as an insurance mechanism to help recover carbon lost from the forest through unintentional reversal via wildfire, pests, disease, et cetera.
Carbon Pools	A biological reservoir that accumulates and store carbon. Forest carbon pools include live tree biomass, harvested wood products, and down, dead woody debris.
Carbon stocking	The amount of carbon contained in a carbon pool. The number of tons of carbon in the standing live trees pool of a forest would be a measure of the carbon stocking.
Clean Development Mechanism	The emission trading scheme developed for countries regulated under the Kyoto Protocol. Regulated countries could earn emission reduction credits through implementing an emission-reduction program in a developing country.

Compliance markets	A market in which participation is required by regulation or law. Utilities, corporations, and other large emitters are required to meet certain reductions or mitigate their emissions through the purchase of offsets.
Conservation Easement	A legal document that removes the threat of development or land use change from a specified land area by placing its development rights in control of a land trust or government entity. The land is to be held into conservation into perpetuity.
Extended Rotation Project	A type of Improved Forest Management forest carbon project for which the management change is extending the timber harvest rotation in the forest. By increasing the harvest interval, there will be greater average carbon stocking in the forest which can be credited.
Forest Carbon Inventory	An inventory of a forest, completed through field sampling and statistical extrapolation that estimates the carbon dioxide removals and emissions of the land area. The forest carbon inventory provides the inputs for the baseline modeling.
Forest Stewardship Council	An international nonprofit organization whose mission is to work towards sustainable forest management. They created and maintain a sustainable forest management certification program.
Greenhouse effect	A process through which radiation from the sun heats up greenhouse gases that are trapped in the atmosphere and subsequently raises earth's surface temperatures.
Improved Forest Management (IFM)	A forest carbon project type in which forest management activities are changed to increase average carbon stocking levels in a forest. This can be done either through improving the overall productivity of the forest or by extending the timber harvest rotation in working forests.
Leakage	Leakage occurs when emissions reductions efforts in one geographic area are merely displaced and lead to increased emissions in another geographic area.

Net Present Value	Considering the time value of money, the net present value is what a certain quantity of money to be realized in the future is worth today. The difference between the value of the money in the future and today is based on the discount rate.
Permanence	Once of the four general requirements for registering a forest carbon project, permanence requirements dictate that the carbon stored in the forest remain in the trees, removed from the atmosphere into perpetuity.
Perpetuity	Commitments or payments that extend into perpetuity do not end.
Production cost	The costs incurred through the process of project development. Ex. forest carbon inventory fee, baseline modeling fee
Project Harvest Interval	In an Extended Rotation Project, the project harvest interval is the timber harvest rotation interval that the forest is being managed for throughout the duration of the project. This is longer than the baseline harvest interval in order to increase the average carbon stocking in the forest.
Reforestation/ Afforestation	A forest carbon project type in which tree cover is restored on land that has <10% cover and minimal short-term commercial opportunities.
Sustainable Forestry Initiative	A nonprofit organization that has developed a sustainable forest certification framework. The framework is currently the most widely used certification program in the world.
Transaction cost	The costs incurred through the process of an economic exchange. Ex. account registration fee, credit transfer fee
Voluntary markets	A market that is not required by regulation or law. Businesses, universities, corporations, or other entities may enter into an emission reductions market to enhance their image, become a leader in the field, et cetera.

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Introduction

As a Southeastern highlands land trust, Southern Appalachian Highlands Conservancy (SAHC) is interested in participating in an emerging forest carbon market as an examination of new conservation strategies. They are eager to learn how efforts in improving forest management can result in more carbon sequestration, and how their landowners could benefit financially from participation. In this paper, SAHC's available carbon market registries and programs are compared, including eligibility requirements, participation requirements, administrative costs, risks, and potential revenues. The comparison was performed through policy analysis and the use of the ForCost forest carbon project model to estimate the potential costs and benefits of developing a project on a parcel of forest for which SAHC holds the conservation easement. Based on the comparison, SAHC would be more confident in helping landowners to make the decision whether and how to register their forest in a carbon market.

Climate Change and Forest Carbon Offset Market

Climate Change is perhaps the greatest challenge that human beings have ever faced. According to estimates provided by USEPA, the earth's average temperature has risen by 1.4° Fahrenheit over the last century, and is projected to increase by another 2 to 11.5 ° Fahrenheit over the course of the next century (USEPA, 2013). During the past decade, an global increase in extreme weather and climate conditions has been observed, including super storms, floods, droughts, severe heat and cold waves (Romm et al, 2012). Though there are other factors which can result in climate change, such as orbital and solar variations, many scientists state that these contemporary climatic changes are largely caused by human activities (National Research Council, 2010). Among several anthropogenic sources of climate change, the enhanced greenhouse effect is viewed as the one of greatest significance. According to the 2007 Assessment Report from Intergovernmental Panel on Climate Change (IPCC): "Most of the observed increase in globally average temperatures since the mid-20th century is very likely due to the observed increase in anthropogenic greenhouse gas concentrations"("Climate Change 2007: Synthesis Report", 2007).

Greenhouse gases absorb and emit infrared radiation (IPCC AR4 SYR Appendix Glossary, 2008). The four major greenhouse gases and their associated atmospheric concentrations are: water vapor (36-70%), carbon dioxide (9-26%), methane (4-9%), ozone (3-7%)("Water vapour: feedback or forcing?", 2005; Kiehl et al, 1997). In the past century, industrialization has led to the emission of a large amount of carbon into the atmosphere. In some locations, the atmospheric carbon dioxide concentration has risen from 316 ppmv to 385 ppmv from the late 1950s to 2007 (Semhur, 2008). According to IPCC estimates, under different scenarios, the carbon dioxide concentration is projected to increase from 500 ppmv to nearly 1000 ppmv during this century (IPCC, 2013). As a result, carbon dioxide reduction has become a crucial consideration when dealing with climate change.

Within the U.S., some regional carbon dioxide trading schemes have been established. Most states in the northeast have joined the Regional Greenhouse Gas Initiative (RGGI) with a commitment to reduce carbon dioxide emissions from electric utilities by 10% by 2019 (Salzman et al, 2010). In 2006, Assembly Bill 32 (also referred to as the Global

Warming Solutions Act of 2006) was passed by the California State Legislature. The goal of AB32 is to reduce the level of state greenhouse gas emissions to 1990 levels by the end of the year 2020, which equals an approximate 25% reduction of 2006 emissions levels.

To reach the regional emissions reduction goals while having minimal impact on economic development, carbon offset programs are introduced. A carbon offset is an emission reduction or removal of carbon dioxide or greenhouse gases from the atmosphere made in one place that can compensate emissions in another (Collins English Dictionary, 2013). There are more than 200 types of carbon offsets projects defined by the Clean Development Mechanism (CDM), which include renewable energy, methane collection and combustion, energy efficiency, industrial pollutants destruction, land-use change and forestry, and so forth (*CDM projects grouped in types,* 2013). Among these projects, forest-based offset projects are of great significance. Forests can store large quantities of carbon in their biomass and act as a carbon sink (Brown et al, 2000). There are several ways in which forest projects can increase carbon storage and generate offsets. For example, maintaining or increasing carbon sequestration by expanding forest area or density, and avoiding emissions from existing carbon pools by preventing deforestation are both eligible project actions (Brown et al, 2000). There are also substantial benefits associated with forest-based projects. Since these projects provide economic incentives to conserve forests, they also result in land and biodiversity conservation and air pollution reduction (Brown et al, 2000).

Forests in the Southern U.S. are an important player in global climate change adaptation. It is estimated that the carbon sequestered by managing forests in the South equals approximately one third of the total national capacity (Jose, 2007). However, it is projected that several factors will affect the distribution and health of southern forests over the next 30 years, such as suburban and agricultural development, plant distribution shifts, wildfires, and pest outbreak (Hanson, 2010). For landowners, one approach to addressing these risks is to receive payments by participating forest carbon offsets projects (Yonavjak et al, 2011).

There are two types of offset markets: voluntary markets, and compliance markets. In each market, forest carbon offset projects are divided into three types: Reforestation/ Afforestation (RA), Avoided Conversion (AC), and Improved Forest Management (IFM) (Yonavjak et al, 2011). In order to make the offsets creditable, several quality criteria need to be met. First, landowners must prove the offset represents real carbon dioxide reductions. This means that the project's emission reductions must be tracked and maintained by a reputable offset supplier, or a registry. These registries develop strict and uniform protocols that dictate offset generation actions, and offer transparency in terms of project requirements, offset pricing, and credit retirement. Second, the creditable offsets must be additional, meaning that they would not exist without the project, and any emissions reductions or removals go above and beyond business as usual circumstances or any legal requirement in place on the land. Third, the offsets need to be verified by a third party verifier who confirms that the reported removals are real before any offsets can be issued. Fourth, the offsets need to be permanent, which indicates the carbon reduction cannot be released into the atmosphere again. Fifth, the offsets need to be enforceable, so that both the seller and buyer are clear how many credits are valid for use. Sixth, forest carbon offset projects need be economically viable, so for landowners, the payments they receive by joining the market are higher than the costs (Yonavjak et al, 2011).

Client

The Southern Appalachian Highlands Conservancy (SAHC) is an Asheville, North Carolina based nonprofit land trust, accredited by the national Land Trust Accreditation Commission. SAHC's mission is to "conserve the unique plant and animal habitat, clean water, local farmland, and scenic beauty of the mountains of North Carolina and east Tennessee for the benefit of future generations" (Southern Appalachian Highlands Conservancy, 2012). Born as a chapter of the Appalachian Trail Conservancy, SAHC was formed by a group of conservation-minded individuals who wanted to expand this corridor of forest protection to include the greater Roan Massif, a 25,000-acre area of mountain peaks and ridges known for its biodiversity, scenic beauty, and cultural significance (Southern Appalachian Highlands Conservancy, 2013). As a result, in 1974 the Southern Appalachian Highlands Conservancy became an independent land trust in order to work towards enlarging and connecting large blocks of protected lands in the Roan Mountains. SAHC later expanded its territory to include a larger Appalachian Trail corridor, the Black Mountains, French Broad River Valley, Balsam Mountains, and Smoky Mountains. SAHC has 1,500 members, ten full-time staff, two part-time staff, 4 AmeriCorps service members, and an annual operating budget of $830,000. SAHC has successfully safeguarded over 60,000 acres of land in the Southern Appalachian Mountains (Southern Appalachian Highlands Conservancy, 2013). As a regional conservation leader in the Southeastern US, it is important for SAHC to keep abreast of new issues in the changing field of land conservation. Attention to the effects of climate change is particularly imperative for land trusts as it "threatens virtually every category of land conservation and will require conservation organizations to rethink their strategies and tools" (Thompson, 2012). Land trusts have the ability to engage on the issue of climate change in a myriad of ways, ranging from rethinking land acquisition strategies to changing the language of conservation easements to better allow for adaptive land management (Thompson, 2012). One option for land trusts is to get involved with policy-based climate change mitigation. A 2009 article issued by the Land Trust Alliance reports that "the opportunity for selling forest and agricultural carbon credits is only expected to grow as more states, the federal government, and the international community work their way toward requiring more reductions in emissions of greenhouse gasses- thereby driving demand for less expensive ways to reduce or store emissions" (Gentry, 2009). Recognizing this opportunity to continue the pursuit of their mission of conserving critical Southern Appalachian landscapes while simultaneously increasing revenue for small private landowners and capital for further conservation projects, SAHC began to consider carbon market participation.

Description of Three Options: CAR, ACR, Carbon Canopy

The three participation options considered in this analysis are registering independently with the Climate Action Reserve (CAR), registering independently with the American

Carbon Registry (ACR), and joining the Carbon Canopy, a forest carbon project development campaign, run by Asheville-based nonprofit organization Dogwood Alliance. The goal of this analysis is to communicate and compare the project development administrative responsibilities of registering a forest carbon project with each of the three participation routes.

Climate Action Reserve

The Climate Action Reserve (CAR) is the parent company of the California Climate Action Registry, a program started in 2001 through the signing of SB1771 by California Governor Gray Davis. The bill aimed to aid early actors in accounting, reporting, and reducing greenhouse gases (GHG) as well as adopting standards for emissions reductions and verification auditing (Senate Bill No. 1771, 2001). With the passing of AB32, the work of the California Climate Action Registry ended in 2010, and control transitioned into the hands of CAR, whose goal was to develop emissions guidelines for the development, quantification, and verification of offset projects for both voluntary and compliance carbon markets (California Climate Action Registry, 2013). CAR's mission is to develop credible market-based policies and solutions, and their high standards work to ensure that emissions reductions are real, additional, verifiable, and permanent (Climate Action Reserve, 2010). The Forest Project Protocol contains the guidelines for developing a forest-based offset project. CAR recognizes forest offsets from RA, AC, and IFM projects (Climate Action Reserve, 2010). Because SAHC preserves natural forest areas, most commonly through conservation easements, the IFM projects that work to change forest management activity to "maintain or increase carbon stocks on forested land relative to baseline levels" are their best option (Climate Action Reserve, 2010). Reforestation projects through CAR would not be the best choice for SAHC, as they are more expensive to implement and most of SAHC's non-forested land parcels are used for agriculture. Also, CAR's Forest Project Protocol requires that all project actions be additional to any legal requirements. This means that an avoided conversion project would not be feasible because most of SAHC's lands are protected using conservation easements that permanently restrict development and land clearing activities; therefore, proving threat of conversion to the area would be difficult.

American Carbon Registry

The American Carbon Registry (ACR), born out of the Environmental Defense Fund's Environmental Resources Trust, was established in 1996 as the country's first private greenhouse gas registry. A part of the natural resource and development nonprofit Winrock International since 2007, ACR's mission is to ensure transparency, clear ownership, and environmental integrity in their offset registration duties (American Carbon Registry, 2010). ACR's Forest Carbon Project Standard identifies AR, IFM, and Reducing Emissions from Deforestation and Degradation (REDD) projects for forest-based offset development (American Carbon Registry, 2010). As described above for the CAR program, SAHC would benefit most from developing an IFM project under ACR's registration process.

Carbon Canopy

The Carbon Canopy is a campaign started in 2007 by Asheville, NC-based forest conservation nonprofit Dogwood Alliance and their corporate partner Staples, Inc. The

Carbon Canopy initiative's goal is to expand the emerging voluntary and compliance carbon market presence into the Southeastern U.S. by engaging small private landowners into the process for the purpose of promoting Southern forest conservation, increasing the national supply of Forest Stewardship Council certified sustainable forest products, and generating additional revenue for conservation-minded landowners (Carbon Canopy, 2009). The campaign brings together a diversity of stakeholders, including private corporations, environmental nonprofits, and forest products companies to increase small forestland owner participation in policy-based solutions to problems facing the lands they manage. Carbon Canopy uses the CAR Forest Project Protocol to register their projects (Carbon Canopy, 2009).

Comparison of the Two Registries: CAR and ACR

The process and project developer responsibilities of registering an IFM carbon project with CAR and ACR are very similar. First, a comprehensive inventory of the project area must be conducted in order to determine initial carbon stocks. Next, information on the current amount of carbon stored in the forest should be used for growth and yield modeling that is in compliance with approved methodologies and tools in order to calculate both the project baseline and IFM project scenario carbon stocks. The models must take permanence and leakage into consideration, and include a risk analysis for any predicted negative impacts on the community and environment. Then, the project developer writes the project document and action plan, which includes the calculated GHG removals. An approved verifier must be selected to verify the project before it can be submitted for final approval. If approval is granted, the registry will issue offset credits to the project developer. Lastly, the project must be periodically monitored by the verifier and the inventory data updated. Please see Appendix A for step-by-step descriptions of the necessary project development requirements for each protocol.

The key differences between the CAR and ACR forest project protocols concern project length and forest management requirements. In order to ensure permanence of the climate change mitigating GHG removals, project carbon stocks should be maintained into perpetuity. CAR necessitates a minimum project length of 100 years, meaning that there is a 100 year commitment to maintain carbon stocks starting during the final year that offset credits are issued. So, if a project began in 2000 and lasts 100 years, selling its last credits in 2100, the tons of CO_2 equivalent sold in the last year of the project must remain sequestered in the forest until 2200. This requirement reflects CAR's strict interpretation of perpetuity. ACR, on the other hand, has a minimum project length of 40 years. There is no maximum project length listed in either protocol. In regards to forest management practices, the two protocols diverge once again. CAR prohibits the use of broadcast fertilization, where ACR permits this practice. Also, ACR requires official forest certification with the Forest Stewardship Council, Sustainable Forestry Initiative, or American Tree Farm System. CAR doesn't mandate official certification, but they do require specific natural forest management practices to be laid out in the forest management plan.

Recommendation: Carbon Canopy

Since SAHC is a regional nonprofit land trust, with limited funding and staff, it is recommended that the organization pursue carbon market involvement through

Dogwood Alliance's Carbon Canopy campaign. Carbon Canopy utilizes the CAR protocol in their project development. Moreover, the upfront costs for completing a comprehensive carbon inventory and the required growth modeling for project baseline development are beyond the capacity of SAHC's staff and operating budget. Carbon Canopy partners with both forest consultants that have experience in inventorying carbon stocking and modeling forest growth and private corporations and NGOs and philanthropic foundations that have provided funds to help small private landowners develop projects. Their philanthropic partners include The Home Depot Foundation, Staples, Inc., the Merck Family Fund, Columbia Forest Products, and Domtar (Carbon Canopy, 2009). Carbon Canopy has successfully listed one project in Southwestern Virginia and is currently in the preliminary project development stage for a number of other potential projects in the region (Project Report: Carbon Canopy, 2013). The extent of funding for a new project is dependent upon further discussion between landowners and Dogwood Alliance.

Big Tom Wilson Preserve

One of the largest properties protected by SAHC is an 8,502 acre forest called Big Tom Wilson Preserve (BTW) in Yancey County, NC. BTW is a part of the Southern Blue Ridge Mountain Physiographic Province in the Black Mountains. The preserve is connected to a contiguous 85,000 acre stretch of forestland within the Black and Craggy Mountains, and it contains nearly all of the Upper Cane River watershed and part of the French Broad River watershed, protecting headwater streams and successive waterways from sedimentation and other sources of pollution (Muerdter, 2012). Because of its high biodiversity, good location, and lack of invasive-exotic species, the owners of BTW preserved the forest with a conservation easement with the American Farmland Trust in 1990. The conservation easement was assigned to SAHC in 2012. The property is owned by members of the Cane River Fishing and Hunting Club, and so the current land use at BTW is recreational fishing and hunting, passive recreational entertainment, and timber management. Because of the attractive timber from yellow poplar (*Liriodendron tulipifera*) and high grade oak and other upland hardwood species contained in BTW's Northern Hardwood and Southern and Central Appalachian Cove Forest types, the property has a history of acting as a working forest. Over 3.7 million board feet of lumber over 50 acres was removed from BTW from 1991 to 1999. After an additional 17-acre harvest from 2007 to 2008, another 70 acre cut was planned in 2010, but the operation was shut down halfway through because of landowner disapproval of the effect of the harvest on the aesthetics of the preserve (Meurdter, 2012). Because of BTW's size and harvest history, it is SAHC's best option for a successful project that would generate a large number of offset credits.

Methods

Cost-benefit Analysis

In order to provide the land owner with a better idea of the economic viability of carbon market participation, we used a tool to calculate the costs and benefits of a forest carbon project at BTW.

The tool is Forest Creditable Offset and Sequestration Tool (ForCOST), developed by Mr. Christopher Galik at Duke University's Nicholas Institute for Environmental Policy

Solutions. ForCOST is a menu-driven tool which allows users to estimate the quantity of carbon offsets generated through different management scenarios (Figure 1). For a given project, the outputs from the ForCOST are: the amount of creditable carbon (Mg CO_2e), the net present value (NPV) of the project under a high cost estimation ($), and the NPV of the project under a low cost estimation ($). The tool uses two different cost estimations (high/low) because it estimates costs based on a range, not a specific number. The cost information is gathered from project-related reports and professional experience (Galik et al, 2012). The information is part of the database underlying in the tool (Appendix C). When collecting information, if one report shows the cost to conduct initial inventory on a 100 ha forest is $5/ha, while another report indicates the cost is $35/ha, it will be assumed that the cost range is from $5 to $35 per ha. When calculating the project NPV under the high cost estimate, $35/ha is applied. $5/ha is used to calculate project NPV under the low cost estimate. Therefore, instead of providing a specific number, the tool gives decisionmakers a range to evaluate project value. Sometimes, the difference between the high and low cost estimates can be substantial. To make the results of the cost-benefit analysis more reflective of the project reality, land owners and managers need to further investigate the assumptions and uncertainty of the ForCOST tool and collect project-specific data in as detailed a manner as possible.

Although there are limitations and drawbacks, the ForCOST tool is still very powerful. To help the client better understand how it works, we used BTW Preserve as an example, inputting its information to run the tool and analyze the results. Before running the tool, detailed inputs are required (Table 1). The inputs can be divided into two categories:

project design options, and financial and administrative options. Project design options are the ones about the project itself, over which land owners usually have control. These include project type, project size, forest type, project length, project harvest interval, forest inventory interval, et cetera. The financial and administrative options are more about the environment shared by all similar forest carbon projects, and so land owners and project developers usually have little influence over them. Some main financial and administrative options are: discount rate, carbon price, carbon price increase rate, timber price, project registration fee, verification fee, and credits trading fee.

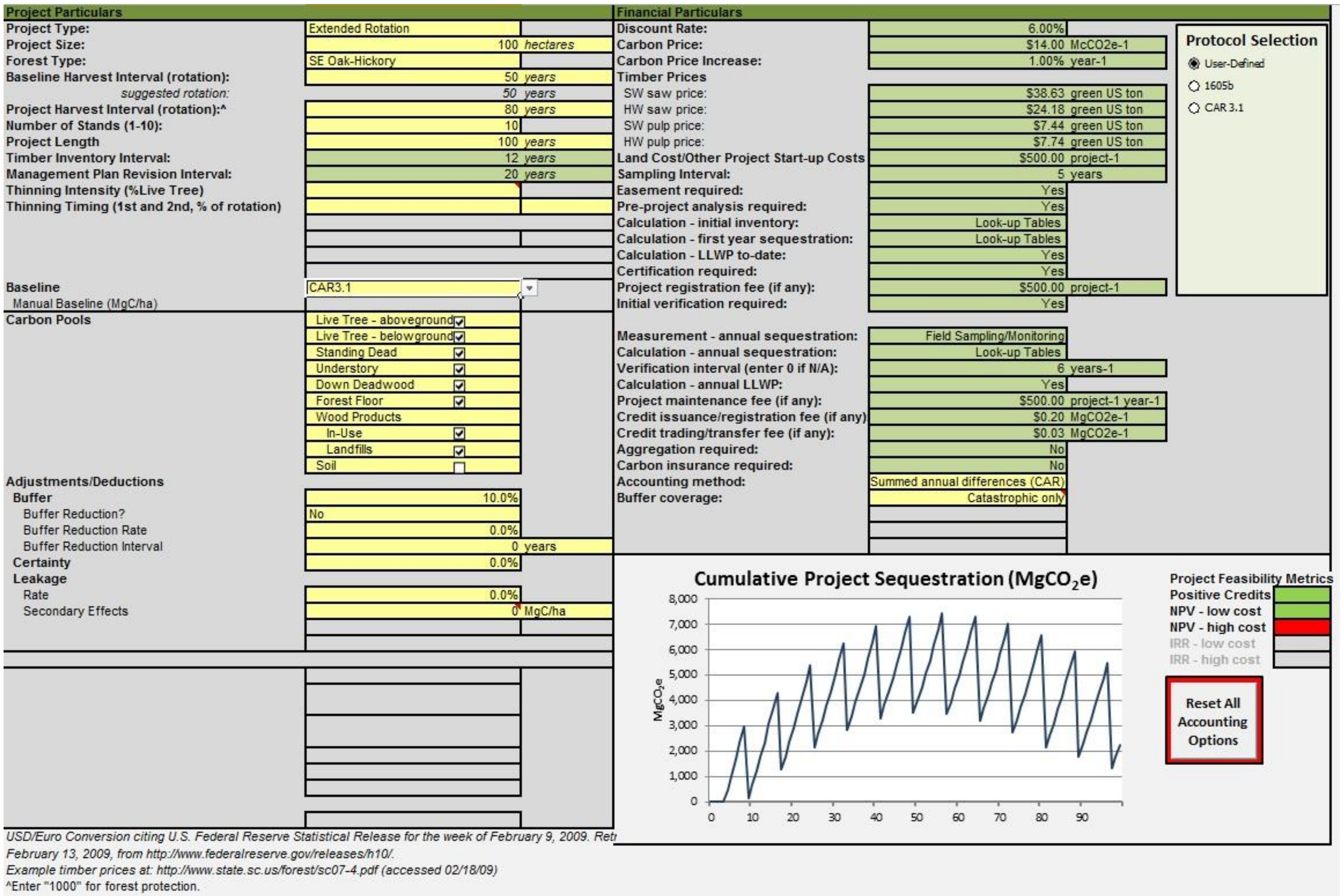

Figure 1. ForCost Tool work interface

Table 1 Required inputs in ForCOST tool

Project Design	Options	Selected Options	Note
Project Type	Afforestation		
	Avoided Conversion		
	Extended Rotation	√	Applicable to BTW
	Improved Productivity		
	Reforestration		
Project Size	100 Hectares	√	
	1000 Hectares	√	
	10,000 Hectares	√	
Forest Type	Available forest types are	SE Oak-Hickory	Applicable to BTW
Baseline Harvest Interval	Suggested 50 years	50 years	Applicable to BTW
Project Harvest Interval	User defined	80 years	Applicable to BTW
Number of Stands	1-10	10	Applicable to BTW
Project Length	User defined	100 years	Minimum project length required by CAR
Timber Inventory Interval	User defined	12 years	
Management Plan Revision	User defined	20 years	Yancy County Requirements
Thinning Intensity (% Live	User defined		
Thinning Timing (1st and	User defined		
Baseline	Base year		
	CAR3.1	√	
	FIA mean		
	Manual		
	Single Project		
Carbon Pools (multiple)	Live Tree-aboveground	√	Required by CAR
	Live Tree-belowground	√	Required by CAR
	Standing Dead	√	Required by CAR
	Understory	√	Required by CAR
	Down Deadwood	√	Required by CAR
	Forest Floor	√	Required by CAR
	Wood In-Use	√	Required by CAR
	Product Landfills	√	Required by CAR
	Soil		
Buffer	User defined	10.0%	Assumption
Buffer Reduction	Yes		
	No	√	
Buffer Reduction Rate	User defined	0.0%	

Buffer Reduction Interval	User defined	0 year	
Certainty	User defined	0.0%	
Leakage Rate	User defined	0.0%	
Leakage Secondary Effects	User defined	0 MgC/ha	
Financial/Administrative	**Options**	**Selected Options**	**Note**
Discount Rate	User defined	6.00%	
Carbon Price	User defined	$14.00 /MgCO2e	
Carbon Price Increase	User defined	1.00%/year	
Timber Prices	SW saw price	$38.63 green US ton	
	HW saw price	$24.18 green US ton	
	SW pulp price	$7.44 green US ton	
	HW pulp price	$7.74 green US ton	
Land Cost/Other Project		$500.00/project	Required by CAR
Sampling Interval		12 years	Required by CAR
Easement required	Yes		
	No	√	
Pre-project analysis required	Yes	√	
	No		
Calculation-initial inventory	Look-up tables	√	
	Site data from sampling		Not applicable for this project
Calculation-first year sequestration	Look-up tables	√	
	Site data from sampling		Not applicable for this project
Calculation-LLWP to-date	Yes	√	
	No		
Certification required	Yes		
	No	√	
Project registration fee	User defined	$500.00/project	Required by CAR
Initial verification required	Yes	√	
	No		
Measurement-annual sequestration	Modeling, Look-up table		
	Field	√	
Calculation-annual sequestration	Look-up tables	√	
	Site data from sampling		
Verification interval	User defined	6 years	Required by CAR
Calculation-annual LLWP	Yes	√	
	No		

Project maintenance fee	User defined	\$500.00/project/year	Required by CAR
Credit issuance/registration	User defined	\$0.20/ $MgCO_2e$	Required by CAR
Credit trading/transfer fee	User defined	\$0.03/ $MgCO_2e$	Required by CAR
Aggregation required	Yes		
	No	√	
Carbon insurance required	Yes		
	No	√	
Accounting method	Net year-over-year		
	Summed annual	√	
Buffer coverage	All reversals	√	
	Catastrophic only		

According to the actual conditions of BTW, the requirements of CAR's Forest Project Protocol Version 3.2, and the decisions made by Southern Appalachian Highlands Conservancy, the values of inputs have were set on the control panel (Table 1). The project type is extended rotation, which means that by extending the timber harvest rotation from current interval to a longer interval, the forest land will store more carbon on average, satisfying the additionality requirement. Because BTW is adequately stocked and already preserved with a conservation easement, extended rotation is the best project type for this forest. There are only three different project sizes allowed in ForCOST: 100 ha, 1000 ha, 10000 ha. Since BTW is about 3400 ha, and one cannot directly set the project at this size, the tool was run separately for 100 ha, 1000 ha and 10000 ha forest sizes. Then, a trend line was created to show the relationship between project size and project value. Based on the trend line, the project value of a forest of BTW's size can be determined. The forest cover type input is Southeast Oak and Hickory. Although Oak and Hickory are not the dominant forest cover type at BTW, this is the ForCOST forest type option that is most comparable to the actual forest communities at BTW. Setting the project harvest interval at 80 and the baseline harvest interval at 50 signifies a 30 year increase in rotation of the forest. This is the "improved" management change that sequesters more carbon in the forest and generates the offset credits. The forest will be divided into 10 stands. If the project harvest interval is 80 years, there will be one stand harvested every 10 years, and all the stands will be harvested one time over the course of 80 years. CAR's Forest Project Protocol Version 3.2 dictated many of the input selections for the tool, including project length, management plan revision interval, carbon pools to be measured, costs of registering the project with the reserve, verification interval, and costs of transferring credits from sellers to buyers. The inputs for buffer pool contribution, discount rate, carbon price, and carbon price increase rate were set assumptions that are conservative estimates of projected carbon market trends.

Results

BTW project estimates

In order to estimate the carbon sequestration and NPV of a carbon project at BTW, project sizes of 100 hectares, 1,000 hectares, and 10,000 hectares were modeled first. Relative values for a project the size of BTW are projected based on the trend line, and the red point represents a project of BTW's size (Table 2, Figure 2, Figure 3, Figure 4). The BTW project is about 3,441 ha. Under the initial settings (Table 1), it will generate about 272,038 offset credits over the 100 year project. Under the high cost estimate, the NPV of the project would be $ 1,131,167, meaning that the benefits can offset the costs of developing and registering the project and still have a good profit margin. Additionally, under a low cost estimate, the NPV of the project would be $2,627,061. When calculating NPV, both the income of logging and carbon sales are considered. Appendix C shows the information on which the high and low NPV estimations are based. The difference between the two estimates is huge. Therefore, there is significant uncertainty underlying the estimates and the conclusions derived from them.

Table 2 BTW Project Estimates from ForCost Tool

Project Size (ha)	Cumulative CO_2 (Mg CO_2 e)	NPV(high cost)$	NPV (low cost)$
3,441	272,038	1,131,167	2,627,061

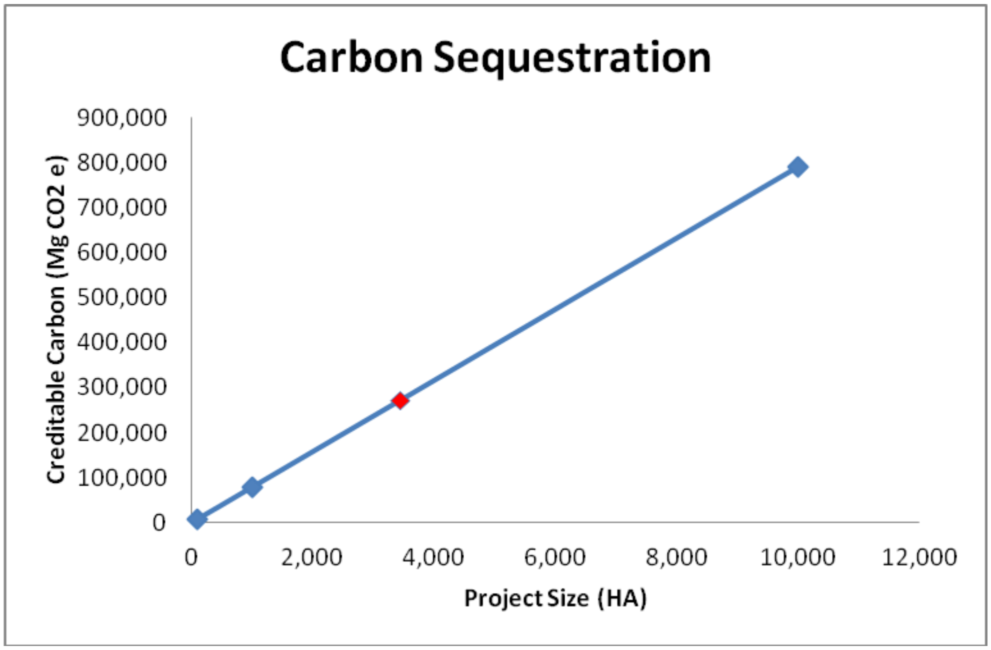

Figure 2 Relationship between project size and creditable carbon amount

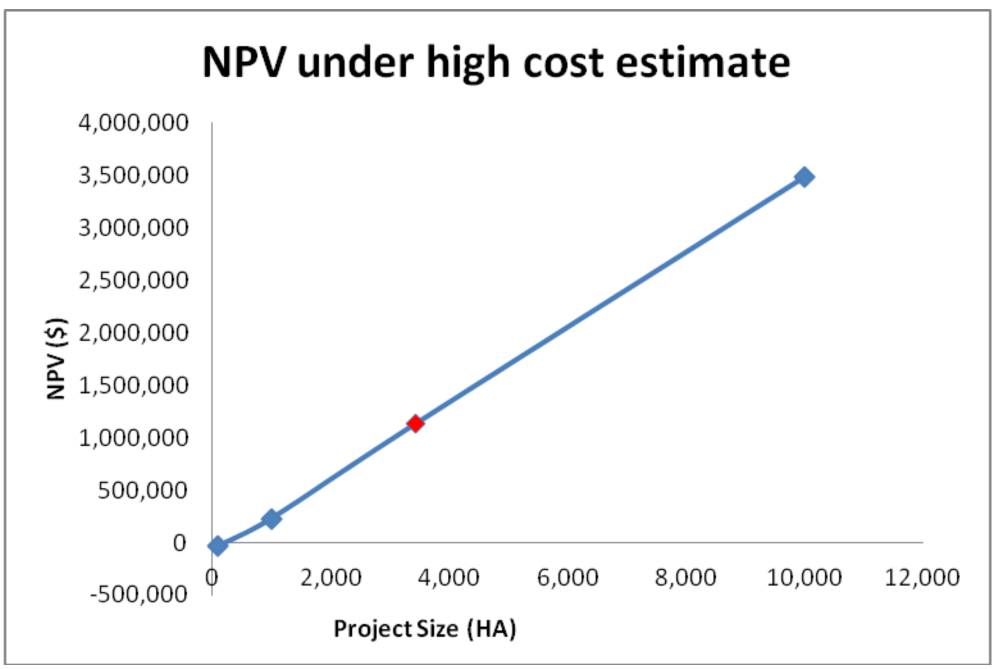

Figure 3 Relationship between project size the project NPV under high cost estimate

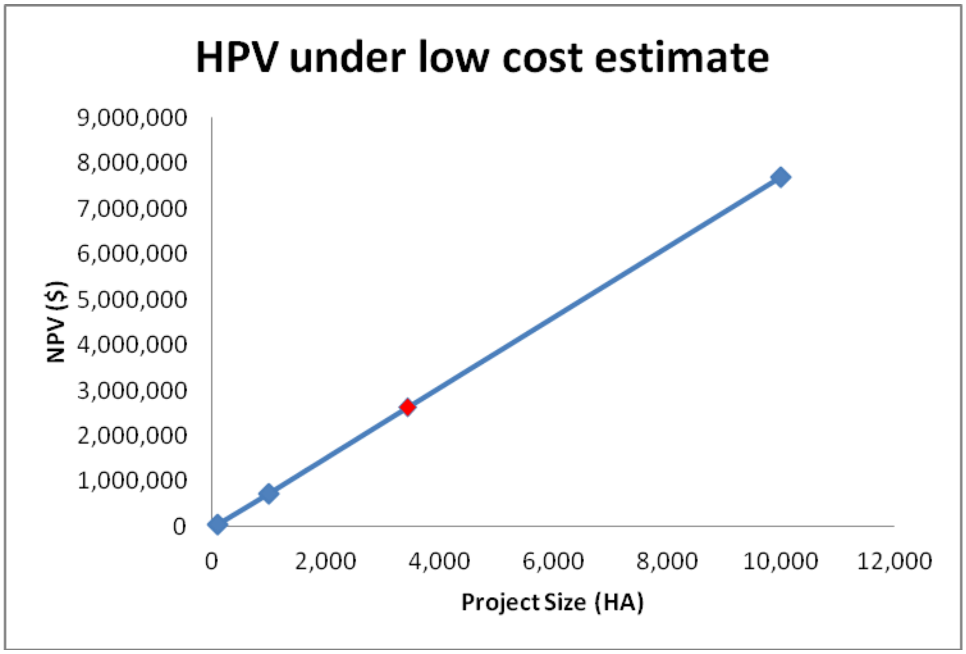

Figure 4 Relationship between project size the project NPV under low cost estimate

Identifying influential variables to project net present value

To help SAHC make an informed decision on carbon market participation, it is necessary to identify some variables which will have significant influence on the project NPV. Based on the inputs required by the ForCOST tool, five variables were examined: project size, timber harvest interval, discount rate, timber price, and carbon price. Project size and timber harvest interval are variables over which land-owners possesses a certain degree of control control. Discount rate, timber price, and carbon price are important financial parameters which will affect the economic viability of the forest carbon project. Although land-owners cannot control these prices, an understanding of how these variables may change the project can still prepare them well to make better decisions.

Project Size

Generally, a larger project size will yield a higher NPV (Figure 5). This is not only because larger projects have higher timber harvest income and carbon credit income, but they also have lower production and transaction costs per hectare (Appendix C). In other words, land owners can take advantage of economies of the scale with a larger project area. For small land owners, an aggregate project will allow them to register more than one land parcel in a carbon project, which will enlarge the total project size and generate higher revenue. However, a large project also has some drawbacks. It may require more maintenance work, and it would have a higher risk of unexpected carbon stock reversals from fire or pest outbreak.

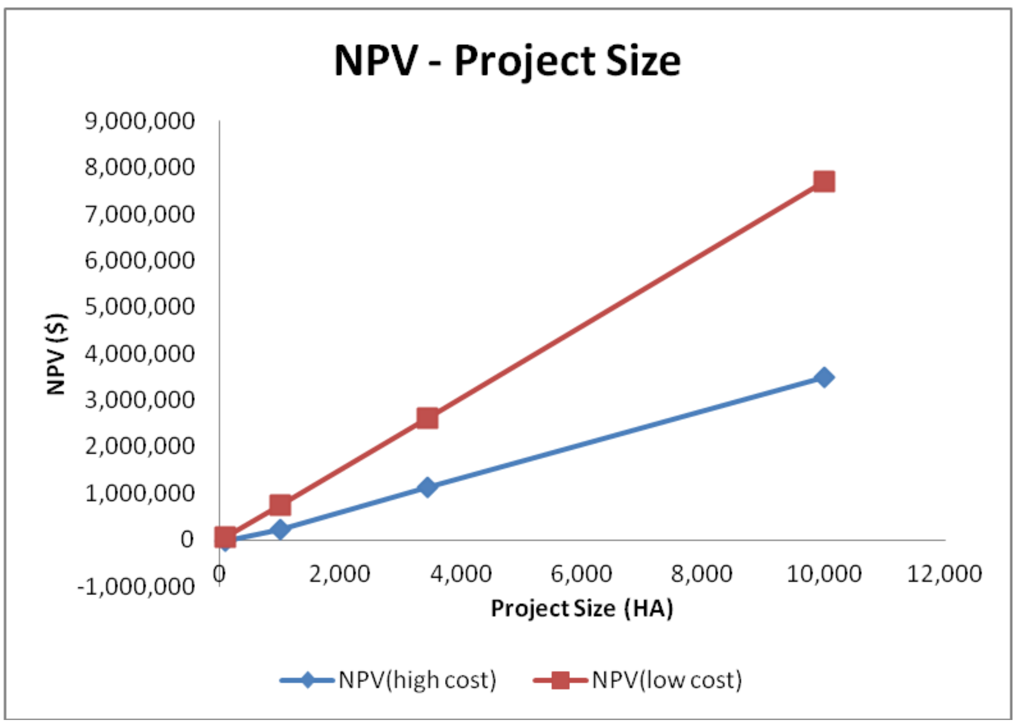

Figure 5 Relationship between project size and NPV

Project Harvest Interval

To test whether the total carbon sequestration and NPV of the project will be affected by the harvest interval, ForCOST was run using different project harvest interval lengths while the baseline harvest interval was kept the same. The baseline harvest interval was set to 50 years, while the project harvest interval was changed from 60 years to 100 years (Figure 6). In general, as the rotation period extended, both the amount of carbon sequestration and the NPV of the project increased (Figure 6, Figure 7). Built on the assumptions, a change from 60-year harvest interval to 100-year harvest interval will result in nearly 400,000 more tons of CO_2 captured, and the NPV of the project will increase by around $1,000,000 under either high or low cost estimates. Therefore, it is suggested that BTW could extend its rotation period to achieve a higher carbon sequestration and project value. However, it is worth noting that the output numbers (400,000 tons of CO_2, $ 1,000,000 NPV) are reached based on an extensive suite of assumptions. Considering the very high uncertainty underlying in this model, it is more appropriate to conclude that longer harvest interval will make the forest carbon project more profitable, rather than claiming that landowners can expect exactly $ 1,000,000 more revenue when they extend rotation from every 60 years to every 100 years.

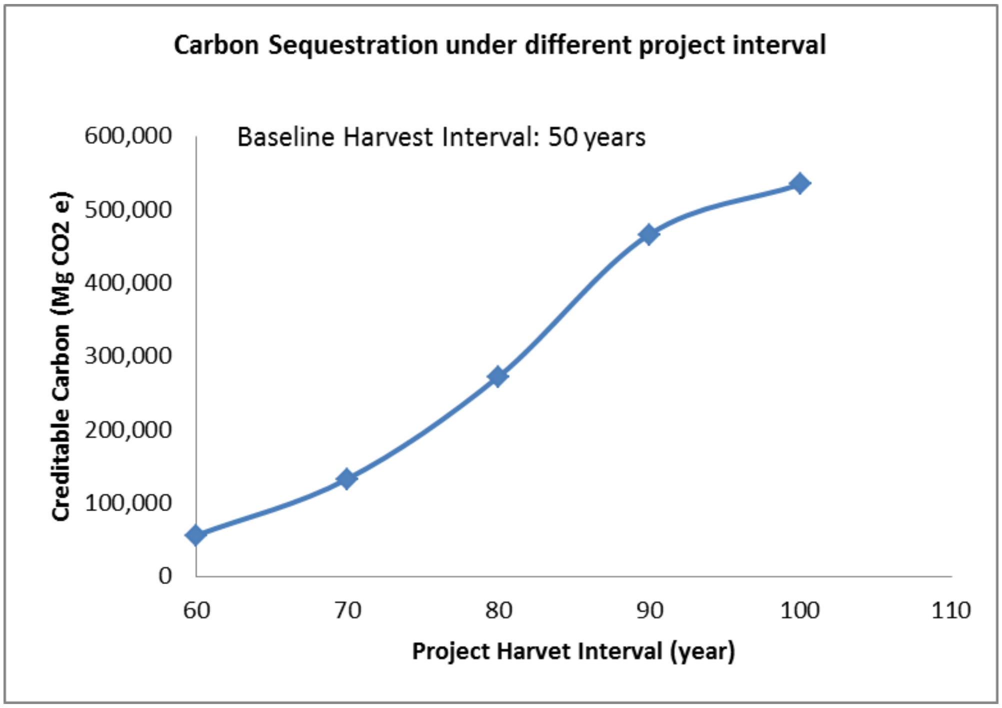

Figure 6 Relationship between project harvest interval and creditable carbon amount

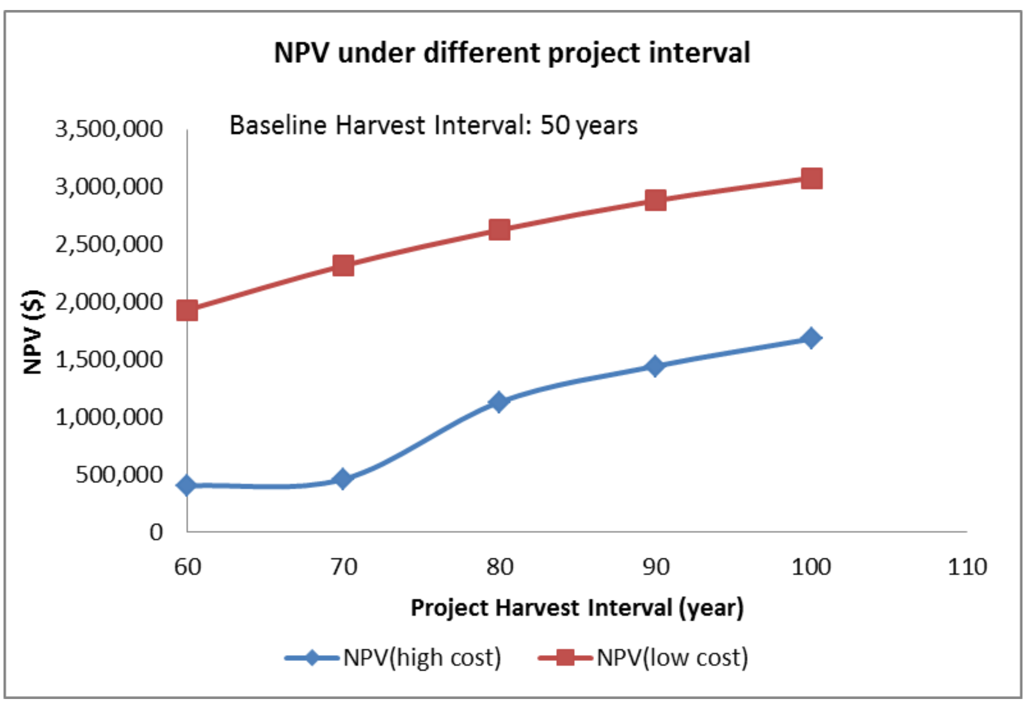

Figure 7 Relationship between project harvest interval and NPV

Discount Rate

The discount rate represents how people view future values today. A high discount rate means the value in the future will be very small today. As a result, the cost and benefit in the future have less impact on the present value of the project. Therefore, the project decision will be more short-term focused.

When estimating the impact of the discount rate, the analysis was made based on a 10,000 ha project, with a baseline harvest interval of 50 years, and a new project harvest interval of 80 years. The other settings are the same as the BTW project conditions. As the discount rate goes up from 4% to 10%, the project NPV significantly decreases (Figure 8). This result indicates that whether a project is economically viable also depends on how the decision maker values the future.

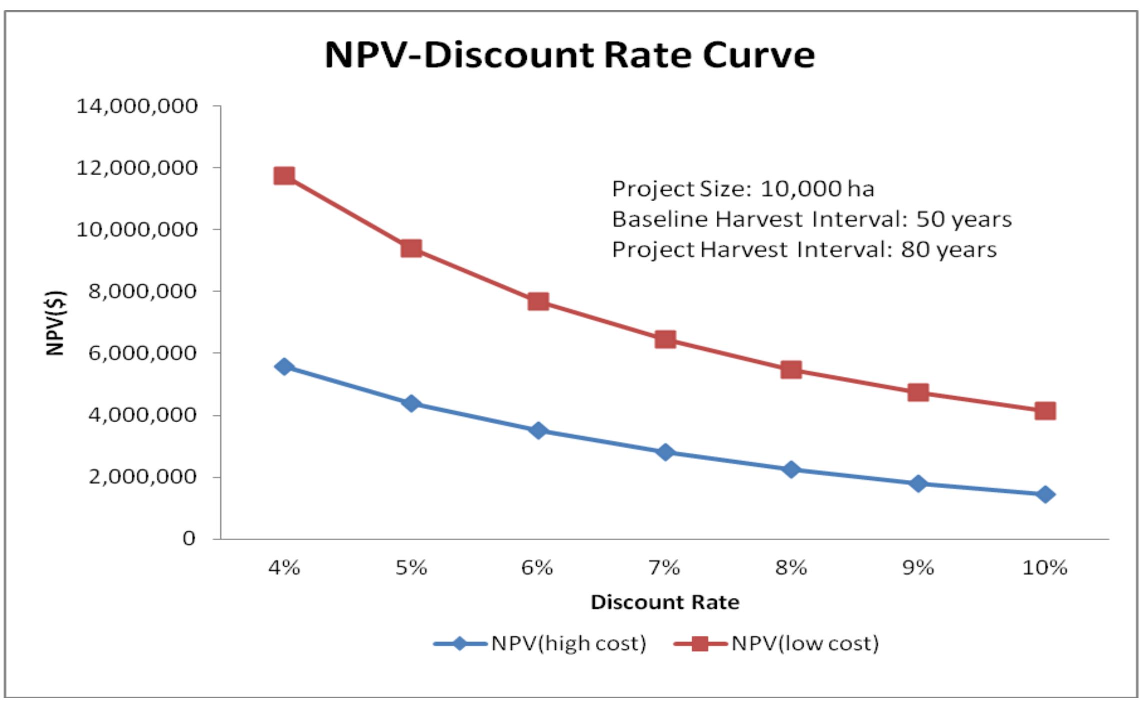

Figure 8 Relationship between discount rate the NPV

Timber Price

Timber harvest income is one of the revenue sources for a forest project, regardless of whether or not a carbon project is enacted on the forest. Therefore, a change in timber price will directly lead to a project benefit change. The current timber price (mean value in Figure 9) is: $38.63 green US ton for softwood sawtimber, $24.18 green US ton for hardwood sawtimber, $7.44 green US ton for softwood pulp, $7.74 green US ton for hardwood pulp. To understand to what extent timber price will affect total project benefits, timber price was adjusted by 10% and 20%, both above and below current price, holding other variables constant. When timber price is lowered below the actual price, the project NPV increases in proportion with the timber price increase. When timber price is raised above the actual price, project NPV still goes up when timber price increase, but at a slower rate.

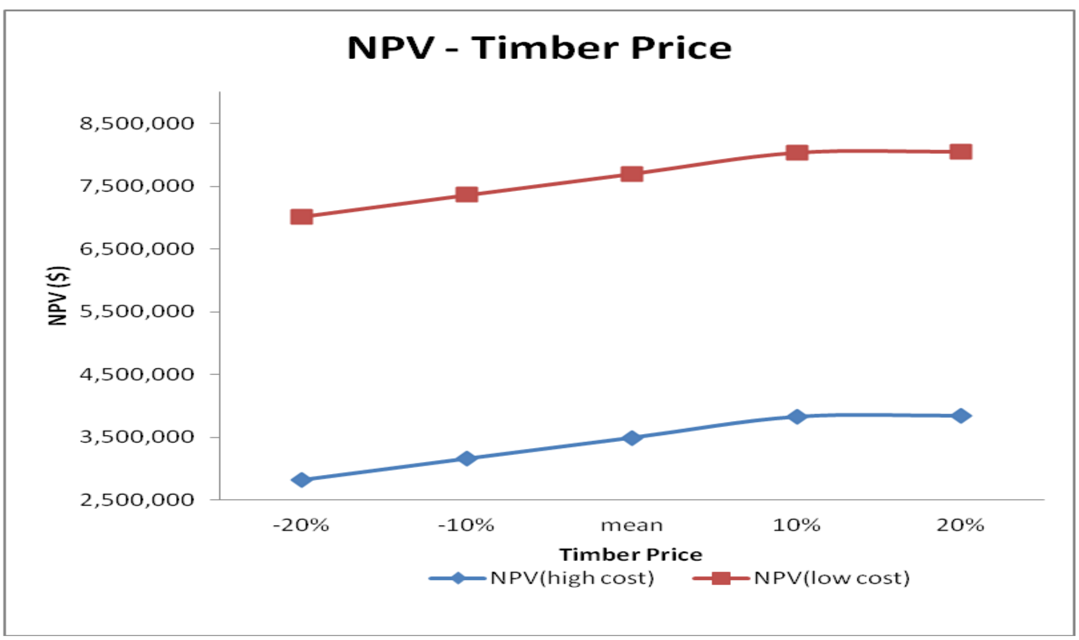

Figure 9 Relationship between timber price and NPV

Carbon Price

The income from carbon credit sales is another revenue source for a forest carbon project. Similar to the analysis of timber price, carbon price was adjusted by 10% and 20%, above and below current price. The results show that project NPV increases in proportion with carbon price change (Figure 10). Timber harvest revenue and carbon credit sales make up total project income, and to some extent, one will influence the other. A harvest will generate timber sale income and, at the same time, carbon credit income will drop during that year because carbon credits were originally tradable are reversed during the harvest (Figure 12).

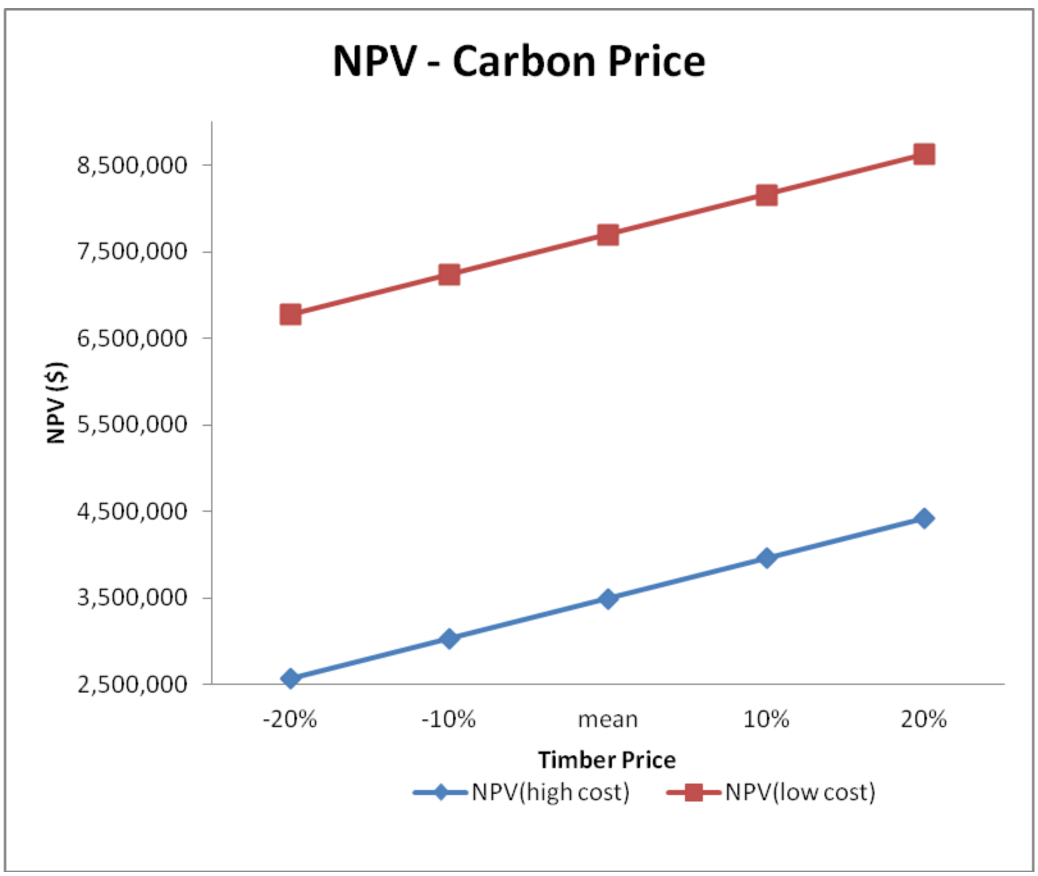

Figure 10 Relationship between carbon price and NPV

Incomes and Costs along Project Lifetime

It will be also helpful to know the composition of project costs and incomes, and also how those change along project lifetime. The analysis was based on a 10,000 ha project, all the costs were under high cost estimates, with all other initial setting same to BTW project.

The total cost can be divided into three categories: timber cost, project transaction cost, and trading/registration fee (Figure 11). Timber cost is the sum of the costs on site preparation, inventory, management plan preparation, forest regeneration cost, project land cost, site maintenance, administer harvests, timber insurance, and property tax (Galik et al, 2012). Timber cost is the main cost in total cost, which drives the curve of total cost. Every peak in timber cost curve represents a harvest. Since in this analysis, project harvest interval is every 80 years, and the forest is viewed as 10 stands, which means one stand will be harvested every 8 years, we can find there is a peak in timber cost every 8 years. Compared to timber cost, project transaction cost and trading/registration fee are really low. The main drivers of timber cost are site preparation cost and forest regeneration cost.

Project total income comes from two sources: timber sales income and carbon credits sales income (Figure 12). The timber income curve has a peak every 8 years, it is still because timber will be harvested every 8 years. Consequently, at the same year, there is a trough on carbon income curve, it is because when part of the forest is harvested, that amount of credits are reversed. Both timber income and carbon income increase along time. Part of the reason may be we assume the price of carbon credit will increase by 1%

every year. Moreover, since the harvest interval is extended, trees are allow to grow bigger before cutting down, there are more timber harvested at each stand.

The total revenue curve is calcuated based on costs and incomes (Figure 13). Generally, the revenue curve has the same trend with income curve, which indicates income is more important than cost in affacting revenue. Therefore, to make a project economically viable, land owners can focus more on how to generate higher income rather than reducing cost. The project net present value was negetive in the very beginning, this is because the intial costs was not covered by incomes. One reason is because the initial cost to establish a carbon project is higher than maintaining a project. Once the project has started, the cost will decline. Another reason is it takes some time to generate the carbon credits. The income from carbon credits sales will not be available right after the project started.

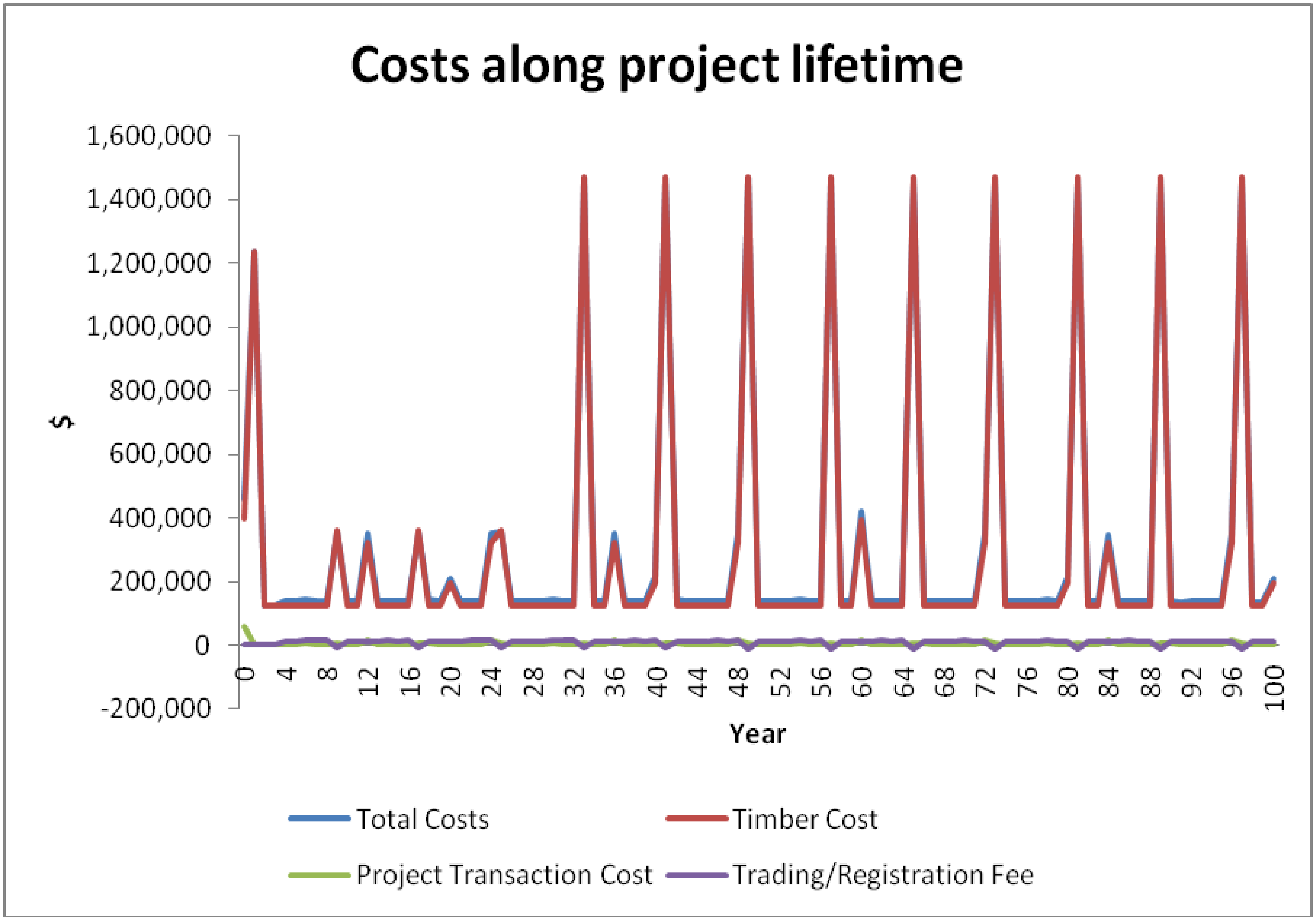

Figure 11 Costs along 100 year project lifetime

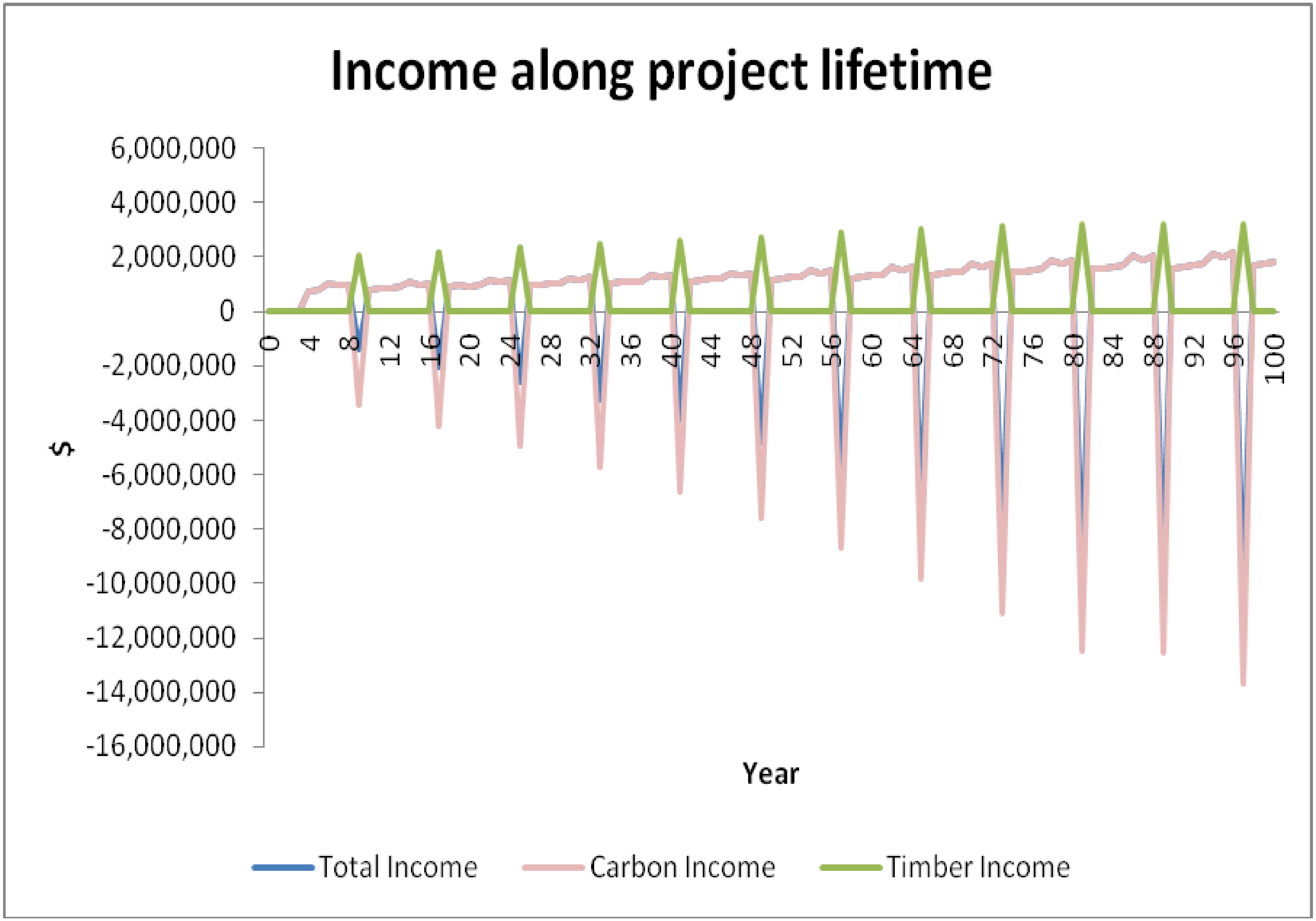

Figure 12 Income along 100 years project lifetime

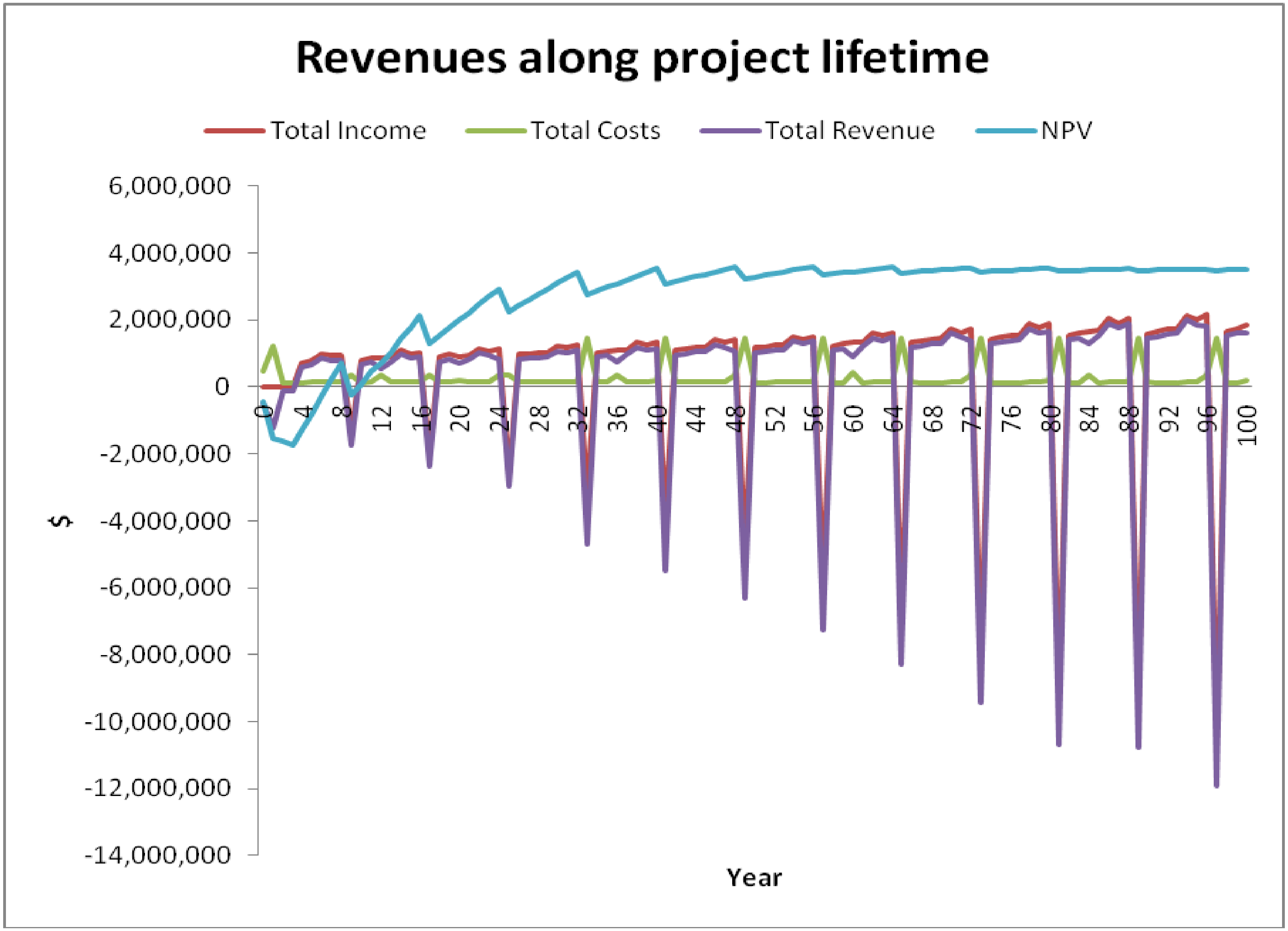

Figure 13 Revenues along 100 years project lifeitme

Discussion

Nowadays, in the U.S., landowners and land trust like SAHC have many options in terms of participating in carbon market. They can join the national wide markets like CAR or ACR, at the same time supported by local organizations like Dogwood Alliance, Northern Forest Center, et cetera. According to our analysis, the economic viability of a forest carbon project depends on many factors, such as project size, project type, harvest interval, discount rate, carbon and timber price, and so on. Generally, a larger project with longer harvest interval will be more profitable. We also find change on both carbon and timber price has significant impact on project NPV. However, there are studies with conclusions different from ours. In the paper *What makes carbon work*, Mr. Galik and his colleague did sensitive analysis on all the factors that may influence project net present value (Galik et al, 2012a). For loblolly-shortleaf pine stands, they found under extended rotation, timber price and discount rate are the two most important drivers, followed by leakage and buffer, while the impact of carbon price is so small which can be neglected (Galik et al, 2012a). Though we both use ForCOST tool to calculate project NPV, we have different initial settings. For example, the forest type, project size, carbon price and timber price are all different, which makes the results not comparable.

This analysis is helpful to SAHC because it makes it clear what they need to pay attention to and how they can make better management plan. Built upon this, for SAHC, an aggregate project is also worth considering. For the BTW project, landowners would play the role of forest owner. Because SAHC only holds the BTW conservation easement, SAHC would not receive any income from sold carbon. SAHC does own and manage 40 tracts of forestland in fee simple, which total over 5,000 acres. CAR has developed an aggregate forest carbon project option in order to encourage greater participation by forest landowners. Aggregate projects alleviate transaction costs and reduce overall costs by enabling economies of scale (Climate Action Reserve, 2010). Because they involve a larger group of participants, aggregate projects can oftentimes be more volatile and difficult to manage. However, grouping their fee simple forest properties into one aggregate project, would allow SAHC to keep all carbon credit profits to use to help manage current forests and acquire new lands for conservation. Registering an aggregate project with CAR would provide SAHC with greater flexibility in choosing which lands are viable for project development. CAR allows aggregate projects to be made up of a combination of IFM, AC, and reforestation projects. Moreover, they require fewer sample plots to generate the forest carbon inventory, as the larger individual uncertainty is compensated through aggregation with other projects. Each individual project must submit an annual desk verification report, but there is an overall less frequent on-the-ground verification schedule in comparison to conventional forest carbon projects (Climate Action Reserve, 2010). Please see Appendix B for a more detailed description of the specific requirements for registering an aggregate project.

The limitations of this analysis are also worth noting. Due to the oversimplifying on forest type, huge variation between high and low cost estimates, and limited options provided, the analysis cannot be used to generate any specific cash flow. To make a better evaluation on a potential forest carbon project, comprehensive forest inventory data is required.

Conclusions

Under the CAR Forest Project Protocol Version 3.2, a forest carbon project of BTW's size and condition will generate a significant number of offset credits over the project lifetime if the timber is harvested less frequently. Also, projects with lower transaction costs will generate more profits than those with higher transaction costs. It is important to keep in mind, however, that without accurate forest inventory data the ForCOST tool is unable to give a precise estimate of potential carbon returns from a project. While the tool is helpful for analyzing general differences between projects of different sizes and timber harvest intervals, it cannot provide a reliable assessment of a project's exact financial returns. Nevertheless, BTW's large size, moderate timber harvest history, and working forest status contribute to its high probability of project success. Figure 14 from the Manomet Center for Conservation Sciences report "Selling Forest Carbon" gives general guidelines for acreage cutoffs and management restrictions for profitable and prosperous projects. A forest is considered a good candidate for project development if it is over 2,000 acres, well stocked, and eligible for timber harvest. A forest, smaller than 500 acres that has recently been harvested or is not authorized for timber harvest, would not have a high probability of success.

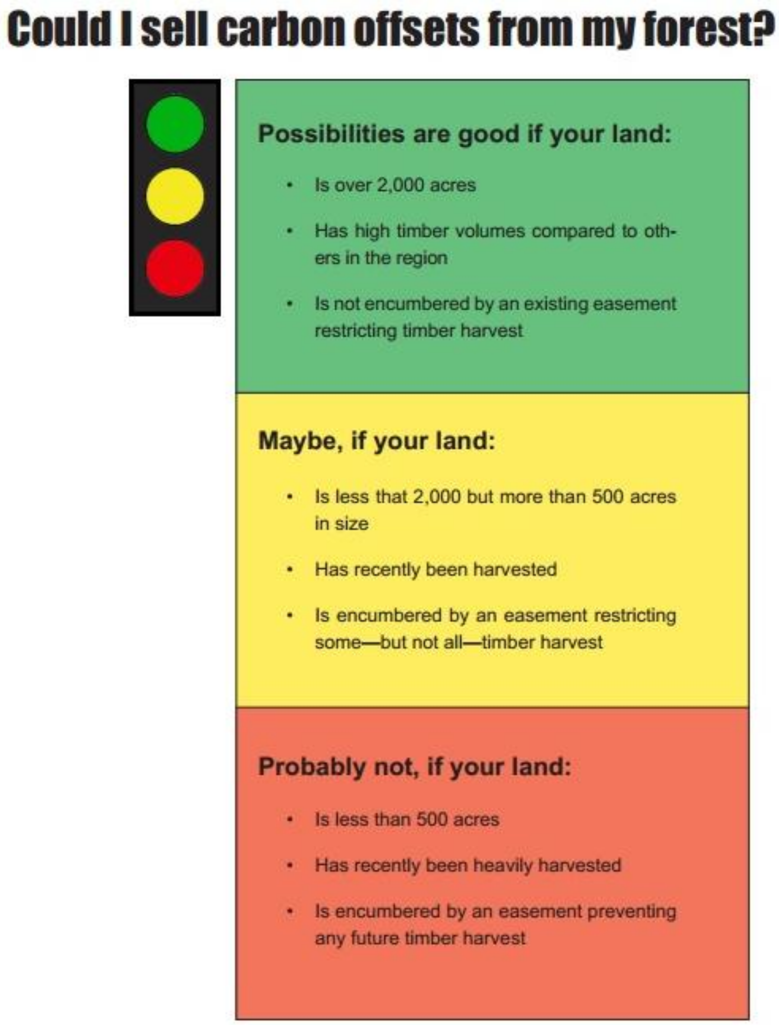

Figure 14 Forest carbon project general viability guidelines (Beane, 2012)

Considering the uncertainty of the ForCOST tool, we conclude that SAHC should recommend that their landowners pursue carbon market participation through Dogwood Alliance's Carbon Canopy campaign. This program that brings multiple stakeholders to the project development table has the capacity to subsidize project development, thereby lowering the overall transaction costs. Campaigns like Carbon Canopy are an ideal option for small private landowners who wish to participate in carbon markets, but do not possess the resources to develop a project on their own.

Acknowledgements

We would like to thank our friends, family, and advisers for their support throughout the Master's Project process. More specifically, we would like to express great appreciation for our Nicholas School adviser Dr. James Clark, PhD., our contact at the Nicholas Institute for Environmental Policy Solutions Mr. Christopher Galik, and our contact at the Southern Appalachian Highlands Conservancy Ms. Michelle Pugliese.

Appendices

Appendix A

SAHC's administrative responsibilities as project developer under CAR (Climate Action Reserve, 2013)

1. Register an account as a project developer.

   This includes completing an online application, agreeing to Terms of Use, and the payment of a $500 annual account maintenance fee within 30 days.

   Several projects can be maintained under one account, and the developer can allow other agents to access the account (i.e. technical consultants) by completing a Designation of Authority Form

2. Complete and upload a project submittal form.

   This includes paying the one-time $500 project submittal fee and completing and submitting all forms required of the specific project type.

   Required forms for an Improved Forest Management project:

   Attestation of Title: This document states that the project developer owns the rights to any removals generated from project activities

   Attestation of Regulatory Compliance: This document states that the project has met regulatory compliance and that any case of noncompliance has been disclosed to the third party verification body.

   Attestation of Voluntary Implementation: This document states that the project was developed voluntarily and not mandated by any regulation or legally binding mandate.

   Forest Project Submittal Form: This document is a proposal to begin an Improved Forest Management, Reforestation, or Avoided Conversion project. It calls for general contact information and proof of land ownership, as well as descriptions of project boundaries, forest conditions, land management practices, and plans to meet natural forest management and sustainable harvesting requirements.

   Physical Boundary Map: This should include all roads, towns, major watercourses, topography, and latitude and longitude

Project Implementation Agreement: This document is the contract between the Reserve and the forest owner. In it, the forest owner agrees to comply with the project protocol and other requirements of registering with the Reserve.

Project Design Document: This is an outline of the project operations that ensures consistency and completeness in documentation for the project. This is the main document reviewed by verifiers.
In this document the project developer must provide:

- -proof of project eligibility requirements
  - -additionality, sustainable harvest, natural forest management
- -list of all carbon sources, sinks, and reservoirs
- -inventory designs, data management plan, quantification methodology
- -plan for forest inventory update (at least every 12 years)
- -baseline carbon stock estimates, including legal and financial restraints
- -actual onsite carbon stocks
- -calculation of net GHG removals
- -calculation of reversal risk rating and buffer pool contribution

Annual Monitoring Report: This document ensures that the project is still meeting any requirements. It includes current carbon stock estimates and any updates on carbon quantification methodologies and carbon stock reversal status.

When all documents are uploaded onto the CAR software, the Reserve staff conducts a preliminary review for completion and compliance with the requirements of the protocols. At this point **the project is considered 'listed'** and available for public review. This is not a guarantee of project approval, but once a project is listed the project developer can move forward with verification activities.

Once a project is submitted and listed, it must be registered within 30 months. A project achieves registration after its first Reserve-approved verification.

3. Select an ISO-accredited and Reserve-approved verification body.

The verification body will submit a **Notice of Verification Activities and Conflict of Interest Evaluation Form (NOVA/COI)** to the Reserve. This document describes the verification activities to take place and provides information necessary to ensure that the verification body is an impartial third party verifier.

4. Upload monitoring information onto Reserve software and submit project for verification.

The verifier will review project data, determine if the project is in full compliance, and upload a **Verification Report**, **Verification Statement**, and **List of Findings** to the Reserve site. An on-site visit from a verifier is required every six years.

5. Review verifier's findings and submit project for final approval.

Once this is done, the Reserve staff will review the forms and, upon approval, send an invoice for CRT issuance for the project developer.
The developer can then pay for the issuance of the offsets and take them to market.

<u>SAHC's administrative responsibilities as project developer under ACR (American Carbon Registry, 2010)</u>

1. Register an account as a project developer.

This includes providing basic account registration information, such as Account Holder name, address, and contact information, etc, to the ACR Administrator through a secure web-page on the ACR website. For the account to be activated, the registrant must review and agree to the ACR Terms of Use agreement. There is an Account Opening fee of $500.

Several Offset projects can be maintained under one account. Any party, including non-Project Proponents, such as traders, marketers, and end-use customers wishing to hold, transfer, or retire ERTs must establish an account in the ACR.

2. Offset Project Registration.

Submit an on-line offset project setup form containing information related to the characteristics of the project. A qualified project needs to meet the following criteria:

Project Document: This document defines how, what and when a Project Proponent shall measure, monitor, and report the GHG project in order for an independent third party to verify project outcomes.

Attestation of Real: It is required that the GHG reduction or removal in this project exist prior to offset issuance.

Attestation of Additionality: It is required that a project-based offset is "in addition to" reductions and/or removals that would have occurred without carbon market incentives.

Attestation of Direct Emissions: It is required that the Project Proponent owns or has control over the GHG sources or sinks from which the emissions reduction or removal originates.

Project Action: This document demonstrates an accepted and discernible project action, change in activity or process, and/or avoidance of commonly occurring action.

Attestation of Title: This document states the project Developer's undisputed title to all GHG reduction and removals prior to offset issuance.

Attestation of Approved Methods, Tools and Emissions Factors: It is required to use best practices as incorporated in ACR approved methodologies for baseline determination, baseline update, additionality determination, permanence risk analysis, buffer determination, land eligibility, GHG modeling and measurement, and monitoring and reporting.

Project Baseline Calculation: ACR required Project Proponents estimate the baseline for all forest and land use projects at the project start. An approved verifier will verify the baseline at time of offset issuance. Project Proponent shall use appropriate methodologies and tools to estimate and update forest project baselines.

Consideration of Permanence: ACR required Project Proponents to assess, account for, and mitigate leakage, and provide documentation to support mitigation assertions. Project must deduct all leakage that reduces the GHG emissions reduction and/or removal benefit or the project.

Analysis of Net Leakage: Leakage is the increase in GHG emissions outside the project boundary that occurs because of the project action. ACR requires Project Proponents to assess, account for, and mitigate leakage, and provide documentation to support mitigation assertions. Project must deduct all leakage that reduces the GHG emissions reduction and/or removal benefit or the project.

Mitigation Plan: This document states any foreseen negative community or environmental impact

Third Party Verification: Project-specific conflict of interest disclosure forms provided by ACR-approved Verifier.

. **Written Disclosure by Project Proponent:** This document states any prior negative community or environmental impacts or claims of negative environmental and community impacts, and any unmitigated, or claims of unmitigated, negative community and environmental impacts caused by the project as they become known, as well as plans for mitigation of any such reported negative environmental or community impacts.

Submit all required documents identified by the ACR electronically by using the Document Upload screen. For documentation to be submitted as hard copy, send to AMERICAN CARBON REGISTRY.

3. Project Registration Process (PD: Project Developer, AD: ACR Administrator, VR: Verifier):

- New Project

PD: Submit project
PD: Pay Project Certification Fee $1000
AD: Review project listing

- Listed Project

PD: Submit project
PD: Revise and resubmit
AD: Review project for certification

- Registered Project

PD: Select verifier (Contact the verifier before selecting)
VR: Submit Conflict of interest disclosure (COI)
AD: Review COI
VR: Resubmit COI
PD: Submit emission reduction data to VR
VR: Review emission reduction data and submit opinion
PD: Revise emission data
PD: Submit project for final approval
AD: Review project
VR: Revise opinion
PD: Submit emission reduction data to VR

As a project is moved to a new status, the ACR automatically sends emails to the party required to perform the action identified as the next step. Once ERTs are issued and the project status is changed to “Issued”, the project proponent will only need to go back into the registry when the next annual verification is available to receive additional ERTs.

4. Other fees

Annual Subscription Fee: $500
This fee is paid by Project Developer, Transaction and Corporate Account Holder upon their account approval and each year on the anniversary of the account approval date.

Activation Fee (per ERT): $0.15
Once ERTs are issued they will be "inactive" and not able to be transacted, retired or de-listed until activated by the account Holder. This can be paid either by any party.

ERT Transfer Fee (per ERT): $0.15
Transfer fees are charged on the first of each month for all accumulated confirmed transfers completed in the prior month. This fee is billed to buyer.

Appendix B

Aggregate Forest Projects with the Climate Action Reserve (Climate Action Reserve, 2010)

1. Actors.

Aggregator

-can be a corporation, city, county, or state entity, and individual (or a combination)
-can be a Forest Owner of one of the projects in the overall aggregate project
-maintains separate Reserve account to which Forest Owners transfer CRTs
-selects verification body, coordinates verification schedules
-can help in project development, provide inventory services, et cetera.
-scope of role determined by Forest Owner and Aggregator
-terms of agreement reflected in contracts

Forest Owner

-each project must be registered separately by the Forest Owner and hold own Reserve account
-must sign individual Project Implementation Agreement
-cannot enroll more than 5,000 acres in aggregate projects overall
-baseline determination, sustainable harvest, natural forest management, and monitoring requirements remain the same
-ultimately responsible for submitting required forms and achieving compliance with Forest Project Protocol

2. Forming an Aggregate Project.

-Aggregator establishes "Broker, Retailer, Trader" account on the Reserve
-submit an "Aggregator Document" that will be available to the public containing:
-Aggregator contact info
-list of Forest Owner participants

To join an aggregate project:

-Forest Owner submits "Aggregate Entry" form containing:
    -statement that Forest Owner wants to join a specific aggregate project
    -copies of any contracts between Forest Owner and Aggregator (at discretion of Forest Owner whether or not made publically available)
    -site-visit verification required before allowed to join

To leave an aggregate project:

-Forest Owner submits an "Aggregate Exit" form containing:
    -statement that FO intends to withdraw
-if FO intends to start standalone project-
    -no further credits issued until standalone inventory standards are met and new inventory verified

-if FO intends to enroll in another aggregate project-
- -24 months to do so, account activities suspended until joined with new project

-if exit of a project changes targeted standard error for the aggregate
- -new project must be added within 12 months
- -or new targeted standard error will apply to remaining projects

Accounts with the Reserve and Transferring CRTs:

-each FO in an aggregate project must have own account with the Reserve
-Aggregator must have Reserve account to which CRTs can be transferred from the accounts of participating FOs
- -subsequently transferred to third parties

Monitoring and Verification:

-site-visit verification at beginning of project
-Aggregator selects single verification body for whole project
-Aggregator must document verification work and report annually to the Reserve

Verification differences:

-scheduled so that a min of 50% of projects must have successfully completed site-visit verification within the previous 6 years, 100% within the past 12 years
-Forest Owner must still submit annual desk monitoring report

Appendix C High and Low Transaction Cost Estimates (Galik et al, 2010)

	100	1000	10000	
Component/Subcomponent	**High**	**High**	**High**	**(units)**
Project Establishment (timber and carbon)				
Site Preparation	$200.00	$200.00	$200.00	acre-1
Inventory	$35.00	$10.00	$8.00	acre-1
Management Plan Preparation	$30.00	$15.00	$3.00	acre-1
Regeneration Costs (planted and natural)	$250.00	$250.00	$250.00	acre-1
Easement Establishment				project-1
Project Establishment (carbon only)				
Carbon Project Development (consultant or owner developed)	$20.00	$5.00	$0.65	acre-1
Pre project calculations, studies, analyses	$5.00	$2.50	$0.75	acre-1
Inventory-conversion of existing inventory to carbon baseline				
Look-up Tables	$3.00	$1.10	$0.35	acre-1
Site data from sampling	$6.50	$2.00	$0.45	acre-1
Growth Modeling-calculating first year(s) sequestration				
Look-up Tables	$1.75	$0.30	$0.10	acre-1
Site data from sampling	$1.75	$0.30	$0.10	acre-1
Calculation of LLWP Carbon pool (All years to date)	$3.00	$0.50	$0.10	acre-1
Certification	$0.00	$0.00	$0.00	acre-1
Registry Fee	$500.00	$500.00	$500.00	project-1
Initial Verification Fees	$12.00	$2.60	$0.40	acre-1
Project Implementation (timber and carbon)				
Site Maintenance	$5.00	$5.00	$5.00	acre-1
Mark/Administer Harvests	$120.00	$110.00	$95.00	acre harvested-1
Timber Insurance				
Property Tax (no easement)	$0.00	$0.00	$0.00	acre-1
Property Tax (easement)	$0.00	$0.00	$0.00	acre-1
Project Implementation (carbon only)				
Measurement/Monitoring				
Modeling, Look-up Tables	$0.84	$0.14	$0.03	acre-1
Field Sampling/Monitoring	$26.85	$3.15	$0.36	acre-1
Annual Verification Report	$8.00	$1.50	$0.18	event-1
Growth Modeling-calculating each year(s) sequestration				
Look-up Tables	$1.50	$0.20	$0.05	acre-1
Site data from sampling (largely automated)	$1.50	$0.20	$0.05	acre-1
Calculation of LLWP Carbon pool per year	$0.75	$0.50	$0.15	
Registry Maintenance Fee	$500.00	$500.00	$500.00	project-1
Issuance/Registration Fee	$0.15	$0.15	$0.15	Mg CO2e-1
Trading/Transfer Fee	$0.06	$0.06	$0.06	Mg CO2e-1
Aggregation Fee	12.00%	10.00%	10.00%	Mg CO2e-1

Carbon Insurance				
	100	1000	10000	
Component/Subcomponent	Low	Low	Low	(units)
Project Establishment (timber and carbon)				
Site Preparation	$0.00	$0.00	$0.00	acre-1
Inventory	$5.00	$5.00	$3.00	acre-1
Management Plan Preparation	$0.00	$0.00	$0.00	acre-1
Regeneration Costs (planted and natural)	$0.00	$0.00	$0.00	acre-1
Easement Establishment				project-1
Project Establishment (carbon only)				
Carbon Project Development (consultant or owner developed)	$0.00	$0.00	$0.00	acre-1
Pre project calculations, studies, analyses	$0.00	$0.00	$0.00	acre-1
Inventory-conversion of existing inventory to carbon baseline				
Look-up Tables	$0.00	$0.00	$0.00	acre-1
Site data from sampling	$0.00	$0.00	$0.00	acre-1
Growth Modeling-calculating first year(s) sequestration				
Look-up Tables	$0.00	$0.00	$0.00	acre-1
Site data from sampling	$0.00	$0.00	$0.00	acre-1
Calculation of LLWP Carbon pool (All years to date)	$0.00	$0.00	$0.00	acre-1
Certification	$0.00	$0.00	$0.00	acre-1
Registry Fee	$0.00	$0.00	$0.00	project-1
Initial Verification Fees	$8.00	$1.50	$0.25	acre-1
Project Implementation (timber and carbon)				
Site Maintenance	$0.00	$0.00	$0.00	acre-1
Mark/Administer Harvests	$5.00	$5.00	$5.00	acre harvested-1
Timber Insurance				
Property Tax (no easement)	$0.00	$0.00	$0.00	acre-1
Property Tax (easement)	$0.00	$0.00	$0.00	acre-1
Project Implementation (carbon only)				
Measurement/Monitoring				
Modeling, Look-up Tables	$0.00	$0.00	$0.00	acre-1
Field Sampling/Monitoring	$9.60	$1.33	$0.13	acre-1
Annual Verification Report	$6.00	$1.00	$0.12	event-1
Growth Modeling-calculating each year(s) sequestration				
Look-up Tables	$0.00	$0.00	$0.00	acre-1
Site data from sampling (largely automated)	$0.00	$0.00	$0.00	acre-1
Calculation of LLWP Carbon pool per year	$0.00	$0.00	$0.00	
Registry Maintenance Fee	$0.00	$0.00	$0.00	project-1
Issuance/Registration Fee	$0.00	$0.00	$0.00	Mg CO2e-1
Trading/Transfer Fee	$0.00	$0.00	$0.00	Mg CO2e-1
Aggregation Fee	10.00%	10.00%	8.00%	Mg CO2e-1
Carbon Insurance				

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