Final Report Submitted to the USDA Natural Resources Conservation Service
Conservation Innovation Grants Program

Project Title: The Development of an Ecosystem Services Trading Program for Family Forest Landowners to Promote the Protection of Atmospheric, Water, and Soil Resources in Maine.

Grant Agreement Number: NRCS 68-3A75-6-136

November 5, 2008

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Matching Funds Sources:
Professional Logging Contractors of Maine
Forest Stewardship Council-US

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Introduction

The 2004 Maine Climate Action Plan states a goal of reducing greenhouse gas (primarily CO2, referred to here as carbon) emissions to 1990 levels by 2010, and 10% below those levels by 2020. The Plan recommends several options that involve specific forest management actions to fill the gap between the baseline and the legislative targets. Maine's Climate Action Plan is the first in the United States to fully consider the forest carbon cycle and active management options as a significant part of the overall Greenhouse Gas (GHG) mitigation effort.

In 2003, a Regional Greenhouse Gas Initiative (RGGI) was launched in ten Northeastern states to facilitate meeting greenhouse gas reduction commitments. A memorandum of understanding has been signed by the governors of ten Northeastern states, which includes guidance on the use of offsets to meet emission caps. Work has been underway in Maine to propose ways forest management regimes can increase carbon sequestration and decrease forest GHG emissions. To date, forest management offsets are not accepted as an approved offset type. In late 2008, the first offset auction occurred, which sets the stage for a functioning cap and trade system that may yet accept forest-based carbon offsets.

Increasingly the forestry and conservation community has focused on the potential role of forests to store carbon and help mitigate climate change. Many see a forest-based strategy to reduce atmospheric CO2 as an opportunity to reward forest conservation. However, experience around the country—through the launch of state and regional cap and trade schemes, voluntary credit-trading and offset projects, and attempts to enlist landowners to bring carbon to market—demonstrates that storing more carbon in forests as a climate strategy still faces some technical and political hurdles. The broad constituency advocating for forestry and conservation in climate legislation is still divided on many issues. Some of these details will determine whether small private landowners across the country will be part of the U.S. solution to climate change. Lessons learned so far suggest that forestlands in this region are not likely to be an important contributor to climate change mitigation unless a mechanism is carefully designed to engage landowners in profitable and effective ways to sequester additional carbon. Presently, there is no such mechanism in place.

There have been significant developments since the inception of this project that have increased our understanding of how managed forests could play a formal role in markets. One of these developments is the creation of an international Voluntary Carbon Standard (VCS) that has gained widespread endorsement from environmental organizations engaged in climate change mitigation. We discuss this standard in the context of the Maine Pilot Project and evaluate its applicability to family forest landowners. Many lessons have also been learned from the Chicago Climate Exchange (CCX) and the California Climate Action Registry (CCAR). The CCX has served as a testing ground for the practical aspects of a carbon offset market in general, and forest offsets in particular. We draw on these lessons in this report.

Family Forests and Carbon

Incentives are needed to better manage family forests and increase carbon sequestration or avoid further carbon emissions generated by the conversion or degradation of forests. If Maine landowners are to participate in a global carbon market, an innovative approach to forest management practices that increase carbon uptake and retention must be employed on the existing forest land base with landowners being compensated for practices outside of typical management. Small non-industrial private landowners (i.e., family forest owners with 5,000 acres and less) will have difficulty participating in a carbon market – yet more than 40% of the timber harvested annually in Maine comes from these lands. Indeed, there are more than 100,000 small woodland owners in Maine, who together own more than 5.5 million acres, or 33% of Maine's woodlands. The primary barriers to family forest landowner participation in carbon markets will be the costs related to baseline inventory acquisition, management planning, verification of carbon and certification of sustainable forest management practices, and long-term monitoring. Individually these are all significant costs, but taken all together, the burden of these transaction costs may prove a fatal flaw. We discuss the specifics of these transaction costs in the Case Study presented below. Still, given the significant role of family forests in climate change mitigation and forest landscape in Maine and nationally, the development of a credible forest carbon program strategy that is adaptive to the needs of small landowners is necessary if this important land base is to be included in the broader efforts to control greenhouse gases. These family forest lands are generally at risk from the process of forest conversion that occurs as land changes hands generationally or through outright sale. Indeed, the National Woodland Owners Survey found the average age of family forest landowners in the northern US is 60 (NWOS 2008). From a GHG mitigation standpoint, these landowner transitions represent a significant risk to the atmosphere. Figuring out many of the issues related to carbon markets and family forest landowners will set the basis for additional ecosystem service markets as they develop. Many of the same concepts such as baselines, additionality, and permanence are all issues that must be addressed whether the transactions involve carbon, water, or biodiversity.

We attempted to develop a pilot program in Maine that integrates current state, federal, and third-party forest certification mechanisms that support responsible forestry, and would satisfy a credible reporting mechanism (e.g., protocol) that that can connect landowners with existing carbon exchange markets including voluntary cap and trade and emerging voluntary over-the-counter (OTC) markets. The overall intent of the case study below was to explore the tools and infrastructure that would need to be in place for family forest landowners in Maine to efficiently participate in credible carbon credit markets. Failing the ability to engage formally in markets, we explored the policy opportunities for state or federal agencies to achieve forest carbon sequestration objectives. The world of carbon markets and protocols is extremely dynamic and we have tried to capture the relevant issues in a manner that advances our knowledge of what is possible and what gaps remain to be addressed.

Evaluation of the compatibility of existing registries and protocols, including CCX, RGGI, VCS and CCAR available to Maine and other landowners in the Northeast

Private and public sector initiatives concerning climate change and the potential role of terrestrial sequestration have rapidly emerged over the last few years. Though voluntary, the CCX is now the third largest carbon trading platform in the world, and a number of independent aggregators have sprung up around the country to market offsets. State registries have also proliferated, in service of state climate action plans. The state-level programs—initially tailored to their own emissions scenarios—have enjoined multi-state cap and trade schemes, which may at least serve as precursors to federal action, and whose approaches may become accepted by a federal scheme. However, there is much still to be worked out, especially among states hoping that sequestration within their managed forestland base can be rewarded.

The challenge remains to devise a protocol that a great number of landowners could adopt to both succeed in sequestering more carbon than they otherwise would have, and then empirically prove these gains. This challenge has several dimensions, which have shaped the TCNF project. These dimensions are characterized below as *credibility*, *applicability*, *viability*, *eligibility*, and *complementarity*, and help guide project for the pilot project. The project decisions are summarized below, and are similar to the decisions behind some registries (i.e., and what type of protocol they would require), and how they are different from others. Our evaluation is concentrated on the following four emerging protocols that have the most relevance to landowners in Maine and throughout the Northeast:

- Chicago Climate Exchange (CCX)
- California Climate Action Registry (CCAR)
- Voluntary Carbon Standard (VCS)
- Regional Greenhouse Gas Initiative (RGGI)

1.) Credibility. If carbon-sequestering actions are to be rewarded, whether through credits or some other means, then they need to reliably remove CO_2 from the atmosphere in known and provable quantities. The common terms used to define the credibility of a carbon offset are ***permanence, additionality, and leakage***.

Project Decision: The project needs to ensure that CO_2 *sequestration exceeds sequestration rates of "other" forests with comparable baseline stocks and practices or there will be no effect on climate change.*

2.) Applicability. The on-the-ground silvicultural techniques that will most successfully result in either more carbon stored onsite or captured in products removed from the forest will vary by forest type and conditions, as well as market opportunities.

Project Decision: A set of sequestration strategies that work in particular forest types and conditions are developed, such that certain management practices can be defined, promoted, and verified by an aggregator.

3.) Viability. It will likely prove too expensive for any single landowner (or their forester) to do the work of documenting, monitoring and reporting carbon stocks on their own.

Project Decision: TCNF demonstrates the role of an aggregator as a means to reduce expenses and technical challenges.

4.) Eligibility. At the end of the day the protocol must be acceptable to existing registries as well as anticipate/influence the requirements of emerging registries, if it is to enable its users to receive offset credits.

Project Decision: The demonstration evaluates a carbon sequestration approach relative to the CCX, RGGI, CCAR and VCS requirements, and proposes an alternative strategy that could be adopted or endorsed by these schemes.

5.) Complementarity. Forestry-based offset strategies have the potential to enhance other important services provided by forests.

Project Decision: The partners involved in demonstrating a carbon protocol are intent on ensuring that a carbon protocol will enhance and not compromise the ecological, cultural and economic values provided by forests.

The following discussion more fully describes each of these five dimensions of a forestry protocol, how they relate to the TCNF demonstration.

Viability. Aggregators like TCNF, or even state agencies, can streamline the adoption of practices that sequester carbon, and carry out functions necessary to benchmark and track the effects of those practices through which guidance can be provided to landowners. TCNF is one of a number of independent, private and non-profit aggregators that have emerged to enroll, evaluate, and market carbon credits from farm and forests in the U.S. The most successful aggregator trading on the CCX is the Iowa Farm Bureau, which enrolls farmland areas that practice no-till agriculture. Participating farmers receive payment from the Farm Bureau based on well-proven calculations of carbon sequestered through no-till practices. Whether or not farmers till is an exceedingly simple strategy to verify.

Forestry aggregators are just beginning to emerge, and there are a variety of approaches being used. A number of existing public and private programs could become good platforms for amassing and selling carbon credits. Presently, the Michigan DNR is using the forest stewardship as the basis for aggregating carbon projects in partnership with the Delta Institute, which has already served as an aggregator for farm-based credits. TCNF is one of only a few non-profit forestry aggregators, and one of several that are using the FSC certification scheme for family forestlands. The American Tree Farm System is also exploring an approach to sequester carbon within groups certified to the ATFS scheme.

The benefits of aggregation are reflected in all phases of project design, development, implementation monitoring, enforcement, trading, and compensation. A more detailed discussion of costs related to these phases will follow. As an aggregator TCNF has borne the bulk of these expenses and delivered the technical capacity required to deliver a carbon project.

Credibility. The Kyoto Protocol Clean Development Mechanism, and the two most developed registries involving U.S. state-governments (i.e. RGGI and CCAR), have strictly adhered to several key tenets of climate change mitigation through forest management. They stipulate that the net carbon emissions reductions (i.e. in the case of forestry, sequestration) must be real, additional, permanent, and not result in leakage. The existing forest-based carbon sequestration efforts, including some that have been registered and even lead to trading of carbon credits, range in how rigorously they deal with these tenets.

The California Climate Action Registry is widely considered one of the most rigorous approaches in the forestry sector. CCAR registrants must show that their sequestration would not have otherwise occurred and are beyond what be expected in business as usual practices. CCAR uses the statewide standard of practice (i.e. minimum) as the default reference condition. For example, Collins Companies in California has been able to register and trade carbon sequestered by exceeding statutory minimums. Technically, and politically, this type of additionality test relies on a relatively high-bar of prescriptive statutory guidance, which exists in

California but not in Maine. In the Maine demonstration, we recognized that key constituencies involved in RGGI might not accept the statutory minimum as an adequate reference condition.

The requirements under the CCX protocol are frequently criticized for a lack of credibility. While we acknowledge that the CCX protocol was largely developed as a pilot program, those criticisms serve to inform how other systems might avoid credibility concerns.

The TCNF explores how to address these criteria, and in the end demonstrates increased sequestration based on changes in harvest type. For example, modified harvest intensity is modeled over the same time period as alternative scenarios, including the type of harvest that is most common in the state, and what would happen without treatment. For baseline and additionality we considered using FIA data and an analysis of harvest notification reports (underway) to document the reference practice. Neither of these has proven adequate (or available, in the case of MFS reports) to reliably assert a "business as usual scenario." In the future the TCNF approach would be strengthened by better state data on removals (FIA-based) or harvest type (MFS harvest reports).

Applicabilty. Recent studies--including a U.S. national assessment conducted by the EPA and a northeastern assessment conducted by The Nature Conservancy and Winrock International--identify biomass-based energy generation, extending rotations of managed forestlands, and silvicultural thinning as the most promising strategies to reduce net emissions through actions in the forestry sector. However, these activities are not appropriate in all settings, depending on the forest type, ownership size, condition, and competing economic opportunities. And while there is good technical guidance on how to measure carbon stocks (especially the federal 1605b program), there is still little guidance for forestland owners on to *how* to change the carbon dynamics of their forestlands. In other words:

- When should a landowner thin to have a net positive effect on carbon stocks?
- Will extending the rotation five years, ten years, make a difference? How? Does this simply delay the carbon benefits of wood products?
- Can shifts in harvest and sale of certain products significantly enhance sequestered carbon?

These are fundamental silvicultural questions on the types of actions landowners can take for which they would deserve credit. Fortunately, the answer to these questions has been researched for decades. The challenge for an aggregator is define where and how these actions should take place—and make adoption easier for landowner participants. For even something as seemingly clear-cut as no-till agriculture, the Iowa Farm Bureau has needed to provide science-based definitions to enrollees (e.g. soils can be bladed but not turned). The CCAR forestry protocol has provided strict definitions for what are eligible activities for afforestation, forest conservation, and forest management—and RGGI model rule of afforestation emulates CCAR's. However, for afforestation the CCAR protocols for proving, registering, and certifying carbon stock changes, essentially help direct the design of a project.

Forest management is a different case, since the protocol cannot tell a landowner how additional carbon can be sequestered in particular settings. In the Collins Companies example, it is the company that has designed how they can exceed the statutory minimums with increased yield. They use expert judgment and data drawn from decades of management to set stand-level prescriptions. In fact, as a business they have been doing an exemplary job of maximizing yield in combination with good stewardship of the forest resources.

The TCNF demonstrates how well-timed and designed management interventions that are uncommon among family forest owners in Maine can sequester additional carbon. Project partners have designed a scheme focused on particular stand types and conditions. The modeling considered carbon outcomes based on the timing and intensity of treatments across these different conditions. The work in the future is therefore already done, for TCNF members and for other landowners who have the requisite data. The data can then be re-evaluated every ten years based on management plan updates and re-inventory. This will reduce the scope of measurement and verification that would otherwise be needed if the treatment were considered a project for an individual landowner, even if that landowner belonged to a group.

Eligibility. For afforestation, RGGI has hewn closely to the approach taken by the CCAR and the guidance provided by the World Resources Institute. At this point the RGGI only includes afforestation as an eligible offset activity in the forestry sector. Based on the constituents involved, and the current model rule for afforestation, it is reasonable to expect that additionality, permanence and leakage will remain as important criteria for any offsets. The case needs to be made that forest management credits need to be included in the RGGI

A core objective of the demonstration project in Maine is to show RGGI, VCS, and even those working on national legislation possible mechanisms to recognize forest management offsets. The current uncertainty on how they and others will consider additionality, permanence, and leakage to judge long-term credibility of forest management as a sequestration strategy, has led us to consider these requirements as strictly as possible. This decision is consistent with the goal to ensure that the sequestered carbon indeed helps to mitigate climate change, and merits payments within a cap and trade system.

Complementarity. A number of constituents are understandably wary of the way in which carbon crediting for forest management will affect emissions under a cap, markets for forest products, and even the condition of forest ecosystems. The RGGI model rule does not include forest management, and only allows for a portion of emissions reductions to be purchased through offsets (3.3% total emissions). A number of forest products companies worry that if only carbon on the stump can be sold as an offset credit, then many landowners will no longer be interested in selling their trees. In contrast, others are concerned that carbon markets which included wood-products accounting could drive forests into a harvest cycle that short-circuits critical ecosystem processes.

The TCNF project worked through some of these issues and demonstrates an approach that includes integrated strategies involving forest management, which are consistent with a high bar of conservation-minded forestry. The goal is to ensure that the offsets support other forest management activities and healthy forests.

Below we present a *Case Study* on how a credible ecosystem services (primarily carbon, but other ecosystem services will need similar elements) program could be developed efficiently for Maine Family Forest Landowners. The *Case Study* includes the following elements described as *Deliverables* for this project:

a. Analysis of technological tools used to document carbon sequestration baseline conditions;
b. Description of forest management strategies that reliably accumulate carbon in;
c. Recommendations for a *Model Carbon Forestry Plan* applicable statewide that incorporates carbon management for tradable offsets;
d. Recommendations for a *Model Carbon Verification and Monitoring Field Protocol*;

The Lessons Learned section below discusses the challenges and opportunities for the Pilot Project to be expanded in a statewide or regional context. The following elements of the *Deliverables* will also be discussed:

a. Forest certification, verification, and conservation mechanisms required to access state, regional, and national registries and markets
    i. Compatibility with existing state forest policies, including tax incentive and cost-share programs
    ii. Economic costs and benefits to landowners who provide additional carbon sequestration within this pilot framework;
b. Assessment of existing and future opportunities for the pilot program to link with carbon and other ecosystem markets.

TCNF Maine Family Forest Carbon Pilot Project Case Study

We evaluated existing protocols with relevance to family forests and assessed them in terms of baseline, additionality, permanence requirements (with some implications of leakage also). The four protocols reviewed above (CCX, VCS, CCAR, RGGI) significantly informed the development of Maine Pilot Project. Each protocol has a unique set of requirements for addressing the key issues of baselines, additionality, and permanence (Table 1).

Table 1. Key structural elements of carbon protocols with relevance to family forest landowners (see also Appendix III for a more detailed comparison).

Carbon Protocols	Baseline	Additionality	Permanence
CCX	Base Year	Net Accumulation (i.e., Growth – Mortality and Harvest)	15 years
VCS	5-10 Years Prior Inventory and Practices	Practices	100+
CCAR	Regulatory	Practices	Permanent Easement
RGGI Proposed	FIA mean	Difference from FIA mean	99 years

Landowner Pool Description

Landowners were recruited to join this pilot group through newsletter notification of the opportunity via several outlets. The respondents were located throughout the state and had many reasons for being interested in the project. Interest ranged from being purely motivated by the revenue potential to one landowner wanting to understand the implications of his woodlot management relative to his own individual carbon footprint. Parcel sizes ranged from 12 to 780 acres (mean = 264 acres). Ultimately, 13 parcels were chosen for inclusion in the pilot group (Table 2). No payments were made directly to landowners. For the purposes of this project, we assumed all landowners would be eligible under the EQIP program as non-industrial private forest landowners that engage in active management of their woodlots.

Table 2. Pilot Project landowner locations and acreage totals.

Landowner	Town	County	Acres
A	Whitefield/Jefferson	Lincoln	780
B	Grand Falls Plt	Aroostook	460
C	Cherryfield	Washington	400
D	Fayette	Androscoggin	325
E	Fryeburg	Oxford	225
F	Otisfield	Oxford	100
G	Strong	Franklin	25
H	Stow	Oxford	200
I	Chelsea	Kennebec	12
J	Skowhegan	Somerset	20
K	Otisfield	Oxford	70
L	Parsonsfield	York	317
M	Parkman	Piscataquis	500
		TOTAL ACREAGE	3,434

Establish Starting Forest Carbon Conditions

For each parcel of forest included in the program, a detailed timber inventory was collected in a statistically rigorous manner using the methods described below. A detailed inventory is required to determine the volume of carbon present at the start of the project (and for modeling purposes) and to establish the potential co-benefits (such as biodiversity and water quality protection) associated with forest management that enhances carbon sequestration rates. The inventory was designed to allow comparison with already established forest inventory procedures such as the Forest Inventory and Analysis (FIA) of the USDA Forest Service (also used by the Maine Forest Service). More importantly, the timber inventory methods are those that are required by the Be WoodsWISE cost-share program of the Maine Forest Service. In addition to the timber inventory, we collected data on coarse woody material to understand the potential volume of carbon stored in this dead wood pool component. The existing protocols have varying requirements on what pools of carbon are allowed as creditable carbon. Generally, if it can be measured, it is eligible for credits (Table 3). The inventory protocols used in the Pilot Project are described in detail below.

Table 3. Potential Creditable Carbon Pools

Category	**Carbon Pool**
Above Ground: Living	Tree biomass Shrubs and Herbaceous Understory
Above Ground: Dead	Standing Dead Coarse and Fine Woody Material Litter
Below Ground	Soil (living and dead organic)
Off-site	Wood Products

Inventory Protocol

Timber Cruise:

- Timber cruise will be done to Maine Forest Service Be WoodsWISE specifications for the minimum number of sample points.
- Data to collect: species, dbh, and Site Index for a representative canopy and sub-canopy tree for each forest type.
- Measure each tree with a minimum 4" dbh
- Assign each tree as Acceptable Growing Stock (AGS) vs. Unacceptable Growing Stock (UGS)
- Diameters can be visually estimated to 2" diameter classes.
- Use stand type classification for the development of a forest type sketch map with acreage estimation for each type. (described in detail below)
- Slope and aspect info for each point
- Regeneration category (ocular estimate of commercial species: under < 350 seedlings per acre, adequate is 350-550 overstocked is > 550)
- Data older than 5 years should not be used and a partial cruise to fill in the shortfall in number of points would be appropriate - as long as the original raw numbers are available to be added to NED, USFS cruise program that will be used for calculations.

Be WoodsWISE Statistical Specifications:

- Sample size: A field inventory must include a minimum of 10 samples on any parcel. The field inventory for the property must meet one of the following standards for sampling intensity. Sampling must occur in all stands where the inventory is required:

- Variable radius plots: an average minimum intensity of 1 sample point (10 BAF) per 3 acres, or 1 sample point (15 BAF) per 2.25 acres, or 1 sample point (20 BAF) per 1.5 acres (distributed randomly or systematically);

- A showing that estimated Total Stand Basal Area, for each inventoried stand, is within a sampling error of 30% with a probability (confidence interval) of 68% or greater. For statistical purposes individual stands of 10 acres or less may be grouped with another stand of similar type and structure to produce a single statistical estimate/error;

- A showing that estimated Total Woodlot Basal Area for all inventoried stands is within a sampling error of less than 15% with a probability (confidence interval) of 90% or greater. For statistical purposes (e.g. stratified sampling) individual stands of 10 acres or less may be grouped with another stand of similar type and structure to produce a statistical estimate/error.

Field-based Stand Descriptions:

A forest stand is defined as a contiguous group of trees/vegetation that share similar characteristics such as: species, height, density, and diameter.

Species are:

Softwood (S): greater than 75% of the species being softwood

Mixedwood (M): having neither hardwood or softwood being greater than 75% of the species mix

Hardwood (H): greater than 75 % of the species being hardwood

Hardwood are described as deciduous or broad leaf trees (red maple, American beech, white and yellow birch, red oak, poplar) and softwood are described as conifers or needle bearing trees (white pine, eastern hemlock, balsam fir, red and white spruce) The one deciduous softwood that exists on the lot is eastern larch (tamarack, hack-ma-tack, juniper).

Height refers to height classes:

Height Class 1: seedling or sapling stand up to 20’tall;
Height Class 2: pole stand up to 50’ tall
Height Class 3: sawlog stand 51’+ tall

Associated with these height classes is also the diameter of the tree or Diameter at Breast Height (DBH). This is the diameter of the tree at 4.5' above the ground and is used as a standard measurement.

Height Class 1 has diameters up to 5"
Height Class 2 has diameters up to 12"
Height Class 3 has diameters 13" and greater

Density or Crown Closure refers to how tightly the tree crowns are packed, i.e. interwoven, touching, or having spaces in-between. Tree crown refers to the green, leafy area of the tree, which is essentially the food factory for the tree.

Crown Closure A: 100% to 75% closed
Crown Closure B: 74% to 40% closed
Crown Closure C: 39% to 10% closed
Crown Closure D: less than 9% closure

For example a forest stand described as S1A is a young softwood stand, less than 20'tall, with diameters ranging 1"-5" and with a crown closure that completely covers the ground. An M3B is a mixedwood stand with large diameter (greater than 13") tall sawlog size trees, which have moderate spacing between the crowns.

Coarse Woody Material Inventory:

For line intersect coarse woody debris do 20 meters (+-1 chain) at each point between points on 20 BAF, 40 meters for 10 BAF cruise. Diameter at intersect was tallied on all pieces 3" and larger. The line transects were identified by forest type as in the timber cruise specifications.

Forest Management and Forest Carbon Modeling

The objective of the forest carbon modeling was to develop a verifiable estimate of the carbon sequestration potential of the stands in the Maine Family Forest Carbon Pilot Project (Pilot Project). Such an approach is generally required by the predominant carbon verification systems (e.g., CCX and CCAR). We also sought to develop an information-efficient framework for assigning carbon valuation to stands similar in size, composition and productivity to those in the Pilot Project. The intent was to develop simulations based on readily available, accessible, and accepted models that depend on easily acquired inventory data. The models should be flexible enough allow generalization to properties and stands not included in the initial inventory (i.e., for future expansion of the Pilot Project).

Model Approach

1. Summarize existing composition, structure, and biomass of the stands.

2. Project baseline growth rates for the next 50 years assuming no active management.

3. Analyze trajectory of 50-year growth record; search for efficient state and transition model.

4. Evaluate model performance.

5. Model multiple forest management scenarios (described in *Additionality* section below).

Tree Growth Simulation Models

NED is a decision support software for forest ecosystem management (Twery et al. 2005) developed by the US Forest Service. The NED software is intended to aid resource managers to develop goals, assess current and future conditions, and produce sustainable management plans for forest properties. The software is extremely user-friendly and widely used. We were interested in testing whether this common tool would provide an opportunity for consulting foresters to evaluate carbon management potential without needing additional training.

We used the NED-2 simulator (beta 2.09). This more recent version includes live tree biomass estimates based on the allometric equations compiled by Jenkins et al (2004). At the core of NED-2 is a growth and yield model developed for forest in the northeastern US – NE-TWIGS. This simulator is based on projecting individual tree diameter growth (Teck and Hilt 1991). It has been incorporated into the Forest Vegetation Simulator (FVS, Crookston and Dixon 2005) framework. It has been formally tested at least twice (Bankowski et al. 1996, Yaussy 2000).

Yaussy 2000 found that while NE-TWIGS performed relatively poorly in predicting stand structure (e.g., stem density and diameter distribution) in 30 year old and 80 year old hardwood stands in Kentucky, live tree biomass simulations using NE-TWIGS were remarkably accurate. Estimates were biased slightly high: 8% above inventory estimates in the 80 year old stand and 15% above inventory estimates in the 30 year old stand. Bankowski et al (1996) tested the basal area projections of NE-TWIGS for stands of tolerant hardwoods in Ontario. While they found significant errors in basal area projections by timber size class (error range: -22% to +33%), NE-TWIGS provided a reliable prediction of stand-level basal error. Apparently, NE-TWIGS does a relatively poor job of modeling ingrowth (i.e., regeneration) and thus projected diameter distributions that match observed distributions poorly (e.g., more than 50% of the stands, predicted diameter distributions were statistically different from the observed diameter distribution; Bankowski et al 1996). The point is that aggregate projections (i.e. stand level) of basal area from NE-TWIGS are reasonable but caution must be used if stands are subdivided by diameter/size class. Bankowski et al (1996) also noted the sensitivity of NE-TWIGS performance to site index and recommended that including stand specific estimates of site index would likely improve model performance.

In addition to these formal evaluations of NE-TWIGS, there is an implied acceptance of its performance by regional experts. In a recent paper, Bill Keeton (UVM forest ecologist) used NED-2/NE-TWIGS to project forest development for 50 years following various forest management regimes at two research forests in Vermont (Keeton 2006). Also the University of Maine project (Simulating the long-term carbon consequences of common timber practices in Maine, Ray et al. SAF Poster Presentation 2006) notes that FVS/NE-TWIGS predicts short-term changes in basal area at Howland Forest (Maine) that are consistent with measurements. Finally it is worth noting that NE-TWIGS is an approved growth model for estimating carbon sequestration contracts sold through the Chicago Climate Exchange.

We completed two additional evaluations of NED-2 performance in estimating live tree biomass. We modeled 42 years of biomass increment for the reference forest at Hubbard Brook Experimental Forest, NH (J. Battles, unpublished data). The research watershed includes species (spruce, fir, hemlock, beech, maple, birch) and stand types (northern hardwood, spruce-fir) similar to the suite of species and stands in the Maine Pilot Project. The baseline inventory (1965) was used to initiate the model and then basal area and live tree biomass were projected for all years where inventory records existed, namely 1977, 1982, 1987, 1992, 1997, 2002, and 2007. These estimates were compared to the measured results. Finally we developed volume-to-biomass relationships from the look-up tables produced by Smith et al. 2006. These tables, developed from USFS FIA, are meant to provide default, average estimates of carbon stocks for forest types in each region of the USA. This predictive equation and the tree volume projections from NED-2 were used to generate an alternative estimate of live tree carbon for stands in the Co-op. The "look-up" carbon estimate was compared with the "NED" estimate.

NED-2 Implementation

NED is designed to be used by the forest manager. It is a reasonable non-commercial application. It does not have a particularly intuitive interface and it has some glitches but it is extraordinarily well-documented. Input and output options are pre-programmed. Thus preparing data for entry can be a chore and capturing output can be tedious. However most users will collect their data in a "NED-ready format" and the typical user will likely desire metrics that are not pre-programmed. Most importantly, NED-2 is a USFS product and thus all its internal workings are transparent. There are no proprietary routines as in some other carbon estimators (e.g., STANDCARB).

As noted above, tree biomass is based on Jenkins et al's (2004) compendium of allometric equations. Basically, NE-TWIGS is designed to project diameter increment of individual trees based on site productivity and various measures of the competitive environment. The species (or species class) is used to select the appropriate equation and then diameter is used to predict live tree biomass. Typically aboveground biomass (everything except coarse roots) is separated from below ground biomass (coarse roots). The rationale for and limitations to this approach for estimating biomass are well-documented (Jenkins et al 2003). The biggest criticism of only using dbh to estimate biomass is that it does not account for the obvious change in dbh-to-height that occurs with elevation in many upland species. Consequently, it is likely that Jenkins' equations have an inherent tendency to overestimate tree biomass.

Simulation Model Results (Natural Stand Development)

NED-2 was then used to develop "no management" projections for the next 50 years for all the stands in the Pilot Project. Stand snapshots were captured at 10-yr intervals. From these projections, a single database of all the stands separated by owner and year was created.

Bottomland conifer was the predominant (32% by area) forest type in the Co-op lands. The core species are balsam fir, eastern white cedar, and black spruce. Another 32% of the area was classified as hemlock hardwoods and other hardwoods. The remaining area was divided among 17 different forest types (Appendix I, Table 1). Initial baseline (2007) structure (e.g., basal area) spans a wide range -- presumably a result of the diverse management history and species composition. For the Northeast region, these stands were moderately productive (modal and median SI = 60). However, site index was not always directly measured in the stand inventories.

In terms of stand composition classifications, 61% of the area was mixedwoods (Appendix I, Table 1). Very little (8%) of the area was pure softwoods by stand class. There were some disparities between the field designation of a stand and the percentage of softwood/hardwood represented in the inventory data. In general the classifications assigned from the field inventories did not crosswalk precisely with the quantitative metrics calculated from the inventories. Canopy cover is always difficult to estimate both in the field and from the measurements but the inconsistencies in the composition assignments (mixed, softwood, hardwood) and the size class assignment (pole, small sawlog, large sawlog) were surprising. Moreover as noted above, NE-TWIGS does a notably poor job of recreating diameter-size class distributions.

In absence of intervention, the 50-yr projections show all forests in the Pilot Project accumulating biomass (Appendix I, Fig. 1) and sequestering carbon in the growth of live trees (Appendix I, Fig. 2). Carbon pools were estimated from live biomass projections assuming a carbon density of 0.5 gC/g biomass. Carbon accumulation rates varied by both ownership and stand type. Annual average accumulation rates were faster in softwood stands than hardwood stands with mixed stands in the middle (Appendix I, Table 2). Rates also varied by site index class but the stands with a higher site index did not consistently out-grow stands with a lower index. Certainly these rates can be confounded by land-use history. Moreover, biomass accumulation with time is a strongly non-linear process (more like a logistic curve, Appendix I, Fig. 4).

In terms of marketing the Pilot Project's carbon for the next 50-yrs, the baseline rates and the variance around those rates are summarized in Figure 3 (Appendix I). Again these projections assume no management and no occurrences of catastrophic disturbances. It is important to note that the rate of biomass accumulation follows a logistic function (Appendix I, Fig. 4). The implication is that younger (low basal area) and older (high basal area stands) will grow at slower per capita rates than the middle-aged stands.

The stand snapshots were compiled into a database in order to quantitatively search for the best predictors of live tree biomass. A regression tree approach with live tree biomass as the dependent variable and the following continuous and categorical metrics as potential independent variables: basal area, Sewall composition class, canopy cover, canopy cover class, size class, mean dbh, median dbh, stem density, site index, and site index bin. The most parsimonious tree (Appendix I, Fig 5) only included basal area and divided the 50-yr projections for the Pilot Project into 4 biomass bins. Transitions between bins was estimated based on the average time it took stands in one bin to "grow" into the next bin. The result is state-transition model of biomass accumulation for a no-management regime (Appendix I, Fig. 6). The only piece of information needed to enter this model is the initial basal area of the stand. None of the other information in the inventories was statistically relevant.

Model Performance

NED-2 biomass estimates are prone to overestimate live tree biomass. For example, NED-2 calculated an average biomass for the reference watershed at Hubbard Brook in 1965 as 202 Mg/ha but our calculations using the specific methods and allometric equations developed at Hubbard Brook result in a biomass estimate 25% lower – 161 Mg/ha (Appendix I, Fig 7). The difference declines in the future projections but the NED-2 estimates still exceed the observed results. As far as we are aware, the Hubbard Brook approach is the only methodology where the biomass estimates have been directly validated (Fahey et al. 2005). At the scale of a watershed, the Hubbard Brook estimates of tree biomass are as good as they get. NED-2 estimates of live tree carbon also exceed the average look-up values calculated from tables in Smith et al. (2006). In this case, NED-2 estimates were about 21% greater, on average, than predicted from volume-to-biomass relationships (Appendix I, Fig. 8).

Despite the apparent bias in NED-2 approach to estimating tree biomass, the simulation model does capture the dynamics of these stands and the biomass projections do fall within the typical confidence interval of biomass estimates. Relative root mean square errors for stand-wide estimates of forest biomass ranged from 15-40%. **Also, it seems that the bias is consistent. Thus if NED-2 is used to estimate the *baseline* and the *additionality* then the bias does not influence the estimate of sequestered carbon.**

Baseline Definition

As described above, there are several ways that *baseline* is defined in emerging carbon protocols (Table 1). Each method comes with unique data needs and external criticism. The least data intensive baseline requirement is the base year approach taken in the CCX protocol. Yet this element of the CCX protocol has been the target of the most severe criticisms. We have dismissed the CCX approach based on concerns over its credibility. Conversely, the most data intensive is approach is that required for CCAR, which takes a *performance standard* or *practices* approach that considers the Business as Usual (BAU) practices in the surrounding landscape (i.e., state). The CCAR approach is described in the protocol as follows:

> "The Registry's approach to this baseline characterization presumes that, unless otherwise required by law, a forest management baseline would reflect a management scenario that resulted in harvest and regeneration of trees to the extent permitted by mandatory forest management laws and regulations. …These laws and regulations are highly prescriptive and measurable, as they include requirements such as minimum basal area retention, rotation ages, harvest adjacency restrictions, watercourse buffer widths and sustained yield requirements. In effect, the approach to this baseline characterization is a type of performance standard."

Maine has a Forest Practices Act (FPA) that primarily addresses the size and separation zone requirements when clearcutting and shelterwood are employed as regeneration or harvest methods. However, the FPA does not define the BAU practice for landowners throughout the state. The FPA in essence acts as a floor for harvests, but the majority of harvests, particularly family forest harvests, do not employ clearcutting as a method. The Maine Forest Service Silvicultural Activities Reports (Fig. 1) indicate that clearcutting is indeed not the typical practice, but "partial harvests" are. This presents landowners in Maine with a scenario that is far from context created by California's regulatory framework.

The VCS protocol, though it is becoming widely accepted internationally, presents challenges to family forest landowners in Maine. The baseline requirement under VCS stipulates that the project defines BAU based on the historical inventory and practices (for the prior 5-10 years) for the specific property being evaluated. This presents two potential hurdles for family forest landowners. First, since less than 25% of the family forest landowners in Maine even have a management plan (which implies some form of timber inventory is present), it is unlikely that a given landowner will have sufficient data and historical records to justify BAU for their property. The second hurdle is a bit more complex because it gets to the heart of the issue of additionality. If a landowner has these data and historical record, and has a history of practicing high quality forest management that promotes the on-site accumulation of carbon, then this landowner would likely have very little if any creditable carbon available to sell to a market. While this makes sense from a strict interpretation of additionality, it precludes the "good actors" from participating in carbon markets that require compliance with the VCS. Part of our intent with this Pilot Project was to explore credible ways that this type of landowner could participate in a carbon market and be rewarded for this beneficial behavior without compromising the credibility of the carbon's additionality.

This led us to consider whether a comparable approach to the CCAR protocol could be developed in the absence of a strict regulatory baseline in Maine. To employ this approach, we would need a verifiable rationale for the definition of BAU practices for Maine. As described above, the "partial harvests" category appears to be the typical harvest practice employed since enacting the FPA in 1989 (Fig. 2). This trend is highlighted in the family forest owner category. In 2006, 76% of all NIPF harvests were "partial harvests" (83% if only parcels under 1,000 acres are considered). The designation of partial harvest presents significant problem because the term captures a range of practices that have not been quantified for the range of forest types in Maine. Moreover, there is currently no other source of data that would help us to quantitatively define what the BAU harvest practices are for the stands in the Pilot Project pool of properties. The only data available are the harvest reports used to develop the annual Maine Forest Service Silvicultural Activities Report and USFS FIA data. As mentioned the Silvicultural Activities Reports do not provide sufficient detail on what constitutes a partial harvest to allow any kind of rigorous analysis or modeling. The FIA data are sparse when it comes to re-measuring plots that have been harvested and would thus provide a limited data set to work with (D. Struble, Maine Forest Service, pers. comm.).

Figure 1. Harvesting Trends in Maine 2001-2007.

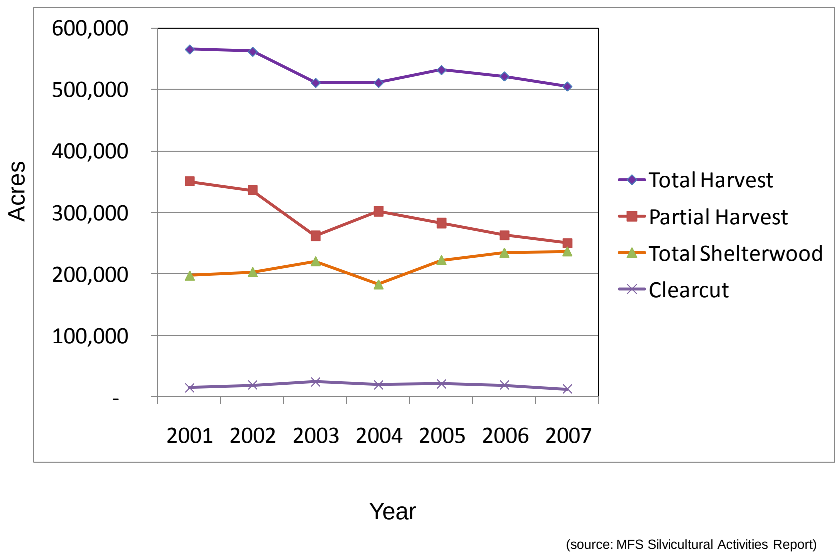
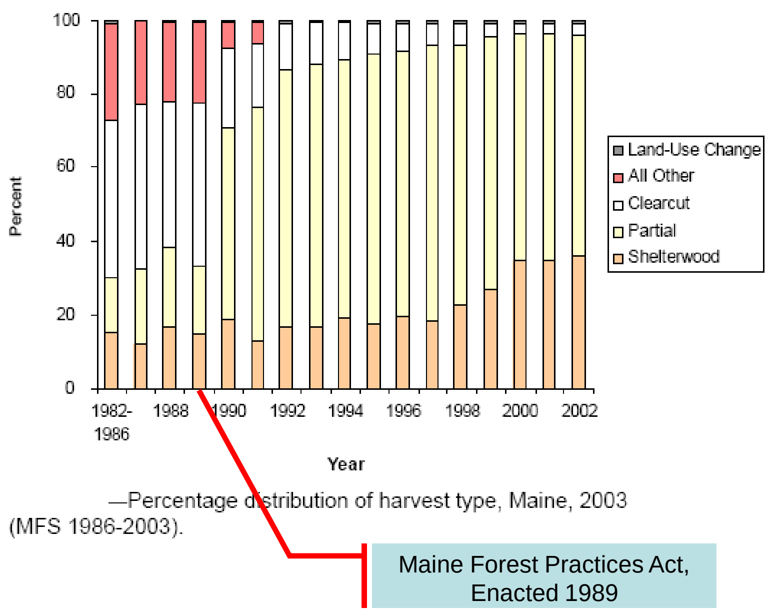


Figure 2. Harvest Trends Since the enacting of the Maine Forest Practices Act (1989).



We were disappointed to find that a performance standard or practices based approach using readily available data would prove to be difficult to test with the Pilot Project landowners. Therefore, we chose to use an expert panel approach to develop BAU harvest scenarios that represented a general consensus of typical practices employed on family forest parcels throughout Maine. Several experts including University of Maine forestry faculty, consulting foresters, and Maine Forest Service staff were assembled to provide input on a definition of BAU practices for the Pilot Project stands. The expert panel was presented with current forest inventories and the 50 year stand development model results. Based on this panel's input, we developed four "Heavy Harvest" scenarios that represented a range of post-harvest retention rates (the most easily modeled parameter, Table X). These Heavy Harvest scenarios were contrasted with the Quality Harvest scenarios described below. Heavy Harvests were defined as a harvest that retained 40 $ft.^2$/acre, 50 $ft.^2$/acre, and 60 $ft.^2$/acre residual basal area post harvest (a clear cut is legally defined as 30 $ft.^2$/acre) at year 1, followed by re-entry into the stand 35 years later (with the same residual basal area retained). For experimental purposes, we evaluated the impacts of a clearcut harvest at year 1, followed by a return after 45 years where the clearcut is repeated.

It was clear from the starting inventory data that not every stand type and development stage would be likely to experience a harvest at year 1, even in a Heavy Harvest scenario (Table 4). Only stands that exceeded the minimum basal area threshold would be harvested under these scenarios.

Table 4. Basal Area (ft^2/ac.) and Mean, Max, Min dbh (in.) and SD for 2007 Stand Types - Stocking Status and Management Options

Stand Type	Mean dbh	Min dbh	Max dbh	Mean BA	Min BA	Max BA	SD dbh	SD BA	Stocking Status	Management Options
H2D	**8.60**	8.60	8.60	**10.01**	10.01	10.01	na	na	Below C	Natural Stand Development
H2C	**8.05**	5.08	11.33	**31.45**	16.11	50.07	2.62	11.47	Below C	Natural Stand Development
H3B	**13.92**	13.92	13.92	**61.83**	61.83	61.83	na	na	Just Below B-line (only one stand)	Natural Stand Development
H2B	**8.67**	5.14	11.02	**78.01**	42.67	122.79	1.53	20.57	Between A and B	Management Priority
H3A	**12.86**	12.86	12.86	**87.96**	87.96	87.96	na	na	Between A and B	Management Priority
H2A	**9.49**	8.43	10.96	**108.21**	97.97	117.57	1.10	10.37	Between A and B	Management Priority
M1D	**4.00**	4.00	4.00	**4.79**	4.79	4.79	na	na	Below C	Natural Stand Development
M3C	**13.10**	12.93	13.27	**30.04**	23.51	36.58	0.24	9.24	Below C	Natural Stand Development
M2C	**8.22**	6.43	9.37	**34.76**	20.03	54.86	1.04	14.37	Below C	Natural Stand Development
M2B	**9.07**	7.27	11.59	**87.00**	64.88	106.25	1.04	12.18	Between B and C	Natural Stand Development
M3B	**13.38**	13.16	13.60	**95.14**	74.89	115.39	0.31	28.63	Between B and C	Natural Stand Development
M2A	**10.26**	8.89	11.25	**138.69**	125.84	172.43	0.99	22.56	Between A and B	Management Priority
S2C	**9.58**	9.10	10.07	**58.35**	50.07	66.62	0.68	11.70	Below C	Natural Stand Development
S3C	**13.68**	12.33	16.14	**62.85**	38.32	90.13	2.14	26.02	Below C	Natural Stand Development
S2B	**9.13**	7.08	10.84	**94.20**	81.43	101.46	1.90	11.10	Between A and B	Management Priority
S3B	**14.92**	14.92	14.92	**97.10**	97.10	97.10	na	na	Between B and C	Natural Stand Development
S2A	**11.35**	11.35	11.35	**169.82**	169.82	169.82	na	na	Between A and B	Natural Stand Development

Baseline carbon stocking trajectories were developed using the same NED-2 methods described above. NED-2 allows for the rapid simulation of prescriptions using current inventory data as a starting point. Prescription parameters such as residual basal area or species targets are easily entered into the model. The four Heavy Harvest scenarios were simulated over the same 50 year period as described in the NED-2 methods above (see also Table 5). Above ground biomass totals were summarized for pre and post harvest conditions every ten years or when harvest entries were prescribed (e.g., 35 years after heavy harvest). Aboveground biomass data were used to derive the CO2 equivalent (CO2e) volume estimates for the baseline. Pre and post harvest removal data were summarized for each landowner and stand type within that ownership. We also summarized basal area and mean stand diameter for each stand type and landowner combination for the same time period. The simulation models did not harvest in stands that didn’t meet the minimum basal area threshold.

Table 5. BAU and Quality Harvest Scenario Models

Run	Treatment Label	Description
Baseline	B	Natural Stand Development
Run 1	H40BA	Heavy Harvest, 40 ft^2 BA residual, return 35 years
Run 2	H50BA	Heavy Harvest, 50 ft^2 BA residual, return 35 years

Run 3	H60BA	Heavy Harvest, 60 ft^2 BA residual, return 35 years
Run 4	Q70BA	Quality Harvest, 70 ft^2 BA residual, return 15 years
Run 5	Q75BA	Quality Harvest, 75 ft^2 BA residual, return 15 years
Run 6	Q100BA	Quality Harvest, 100 ft^2 BA residual, return 15 years
Run 7	Clear Cut	Clearcut Year 1, return 45 years

Additionality (Creditable Carbon)

Once we established the baseline carbon volume trajectories for all stand types and landowners, we then needed to calculate the creditable carbon available for each landowner. Our approach was to model a carbon sequestration – or Quality Harvest – scenario based upon a harvest regime that would promote the development of high quality sawlogs over the long term. We also assumed that by maintaining high residual basal areas post harvest, structural complexity would increase over time. Structural complexity is essentially a strategy of creating or maintaining vertical structure in a stand in the form of taller trees, multiple size/age classes, and an understory component. While the models do not simulate this explicitly, we made the assumption that frequent and light harvest entries would create this structure over time and thus be a viable carbon sequestration forest management strategy. We discuss this concept in more detail below.

We defined three different Quality Harvest residual basal area scenarios, 70 ft^2/acre, 75 ft^2/acre, and 100 ft^2/acre (Table X.). Output data was the same as described above for the Heavy Harvest scenarios. We are then able to use these outputs to define eligible, or *additional*, carbon as the difference between a given Quality Harvest and Heavy Harvest scenario. For the purposes of the Pilot Project, we calculated the difference between the moderate scenarios (Q75BA minus H50BA) during the first ten years of a hypothetical carbon offset project. In some cases, natural stand development becomes the default Quality Harvest option if a minimum basal area threshold is not met for the stand type. We chose ten years because a potential buyer of the Pilot Project's carbon indicated that they would be willing to purchase the 10 year forward stream of carbon accumulation. This also allows for an upfront revenue stream for a landowner that could help offset the initial significant transaction costs (described in more detail below). To illustrate this, Figures X-X show the additionality of carbon for three different stand types. These figures illustrate the three possible outcomes for a given stand. Either (1) there is no management potential (Fig. 3.), or (2) the natural stand development trajectory becomes the Quality option (Fig. 4), or (3) we were able to calculate the difference between Q75BA and H50BA (Fig. 5).

Figure 3. No Management Option, M3B Stand Type, Landowner H. Aboveground biomass (MT/ha) and Treatment Type (from Table X.)

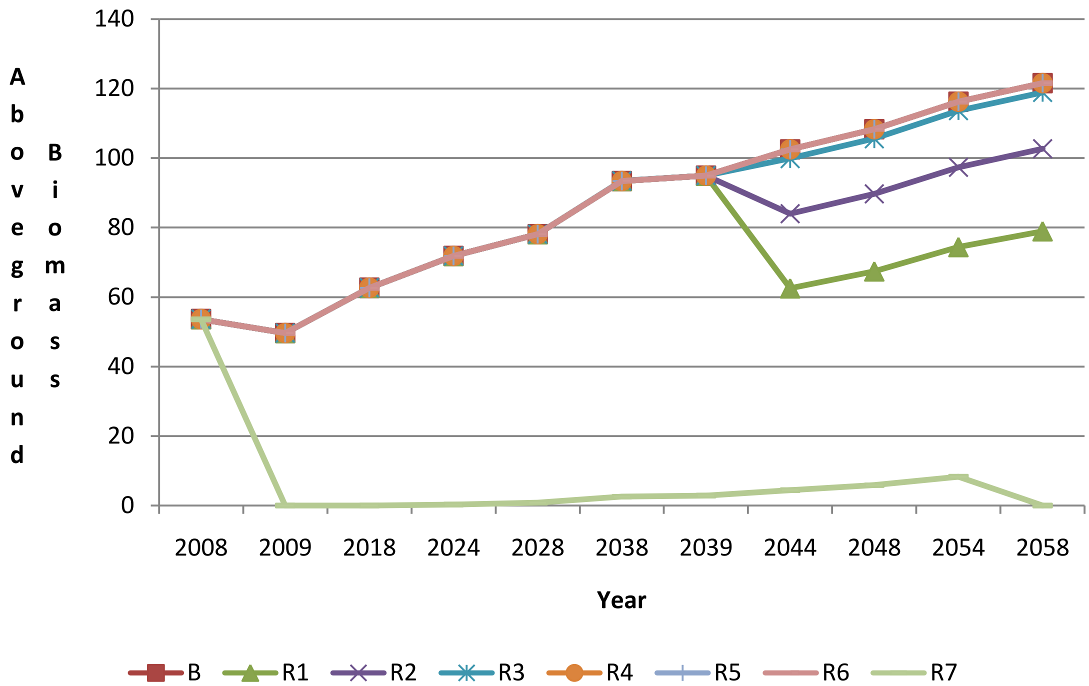


Figure 4. Aboveground Biomass (MT/ha) By Treatment Type (Run) - H2B Stand, Landowner A

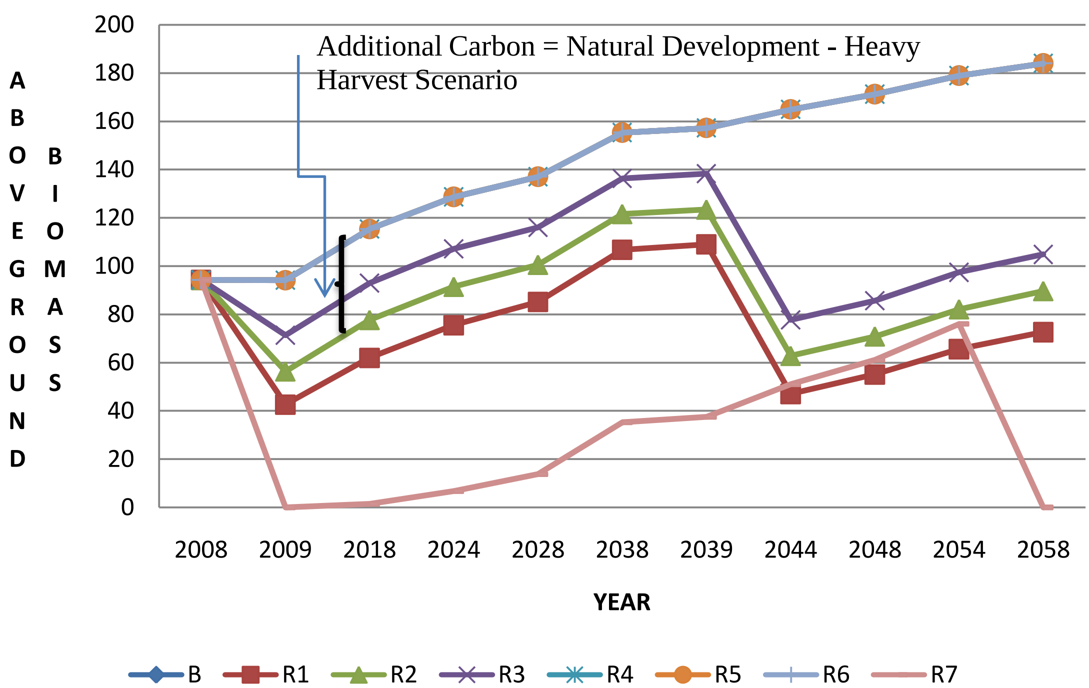
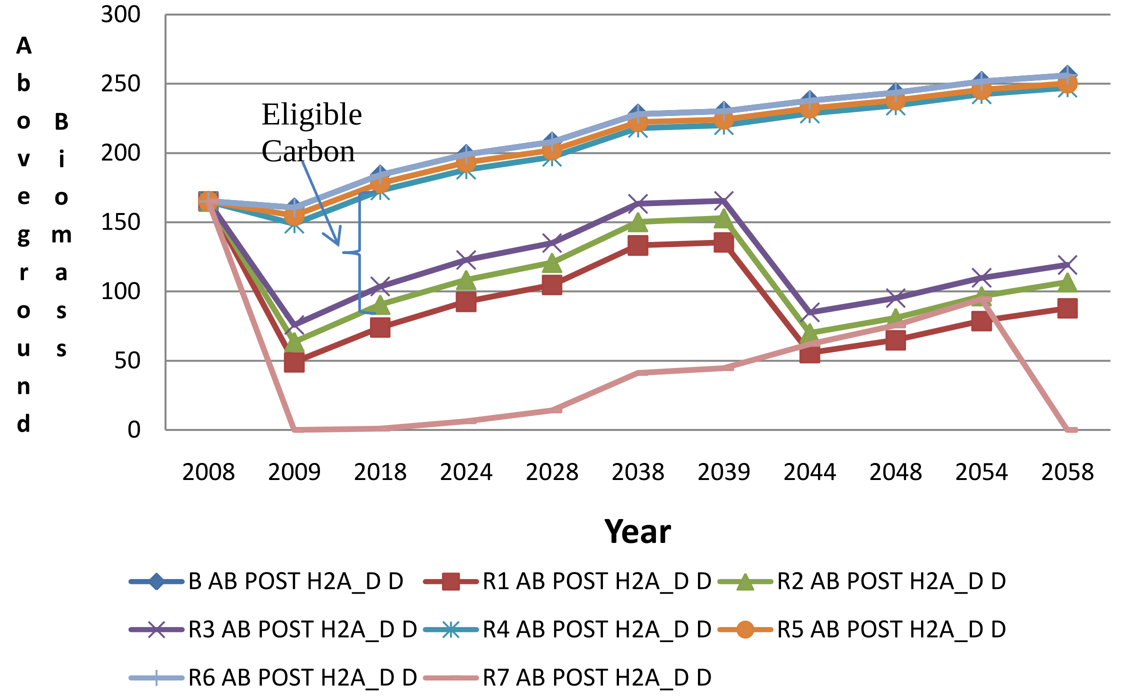


Figure 5. Eligible aboveground biomass (MT/ha) under Q75BA Minus H50BA harvest scenario for H2A Stand, Landowner D.



Taking the results of these model comparisons, we can then develop a summary of the eligible carbon for each landowner and evaluate what kind of revenue could be expected if these management options are chosen. We present here the detailed results from one landowner to demonstrate how this would look. For Landowner H, we evaluated the stands that were available for active management or where natural stand development is the default option versus Heavy Harvest. Table 6 shows the breakdown of stand types and acreages for a property on the Maine/New Hampshire border (Fig. 6).

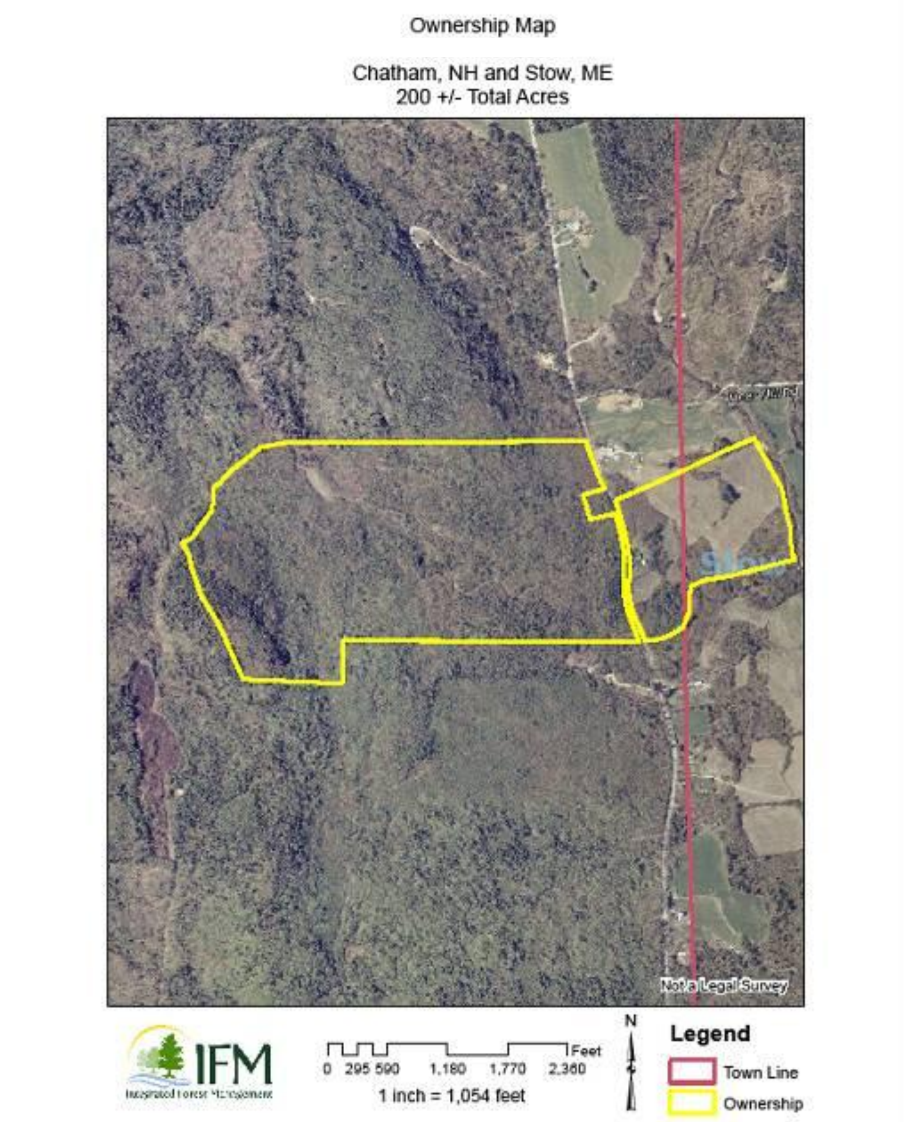
Table 6. Eligible carbon for Landowner H under Heavy Harvest H50BA baseline vs. Quality Harvest Q75BA scenarios. Carbon market value assumed to be $5/MTCO2e.

Stand Type	Landowner H Acreage	Eligible MTCO2e/ac/yr	$/year ($5/t)	10 Year Total Revenue
M3B	15	0.00	$ -	$ -
M2B	30	3.11	$ 466.50	$ 4,665.00
M2A	23	3.33	$ 382.95	$ 3,829.50
H2A	78	3.35	$ 1,306.50	$ 13,065.00
H3B	17	0.43	$ 36.55	$ 365.50

H1A	**32**	**0.00**	**$ -**	**$ -**
TOTALS	**195**	**10.22**	**$ 2,192.50**	**$ 21,925.00**
		$/ac/yr =	**$ 11.24**	
NOTE: 1 Metric Ton (MT) of Biomass = 0.5 MT Carbon =3.667 MTCO2 equivalent (MTCO2e)				

Of the stands listed in Table X, only the M2B stand had a Quality Harvest opportunity, the remaining stands that generated revenue came from calculating the difference between natural development and the Heavy Harvest scenario.

Figure 6. Sample Ownership Map for Landowner H.



Extending this analysis to all landowners yields a range of carbon values per acre, depending primarily upon the starting stand conditions present on the property. We found that 67 of the 80 stands analyzed had a management opportunity. The mean volume of creditable carbon was 2.98MTCO2e/year. The results from Landowner H was lower than the mean and was outside the 95% Confidence Interval (n =80, SD = 2.31, 95% CI = 2.46 – 3.49). The initial stand volumes were quite variable, so each property should be evaluated independently. However, it is useful to look at the potential volume that could be aggregated across the entire pool of landowners. Extrapolating the mean creditable volume to the entire ownership yields 10,246 MTCO2e/year ($51,234/year at $5/MTCO2e, or $14.92/acre/year). The assumption of $5/MTCO2e was made based on an actual offer from an OTC carbon retailer. For the sake of comparison, we also evaluated the best case scenario for a project under the CCX requirements (Table 7, growth only, no harvests or other losses occurring during the project period). Under

CCX less carbon is eligible, which has significant impacts on revenue potential when the price is low as it is predicted to be for the foreseeable future. The potential revenues become more significant when we discuss the project transaction costs below.

Table 7. Potential revenue comparison for a hypothetical group based on Maine BAU Pilot Project approach vs. CCX high estimate (no harvest).

Scenario	Annual Eligible Carbon (MTCO2e/year)	MTCO2e/acre	Potential Group Annual Revenue	Potential Per Acre Revenue
Maine BAU Performance Standard	10,246	2.98	$51,230 ($5/MT)	$14.92
CCX (Natural Stand Development only)	7,829	2.28	$14,483 ($1.85/MT, Oct. 2008 CCX price)	$4.22

Incorporate Carbon Sequestration in Forest Management Planning

Detailed management plans were prepared for each parcel in the program. The plans meet the Maine Forest Service cost-share requirements under the "Be WoodsWISE" stewardship program. This stewardship program leverages federal dollars to provide a 75% cost-share for the development of comprehensive management plans for family forest landowners. [*Note: The federal component of the funding for WoodsWISE therefore made this money ineligible for the matching requirement of the Conservation Innovation Grant as it was originally intended; other matching funds were obtained by TCNF to replace this obligation*]. The plans require the description of the silvicultural practices and timeline necessary to implement a management regime that produces the desired carbon benefits. Consulting foresters licensed by the State of Maine were contracted to develop the forest management plans. The WoodsWISE planning process requires that state databases are consulted to investigate the presence of rare or threatened natural communities, as well as known important cultural and archaeological features. Forest management plans will be developed in accordance with the requirements of the Forest Stewardship Council's (FSC) Northeast Regional Standard, which meets an internationally accredited framework for sustainable forest management. TCNF has successfully used this management plan template as the basis for a Group FSC Certificate applicable to Maine.

The stewardship plans become important baseline and historical documentation of the condition of the properties at the time of a carbon agreement, as well as documenting the landowners' intent for the management of the property.

The Quality Harvest scenarios are intended to promote carbon sequestration even though removals do take place. Any time a harvest is conducted there is a net loss of on-site stored carbon. This Pilot Project did not consider the complete life cycle assessment (LCA) of products removed from the parcels, though we recognize that LCA has implications for the total carbon budget for a given landowner. We make the assumption that the opportunities for product substitution and long-lived forest product storage will be variable and will require an additional amount of verification work that is beyond the capability of most family forest landowners.

We recommended the following management strategies for inclusion in the management plans that promote carbon sequestration as an objective:

1. Extended rotation (creation of late-successional stands with old forest structures)
2. Structural Complexity Enhancement (high retention of coarse woody material, large diameter trees
3. Crop tree release (to promote the faster development of large diameter sawlog quality trees)
4. Early thinning (to promote the faster development of large diameter sawlog quality trees)
5. Use low-impact harvest practices to minimize soil disturbance

Verification and Monitoring

The Pilot Project relies on an existing group structure established by The Trust to Conserve Northeast Forestlands for the purposes of administering a statewide FSC group forest management certificate. Under this group, an internal monitoring protocol is already established to monitor landowner compliance with FSC certification standards. Additionally, the group is audited annually by a third-party certification body (SmartWood) accredited by the FSC. It is a logical extension of this system that could be applied to an aggregated group of landowners selling carbon to a market. Verification and monitoring of compliance with the carbon forestry protocol and agreement can be efficiently conducted within this framework. Since the group manager is already monitoring activity on the pool properties, compliance with the carbon agreement would not result in significant additional effort. The requirements of FSC certification also provide a built-in mechanism to provide the data needed to true up estimates of carbon volumes. The FSC Standards require that a landowner periodically update both the management plan and the timber inventory data that supports that planning. This update is required at a minimum of every 10 years, which supports the time scale of monitoring that would be required in a forest carbon offset market. We strongly recommend that any forest carbon market program require compliance with rigorous forest certification standards. This will serve to address the Verification and Monitoring requirements that are inherent in all emerging forest carbon offset markets. As an example, TCNF uses the following framework to monitor properties participating in the FSC group certificate:

1. Initial Site Visit
    a. Property walk-through with landowner and consultant
    b. On-site Review of Management Plan (Goals/Objectives, Implementation)
    c. Discussion of Landowner Agreement Letter
2. Formal Review of Management Plan
    a. Review plan vs. Maine Forest Service Be WoodsWISE checklist and FSC Standard
    b. Document required modifications or compliance
3. TCNF Notification of Harvest

   a. Copies of state Harvest Intent Notification form
   b. Estimate of products to be harvested (to facilitate CoC marketing)
   c. Name/number of Master Logger conducting the harvest
4. Harvest Site Visit
   a. Harvest monitoring form completed and filed; Includes:
      i. BMP monitoring
      ii. Silvicultural Prescription Monitoring
      iii. Ecological Values Monitoring
   b. Closeout Form (completed by managing consultant or TCNF; Use MLC Harvest Integrity System Forms)
5. Annual Report from Pool Members
   a. Form filled out by landowner summarizing activity from the prior year
   b. Verified with consultant (if necessary)
   c. Entered into TCNF Database
   d. Properties are visited at least once every five years regardless of harvest activities
6. Management Plan and Inventory Update
   a. Management plans shall be updated periodically (at least every 10 years)
   b. Timber inventory shall be updated periodically (at least every 10 years, or following significant harvest activity or major natural disturbance)
7. Chain of Custody Monitoring
   a. Track Volumes and destinations for FSC-certified products

Permanence (legal framework)

TCNF contracted an attorney familiar with land and conservation legal issues to evaluate the legal instrument options available to achieve the objectives of the Pilot Project related to meaningfully address additionality, verifiability, enforceability, and permanence. The information in this section on *Permanence* was developed by Kirk G. Siegel, an attorney with Hanley & Associates, PA in South Paris, Maine. The information below provides a comprehensive review of the legal aspects that should be considered in the development of a forest carbon offset program.

I. Comparison of securing carbon credits through the use of easements versus contracts.

A. <u>Conservation Easements as Tools to Achieve Permanence.</u> A conservation easement is a legally binding, usually permanent agreement between a landowner and a qualified non-profit or governmental holder that restricts land use activities on a property in order to protect conservation values of the land. As an example relevant to TCNF carbon offsets, a conservation easement could allow timber harvesting pursuant to a long-term forest management plan approved by the easement holder and designed to achieve specific silvicultural goals or standards while protecting forest ecosystems.

The land protection and associated carbon sequestration that could be secured through conservation easements offers the highest possible degree of legal enforceability and permanence. Other than governmental power of eminent domain, well-written conservation easements typically (although not always) have tight limits on amendments and termination. Almost all states have enacted enabling statutes that define and recognize conservation easements, often modeled after the Uniform Conservation Easement Act. Property law is state-specific. Under Maine statute a "conservation easement may not be terminated or amended in such a manner as to materially detract from the conservation values intended for protection without the prior approval of the court in an action in which the Attorney General is made a party."[1] Even a court is limited under Maine law, and may deny enforcement "only when it finds that change of circumstances has rendered that easement no longer in the public interest or no longer serving the publicly beneficial conservation purposes identified in the conservation easement."[2]

Income and estate tax benefits are available to donors of conservation easements that meet IRS requirements, and many landowners are motivated at least in part by the tax benefits.[3] These requirements tend to further "permanence". For example, if a conserved property is subject to a mortgage, consent of the lender is required to ensure that a foreclosure of the mortgage does not

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[1] *See, e.g.*, Title 33 M.R.S.A. §476, which contains numerous additional protections that further enforceability and permanence:

Conservation easement standards

1. **Conservation values.** A conservation easement executed on or after the effective date of this section must include a statement of the conservation purposes of the easement, the conservation attributes associated with the real property and the benefit to the general public intended to be served by the restriction on uses of the real property subject to the conservation easement.
2. **Amendment and termination.** Amendments and termination of a conservation easement may occur only pursuant to this subsection.
A. A conservation easement executed on or after the effective date of this section must include a statement of the holder's power to agree to amendments to the terms of the conservation easement in a manner consistent with the limitations of paragraph B.
B. A conservation easement may not be terminated or amended in such a manner as to materially detract from the conservation values intended for protection without the prior approval of the court in an action in which the Attorney General is made a party. In making this determination, the court shall consider, among other relevant factors, the purposes expressed by the parties in the easement and the public interest. If the value of the landowner's estate is increased by reason of the amendment or termination of a conservation easement, that increase must be paid over to the holder or to such nonprofit or governmental entity as the court may designate, to be used for the protection of conservation lands consistent, as nearly as possible, with the stated publicly beneficial conservation purposes of the easement.
3. **Monitoring.** The holder of a conservation easement shall monitor the condition of the real property subject to the conservation easement at least every 3 years and shall prepare and retain a written monitoring report in its permanent records. The holder shall make available to the landowner, upon request, a copy of the monitoring report.
4. **Failure to comply.** Failure to comply with the requirements of subsection 1, subsection 2, paragraph A or subsection 3 does not invalidate a conservation easement otherwise entitled to the protections of this subchapter.

[2] Title 33 M.R.S.A. §478.

[3] Conservation easements which meet these requirements are termed *qualified conservation contributions*. *See* Section 170(h) of the Internal Revenue Code.

result in extinguishment of the conservation easement. No deduction is allowed "unless the mortgagee subordinates its rights in the property to the right of the qualified organization to enforce the conservation purposes of the gift in perpetuity."[4] This is required by the IRS, and it is also a typical requirement of an easement holder even when there is no tax deduction. A contractual arrangement between a landowner and a conservation organization, by contrast, would not likely have these *substantial* built-in safeguards that have evolved through IRS regulations as well as the Standards and Practices promulgated by the Land Trust Accreditation Commission.[5]

Enforceability is an integral part of conservation easements. In addition to detailed provisions regarding the holder's rights of access to inspect and remedies for violations, the easement's status as an encumbrance against the title means that a landowner may be thwarted from refinancing or selling the property if the land is in violation of the easement. A careful mortgage lender or buyer will request an Estoppel Certificate from the easement holder, stating that the property is not in violation of the easement, because such violation could compromise the lender or buyer's interest. This potential "safety valve" would not exist for unrecorded contractual arrangements. Additionally, easement holder standards require: "The land trust takes necessary and consistent steps to see that violations are resolved and has available, or has a strategy to secure, the financial and legal resources for enforcement and defense."[6]

B. Advantages Over Contractual and Other Arrangements. These and other protections set conservation easements apart from other contractual arrangements, as well as from deed restrictions, which might *appear* to offer permanent protections. Like a conservation easement, a deed restriction "runs with the land" and thus binds future owners, but a deed restriction can normally be removed by agreement between the owner of the restricted land and the holder benefited by the restriction. (The holder or benefitted party is typically an abutting property owner). And although non-perpetual, "term easements" are occasionally accepted by conservation organizations or other qualified holders, the donation of a term easement does not qualify for income and estate tax benefits.

Some other alternatives that might provide a satisfactory middle ground between a conservation easement and an unrecorded contract are discussed in Section II, below. For example, if TCNF carbon sequestration goals can be met in a finite time frame, the term easement could evolve into a more relevant conservation tool.

[4] 26 CFR 1.170A-14(g)(2).

[5] The Commission provides independent verification of the 37 indicator practices from *Land Trust Standards and Practices* that show a land trust's ability to operate in an ethical, legal and technically sound manner and ensure the long-term protection of land in the public interest. For example, with respect to mortgage subordination, Standard 9(H) provides: "Title Investigation and Subordination. The land trust investigates title to each property for which it intends to acquire title or an easement to be sure that it is negotiating with the legal owner(s) and to uncover liens, mortgages, mineral or other leases, water rights and/or other encumbrances or matters of record that may affect the transaction. Mortgages, liens and other encumbrances that could result in extinguishment of the easement or significantly undermine the important conservation values on the property are discharged or properly subordinated to the easement."

[6] *Land Trust Standards and Practices, Standard 11, Practice E.*

C. Burdens of Working with Conservation Easements. Because of their permanence, effect on property value, and necessary encumbrance in the public land records, conservation easements are also cumbersome tools. Although highly adaptable to the conservation values protected, the needs of the landowner, and the distinct qualities of the particular land, they can be intensively negotiated legal documents. While efficient organizations working with focused landowners can sometimes complete an easement project within a few months, in my experience the normal process is rarely completed in less than a year. Ultimately, owner satisfaction is usually high, but appraisals, surveys, title research, drafting and legal advice, and other due diligence for owner and easement holder take time and money.

Landowners are often also asked, and sometimes required, to contribute to conservation easement stewardship funds at the time they grant their easements. Many do so gladly, in light of the tax deductions they have received and the personal satisfaction found. I have seen these run from $1000 to $10,000 per easement, and they could be higher with large ownerships. This focus on stewardship highlights the high priority that easement holders place on *enforceability*: by dedicating funds to a stewardship account, resources will be available to verify compliance with the easement, and if necessary to cover legal fees in an enforcement action.

In short, for both the landowner and aggregator the many advantages that conventional conservation easements offer would come at a price and require a serious commitment.

And although not an outright obstacle, an additional concern regarding conservation easements is the fact that a common easement provision actually prohibits using the protected property as a basis for allowing other development or use of environmental mitigation credits elsewhere.[7] The use of the property for carbon offsets would have to be explicitly allowed in any conservation easement used for carbon offset purposes. This is a simple matter requiring communication between easement drafters and holders and landowners, but is one that should not be overlooked.

D. Contractual and Other Arrangements. Because concerncs have been raised previously about the challenges to securing conservation easements from all of the landowners in the TCNF Pool, we looked at contractual and other arrangements for securing the rights to the landowners' carbon offsets. TCNF has also indicated that due to the high standards of forest management in the TCNF Pool, it may have a higher value carbon offset to market than managed forest carbon offsets traded on the Chicago Climate Exchange (CCX). TCNF Pool members may be willing and able to exceed the 15-year time period over which CCX requires its carbon offset providers to certify that they will maintain their land as forest, for example. The CCX Managed Forest

[7] *See, e.g.*, *The Conservation Easement Handbook*, Byers and Ponte, Trust for Public Land and the Land Trust Alliance (2005) p. 398 ("Drafters must consider the impact of the easement on ancillary development rights that might be redirected by the owner. This can be important to prevent owners from using the land area of the protected property to augment development or other land uses on unrestricted land. This could occur as part of laws and regulations imposing minimum acreage requirements, or permitting cluster zoning, transfer of development rights, and *transfer of carbon sequestration and carbon dioxide credits*. . . . If the owner wants to retain the option of transferring or selling development rights, this option should be explicitly stated in the easement . . . .").

Carbon offset requirements contain some degree of rigor, but they are not in the slightest degree on a par with conservation easements restrictions.[8]

Below is a framework modeled after a contract intended for registration of credits with CCX. The contract was adapted to be more relevant to the TCNF Pool landowners, but both contain common elements with common weaknesses:

1. The seller/landowner agrees to sell and deliver the carbon offsets to TCNF "free from liens and encumbrances." *It would appear to be unlikely that the buyer/aggregator would do any due diligence to ensure the property is, in fact, free of liens, or even that the seller has good title. The landowner is making assertions that are unconfirmed, so the purchaser of the offsets has no assurance that a superior interest in the land will not compromise the desired forest management, or in a worst case scenario, extinguish the landowner's interest in the land.*

2. The seller/landowner agrees to maintain compliance with FSC Standards for at least 15 years from the date of the contract, to adhere to protocols established for the TCNF Pool, and to submit to and cooperate with verifications and inspections. *Failure to abide by the agreement, however, only "shall render the contract null and void" and require the repayment for credits paid for, along with interest and penalties. It is unclear whether and how the aggregator (or CCX, if the offsets were registered with CCX) would attempt to enforce a default by the landowner.*

3. The contract obtained from the CCX aggregator stated that failure to conform to the rules may result in termination of enrollment in CCX and prohibition from all further participation in CCX. In that same contract, false certifications subject the landowner to various penalties, interest, and costs. *Again, while these rights could be useful to the aggregator of the offset, the motivation and capacity to enforce them are not clear.*

In general, the contractual remedies of the aggregator against a non-compliant landowner are likely to be a collection action in court, without the ability to fall back on any type of property interest, collateral, or guarantee. In short, the landowner is agreeing to the obligations, but the likelihood of consequences is doubtful. If a contractual arrangement were the only palatable option for landowners, some sort of insurance or bonding might be advisable. The TCNF Pool as a whole could spread the risk by the use of a Reserve Pool, but these pools are generally intended to protect against catastrophic events rather than "defections" from the pool.[9]

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[8] CCX project participants must provide evidence of sustainable management through certification from approved certification schemes for the United States, including Forest Stewardship Council (FSC), Sustainable Forestry Initiative (SFI) and American Tree Farm System Group Certification. Forest carbon stock quantifications must use a CCX approved quantification procedure, and projects are subject to third party verification by a CCX-approved forestry verifier.

[9] *See*, *e.g.*, Agragate CCX-registered contract form provision regarding a catastrophic loss: "All issuance of CFIs for Exchange Forestry Offsets to CCX-eligible forestry projects shall require the placement of 20% of earned Exchange Forestry Offsets in a Forest Carbon Reserve Pool."

II. Analysis of recording a 50-year "Memorandum of Agreement" to encumber land with carbon obligations as described in the MFCO Agreement.

Notions of permanence differ. The draft MFCO Agreement framework has a 15-year pledge. The CCX projects require a letter of good faith stating that they will maintain enrolled land in forest beyond the 15 year contract period required by the program. The Carbon Fund's Draft Deed of Environmental Assets Easement that I reviewed has a 70-year term. Recommendations submitted to RGGI in June 2008 by the Maine Forest Service and partners state that "to ensure that carbon stocks are maintained after the active crediting period of the project is over, the project must put a carbon easement or lease on the property for the remainder of the 99 year term."[10] The same recommendation to RGGI states:

> We believe that permanent should be defined as 99 years for three reasons: 1) a project which commits to sequestering carbon for 99 years is providing a real benefit to the atmosphere that should not be discounted; 2) the likelihood of the contracting parties being in existence after a century or longer is fairly low; and 3) it is impossible for us today to predict what the best use of that forest might be for society a century from now.

The 50-year term TCNF is exploring would be in the middle of this range of agreements—and closer to the human lifetime than perpetuity. Regardless of the precise term TCNF chooses, I understand that TCNF would like to understand the implications of creating a recordable document to be filed in the public land records, in the 50-year range.

We explored the possibility of recording a "Memorandum"—which is commonly a one-page summary of an actual agreement. The main reason for recording a memorandum is to keep the terms of the actual agreement out of the public record. It is not clear that confidentiality is a concern, but would depend on what information is in the agreement. Having the entire agreement in the public record might actually serve to document the public values that are being served in the public record, as well as fully reflecting the significance of the encumbrance on the property. If there were a small amount of confidential transaction data, such as price terms, they could be simply referenced in the recorded agreement as a non-recorded price term sheet. This would be analogous to mortgages, which are recorded, and which state the term and amount of the loan, but simply reference the non-recorded promissory note which contains, for example the interest rate, monthly payment, and other items, which are not public.

There are a multitude of agreements that are recorded in the public record. A USDA Farm Services Agency Debt Cancellation Conservation Contract[11] was located that relieved certain farm debt on the condition that the farm owner agrees to do neither construction nor excavation on the protected area for a 50 year term. If the landowner defaults, the USDA may require the

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[10] The recommendation continues: "The easement shall require that the property maintain carbon levels at or above the amount sold during the project crediting period. If the project owner chooses not to put an easement on the property at the end of the active crediting period, all offsets must be replaced." *Primary Stakeholder Issues: RGGI Forest Offset Recommendations*, Environment Northeast, *et al.* (6/4/2008)

[11] USDA Form FSA-1951-39 and appendix.

owner to refund the benefits, with interest, or may reinstate the cancelled debt. More important, as a matter of public record, the document encumbers the title, constraining marketability of the property unless and until the USDA either discharges the obligation entirely, or provides a statement or certification that the landowner is in compliance with the agreement.

Thus, the process could be quite simple—finalizing a TCNF MFCO Agreement, having it signed and acknowledged before a notary public, and recording it in the appropriate county's Registry of Deeds. If there are any terms deemed sensitive or confidential, they could be put in a separate document and incorporated by reference only and not recorded. If the public transparency described above is *not* a concern to TCNF and there is a desire to keep all but a bare minimum of the details out of the public eye, a Memorandum of the agreement could be prepared and recorded. There is some reason for concern, however, that a brief summary memorandum may not be adequate to provide notice to other parties and the public of the full scope of TCNF's rights, because, unlike a lease or other conventional document, a MFCO Agreement is virtually unknown. For sake of comparison, a conservation easement, a mortgage, and the above sample 70-year Deed of Environmental Assets Easement, all contain very detailed terms recorded in the public record.

III. Securities and Exchange areas of concern for an entity involved with aggregating atmospheric credits such as carbon.

Research was conducted to determine whether an entity that is involved in matching landowners/sellers with buyers of carbon credits is subject to state or federal securities or other brokerage regulations.

"Commodity" v. "Security." To determine the law applicable to this situation, it is helpful to begin by classifying carbon credits as either a security or a commodity. In general, securities have no intrinsic value; they represent rights in something else.[12] Yet definitions for the term "security" are somewhat amorphous and all encompassing.[13] For example, the Securities Act of 1933 states:

> The term "security" means any note, stock, treasury stock, security future, bond, debenture, evidence of indebtedness, certificate of interest or participation in any profit-sharing agreement, collateral-trust certificate, preorganization certificate or subscription, transferable share, investment contract, voting-trust certificate, certificate of deposit for a security, fractional undivided interest in oil, gas, or other mineral rights, any put, call, straddle, option, or privilege on any security, certificate of deposit, or group or index of securities (including any interest therein or based on the value thereof), or any put, call, straddle, option, or privilege entered into on a national securities exchange relating to foreign currency, or, in general, any interest or instrument commonly known as a "security", or any certificate of interest or participation in, temporary or interim

[12] Thomas Lee Hazen, *The Law of Securities Regulation* § 1.6 (4th ed. 2002).
[13] *Id.* at § 1.1.

> certificate for, receipt for, guarantee of, or warrant or right to subscribe to or purchase, any of the foregoing.[14]

In contrast, "commodities" tend to be tangible goods which can be traded, including agricultural products, currencies, metals, and energy products. For purposes of the Commodity Exchange Act:

> The term "commodity" means wheat, cotton, rice, corn, oats, barley, rye, flaxseed, grain sorghums, mill feeds, butter, eggs, Solanum tuberosum (Irish potatoes), wool, wool tops, fats and oils (including lard, tallow, cottonseed oil, peanut oil, soybean oil, and all other fats and oils), cottonseed meal, cottonseed, peanuts, soybeans, soybean meal, livestock, livestock products, and frozen concentrated orange juice, and all other goods and articles, except onions as provided in section 13–1 of this title, and all services, rights, and interests in which contracts for future delivery are presently or in the future dealt in.[15]
>
> The Maine Commodity Code defines "commodity" as:
>
> [E]xcept as otherwise specified by the administrator by rule or order, any agricultural, grain or livestock products or by-products, any metals or minerals, including a precious metal set forth in subsection 12, any gem or gemstone, whether characterized as precious, semiprecious or otherwise, any fuel, whether liquid, gaseous or otherwise, any foreign currency and all other goods, articles, products or items of any kind provided that the term commodity shall not include:
>
>> A. A numismatic coin whose fair market value is at least 15% higher than the value of the metal it contains;
>>
>> B. Real property or any timber, agricultural or livestock product grown or raised on real property and offered or sold by the owner or lessee of the real property;
>>
>> C. Any work of art offered or sold by art dealers at public auction or offered or sold through a private sale by the owner.[16]

Although carbon credits do not fit neatly into the definitions of "security" or "commodity," they appear to be more akin to a commodity rather than a security. Further, the Chicago Climate Exchange (CCX) refers to the "Carbon Financial Instruments" traded on its exchange as commodities.[17] Moreover, the Commodity Futures Trading Commission (CFTC) – rather than the Securities and Exchange Commission (SEC) – is the federal government agency charged

[14] 15 U.S.C. 77b (a)(1)
[15] 7 U.S.C. § 1a(4)
[16] 32 M.R.S. § 11201(2)
[17] Chicago Climate Exchange, *Overview*, http://www.chicagoclimatex.com/content.jsf?id=821.

with oversight of the Chicago Climate Futures Exchange.[18] The CCX, however, is not regulated by CFTC because it has registered with that agency as an "Exempt Commercial Market."[19] The CCX is not regulated by the SEC.

Under the federal Commodity Exchange Act, carbon credits would appear to fall under the definition of a commodity, by virtue of being an interest "in which contracts for future delivery are presently or in the future dealt in,"[20] especially given the oversight undertaken by the CFTC. In addition, carbon credits are an "exempt commodity" within the meaning of Title 7 U.S.C. § 1a(14), because it is neither an agricultural product nor an excluded commodity.

However, it is less clear whether carbon credits are a commodity under Maine law. Carbon credits are not specifically listed in the statute and I cannot find a rule including them. The specific exclusion of real property and "timber products" by Title 32 M.R.S. § 11201(2)(B), absent the inclusion of carbon credits, *might* support an argument that carbon credits are not a commodity and therefore their sale cannot be regulated by the State of Maine. A message we left for Bonnie Russell, Securities Administrator for the Maine Office of Securities, regarding this matter, has not been returned.

Can Carbon Credits Be Regulated?

The trading of carbon credits on the CCX is regulated by the CFTC. This is because only the credits themselves are traded rather than options or futures on the credits. The jurisdiction of the CFTC covers the sale of options and the sale of "contracts of sale of a commodity for future delivery, traded or executed on a contract market designated . . . pursuant to section 7 or 7a of this title."[21] Still, as I noted above, the CCX does register with the CFTC as an exempt commercial market.

The Trust to Conserve Northeast Forestlands (TCNF) would essentially like to deal in carbon credits. It will not be dealing in options or futures. Nevertheless, it will serve as an administrative and trading representative on behalf of multiple project owners. I believe that this could *potentially* fall under the Commodity Exchange Act. Title 7 U.S.C. § 2(h) enumerates situations in which transactions in exempt commodities are not subject to regulation. However, the examples listed do not apply to TCNF.[22] Therefore, although transactions in exempt commodities, such as carbon credits, appear to be regulated at the federal level, it is not certain by whom and by what instrument.

Whether carbon credits can be regulated by the State of Maine likely turns on an interpretation of Title 32 M.R.S.A. § 11201. Carbon credits are not specifically listed in the statute as a commodity, yet if they are to be considered a commodity by order of the Securities

[18] U.S. Commodity Futures Trading Commission, *Trading Organizations*, http://services.cftc.gov/SIRT/SIRT.aspx?Topic=TradingOrganizations&implicit=true&type=ECM&CustomColumnDisplay=TTTTTTTT.
[19] *Id.* See infra note 10.
[20] 7 U.S.C. § 1a(4)
[21] 7 U.S.C. § 2(a)(1)(A)
[22] TCNF and the parties with which it contracts would have to be "eligible contract participants," meaning broker-dealers subject to SEC regulation, government entities, investors with millions of dollars in assets, etc. *See* 7 U.S.C. § 1a(12).

Administrator, they would be regulated by the Maine Office of Securities, pursuant to the Maine Commodities Code. Unfortunately, it is not clear to me how the TCNF could be cleared by the Office of Securities to sell carbon credits if they are considered a commodity. Under Title 32 M.R.S.A. § 11202, "no person may sell, purchase or offer to sell or purchase any commodity under any commodity contract or any commodity option or offer to enter into or enter into as seller or purchaser any commodity contract or commodity option" except as listed in sections 11203 and 11204. However, the only viable option for TCNF under those sections is to seek an order from the Securities Administrator pursuant to Section 11204(2) allowing it to engage in the sale of carbon credits.

We spoke with Stephen Diamond of the Maine Office of Securities recently as to whether selling carbon credits could be subject to regulation by his office. We left it that he would do a little more digging and get back to us. However, he said that he does not think there are any securities implications for this project and likely would not have any commodities regulation issues either because the project will not deal in futures and options. He did mention that if these credits enabled companies subject to RGGI to increase their emissions, thus resulting in trade in these credits, a possible securities issue could arise. However, he stated that an intermediary simply matching buyers and sellers likely would not be subject to regulation by the State of Maine. I'll let you know if I hear more.

Conclusion

Carbon credits are likely considered a commodity under federal law, and their sale may also be regulated by Title 7. However, Title 7 is extremely complicated and it is unclear precisely how an entity such as TCNF actually qualifies to sell carbon credits.

In contrast, carbon credits may very well not be considered commodities under Maine law. If that is the case, TCNF would likely be able to match buyers and sellers of carbon credits free from government oversight. If additional research or feedback from the State indicates that carbon credits *are* considered a commodity, TCNF could seek an exemption from the Securities Administrator allowing it to engage in the sale of carbon credits.

Transaction Costs

The Transaction Costs associated with the aggregation of family forest landowners for the purposes of selling forest carbon can be significant. There is obviously an economy of scale that is achieved as the group becomes larger and per acre costs can be distributed among the members. However, there are likely to be significant ongoing costs associated with monitoring and maintenance that are largely unknown or difficult to determine.

The startup costs associated with the group included expenses related to the inventory data collection, management planning, forest growth simulation modeling, and legal expenses for the research and development of a sample agreement (Table 8)

Table 8. Summary of transaction costs associated with the Pilot Project.

Transaction Cost	Cost per Acre	Description
Inventory	$6.86	Timber inventory, stand typing, coarse woody material transects
Management Planning	$11.33	Management plan that meets the Be WoodsWISE requirements, including basic GIS data layers
Subtotal Planning and Inventory	**$18.19**	
Growth Models	$4.71	NED-2 growth models and harvest simulations
Legal Expenses	$1.43	Research and contract drafting
Total	**$24.33**	

Costs associated with management planning activities averaged $18.19/acre. This is consistent with what the Maine Forest Service assumes for costs to prepare plans the meet the Be WoodsWSISE requirements. The state will cost share 75% of the planning costs, which is allowed at $12/acre (or $16/acre full cost). The Pilot Project costs could have been reduced by eliminating the coarse woody material transects as these data may not add more detailed information than what could be derived from FIA estimates for the forest types. We have not yet evaluated these data. The total costs for project development ($24.33/acre) could be recovered after the first two years of the project. This highlights the need for the ability of a landowner to "sell the forward stream" of carbon from a project. The eligible carbon from this Pilot Project under the assumptions we have used presents financial challenges to landowner participation at low carbon market prices.

There are additional costs to participation as well. The Pilot Project received a proposal from a third-party to conduct a carbon project verification audit under the Voluntary Carbon Standard (VCS) requirements. The proposal indicated it would cost $12,000 to perform this service – a prerequisite to any project selling carbon to a market. This adds significant upfront costs ($3.49/acre) to the project. Additionally, we have not included estimates of the costs associated with administration of the group and ongoing monitoring costs. Previous experience with FSC certification has shown that these ongoing administrative costs to TCNF have ranged from $200 to $300 per year for each landowner in the group regardless of acreage. **Of significant importance to the feasibility of family forest access to carbon markets is the cost-share programs that significantly reduce the out-of-pocket expenses associated with the fundamental requirements of a timber inventory and a management plan.**

The aggregation of family forests into some form of a group, whether a co-op model or as a buyer that rolls up aggregated carbon is clearly the only viable option to deliver family forest carbon to a market. Efficiencies will also be achieved through combining group certification (e.g., FSC) with carbon aggregation.

Ecosystem Co-benefits – Soil and Water Quality, Biodiversity

Projects that meet requirements for a credible carbon offset registry require the documentation of significant "co-benefits" in addition to carbon sequestration. In addition to reducing atmospheric carbon, projects should increase ecosystem values such as wildlife habitat, protection for rare and endangered plants and animals, soil and water quality, and flood protection. In particular, the certified sustainable forest management standards (FSC) used for this Pilot Group requires the protection of these other values. A critical biodiversity element, the creation of late-successional and old-growth (LSOG) forest characteristics will be a significant benefit associated with the type of forest management being promoted with this Pilot Project. LSOG forest has been identified as a biodiversity concern for Maine and the Northern Forest in general (Hagan and Whitman 2004). Creating and maintaining this forest structure would be the major contribution of Pilot Project properties to biodiversity conservation.

These co-benefits may also have market value in the future, and bundling these values could increase the viability of family forest access to ecosystem service markets. The framework described here is also likely to be applicable for the aggregation of other ecosystem services credits (e.g., water quality and biodiversity). The common elements include baselines, additionality, permanence, monitoring, and certification.

We evaluated the potential of other services to be bundled with the Pilot Project. A municipal water district was approached with the opportunity to evaluate a payment for responsible practices program. This idea was not of interest to the water district as they did not believe forest management practices were a significant factor in the water quality issues they deal with (conversion to impermeable surfaces being a top concern).

The major challenge to developing any payment of ecosystem services (PES) program is the identification of a willing buyer. Carbon has provided an opportunity with many willing buyers, but the opportunities for other PES are currently quite limited and are often geographically or context specific. We will continue to develop these market opportunities, but at the present time there does not seem to be a widespread opportunity with this group of landowners.

Applicability and Feasibility (Lessons Learned)

The Pilot Project has served to identify the major challenges and opportunities for family forest landowners to participate in emerging ecosystem service markets, primarily carbon. The ultimate feasibility will depend on how carbon protocols evolve to address issues of baseline, additionality, and permanence. We know from this work that the more rigorous the requirements for these elements, the more costly it will be to implement in practice and bring real revenue to family forest landowners. We also recognize that the ultimate objective is to achieve real and additional atmospheric benefits from the carbon sequestration of these forests. That is the balance that needs to be achieved.

The performance standard based on BAU practices in the landscape still presents significant challenges to implementation. To do this in a legitimate and verifiable way, data are needed that more quantitatively define typical harvest and management practices throughout the state. These data would most reliably come from state forest service entities that are charged with monitoring harvest activities and impacts on the forest resource. Such a system is in development by the Maine Forest Service (i.e., the Multi-Resource Harvest Assessment). Should this system become implemented, it would provide a sound basis for the definition of landscape BAU harvest practices by which others could be contrasted. This BAU would obviously be dynamic and would need to be adjusted over time. Our proposed approach, though currently lacking in a rationale based in rigorous data, could be adapted for use in a carbon credit protocol or policy incentives framework that sought to change landowner behavior away from a BAU that likely has negative carbon sequestration implications. As a next step, TCNF will be working with other members of the FSC Family Forests Alliance (www.familyforestsalliance.org) to present a proposed methodology for acceptance within the Voluntary Carbon Standard. The methodology will incorporate the lessons learned from this project and seek a broadly applicable BAU approach that could be used for family forest carbon projects throughout North America.

TCNF as a case study for a program to be expanded in a statewide or regional context

The Maine Family Forest Carbon Pilot Project had three principal aims: (1) to develop a credible and practical method to sequester carbon in managed forests; (2) to evaluate this approach relative to existing registries; and (3) to explore how this method could be used in conjunction with existing tools and programs (i.e., *replicability* of the approach).

The case study considered several aspects of replicability, by testing a carbon sequestration approach on lands that are FSC certified, have Be WoodsWISE (forest stewardship plans), and incorporating practices that would be eligible for cost-share funding. TCNF uses FSC certification to assure that a carbon project is sustainable. FSC certification (and other forest certification schemes) could also prove to be a means to verify that scheduled practices that increase carbon sequestration are implemented as planned. Additionally, the demonstration evaluates carbon sequestration strategies that support conformance with a certification standard (i.e., more residual basal area with some retention within the harvest). These same strategies could be incorporated as practices and promoted through public programs for stewardship planning and monitoring, and supported through cost-share funding. As demonstrated in the TCNF Pilot Project, the effect would be to improve common practice using funding from carbon offset allowances or carbon credit markets.

Compatibility with forest certification, verification, and conservation mechanisms required to access state, regional, and national registries and markets

One of the common requirements in existing carbon registries, and an element that appears likely in federal legislation, is some proof that carbon sequestration projects are sustainable. The CCX, the RGGI rules for forest-based offset projects, and the CCAR require assurance that the project is "sustainable" according to prevailing standards. The RGGI rules specify that any harvested afforestation project be certified by FSC, SFI, or ATFS. Whether federal legislation would go so far as to formally require some existing independent third-party certification scheme is up in the air. However, it is likely that some requirement would exist in federal legislation and that rulemaking would at least specify a level of assurance that is monitored and enforced. Some entities that are certified assert that existing certification schemes would be a good way to provide assurance, coupled with the well-tested means of monitoring and enforcement.

Certification in Maine

Maine is a leader in the United State in the percentage of forestland certified as meeting the management standards of recognized national and international forest management certification systems. In Maine a relatively small number of industrial and non-industrial forest products companies and investors own two-thirds of Maine's private forestland, individuals or families own the remaining third. Most of these family forest parcels are 1,000 acres or smaller. Approximately 60% of the larger industrial, non-industrial, and investor-owned parcels are certified, but only 6% of the 250,000 family forests in Maine are certified.

Matching its proportion of the landbase, more than one-third of the total volume of Maine's forest products comes from family forests. Without substantial increases in market incentives to provide certified products, it is unlikely that the certification of family forests can be fully supported by the market. Several states have looked into strategic initiatives to increase certified acreage to both retain selective purchasers (e.g., Maine, Wisconsin and Minnesota) and/or, as a means to demonstrably improve stewardship of forestlands. One report that considered impediments to family forest certification in Minnesota concluded that the cost of certification and the lack of financial benefits are the primary reasons that owners of smaller forest parcels do not engage in certification. Anecdotal evidence suggests that these finding apply to Maine.

Group Certification

There are arrays of costs that make certification expensive for the small private forest landowner. However, there are several ways that certification can be achieved for a reduced price. One option is group certification under the purview of a certified resource manager (CRM). A CRM is an independent expert or consultant who is contracted by forest landowners to manage their forests. Group managers like TCNF have no legal title to the forest resources they manage, however they may form legal instruments for the purposes of the managing lands in conformance with certification requirements, and providing access to participating forestlands by third parties. Group certification under a certified resource manager can save money for all involved by allowing the costs of certification to be shared among multiple landowners or across multiple land ownerships. By essentially treating multiple forestland parcels as a single forest management unit (that undergoes an "overall" forest certification assessment rather than individual assessment on each property), the costs of certification per individual participant in a group are significantly decreased because they are spread across the entire group. The parallel between this concept and the needs associated with carbon aggregation is clear. This seems an obvious vehicle to deliver family forest carbon to a buyer, whether regulatory or over-the-counter.

Currently, there are about 40 FSC group certificates in the U.S covering 0.5 million acres. The majority of FSC group certificates have managers who are private consulting foresters or nonprofit organizations. On the other hand, industrial or consulting forestry programs manage the majority of ATFS group certificates, totaling about 3.5 million acres. Additionally, the State of Wisconsin's Department of Natural Resources manages the largest ATFS group at 29,000 landowners/1.9 million acres.

The intended standard of practice for private landowners enrolled in Maine Forest Service's Be WoodsWISE program would satisfy most certification requirements. Some gaps may arise if implementation is inconsistent. Other FSC and ATFS requirements that appear unmet by Be WoodsWISE could be satisfied through improved coordination with other organizations, such as the Maine Natural Areas Program and the Maine Historical Commission, if their capacity could expand to meet increased demands and functions. Remaining gaps would need to be met through measures introduced through current landowner programs as new performance requirements fulfilled by landowners, or met on behalf of the members by the group manager.

The Be WoodsWISE management plans developed under the auspices of the USDA Forest Stewardship Program are exemplary. Both in this analysis and according to prior reviews the Be WoodsWISE plan requirements are well designed to align with the management planning requirements of the FSC and ATFS certification schemes. Eligibility for cost-share funds conferred by Be WoodsWISE forest management could be also used for activities that enhance conformance with certification standards. Revisions are presently underway to further strengthen the management and internal controls for the forest stewardship program, improvements that will help conformance with administration and monitoring requirements for group managers.

Considering the Maine Tree Growth Tax Program and the Be WoodsWISE program, there are significant incentives for private landowners in the state to achieve basic conformance with certification standards. The resources that have already been made available to group entities, consulting foresters and their clients are substantial and valuable. Neither of these programs was originally designed to encourage more landowners to seek certification, though Be WoodsWISE in particular supports a high-level of conformance with certification standards and has facilitated enrollment in other groups. Many private landowners, including those participating in the TCNF demonstration group, have been certified through groups have Be WoodsWISE plans.

The Maine Forest Service and others have reported the need for additional incentives for landowners to adopt certification. Increased market demand and/or direct producer incentives could prove the best inducement for more landowners to seek certification. Additional incentives would strengthen most options, including the creation of a state-brokered certified group. The *Future of Maine Forests* report encourages Maine Forest Service to increase dialogue with certification systems, processors, and end-buyers on marketing and purchasing certified wood. A report commissioned by the Governor's Council on the Sustainability of the Forest Products Industry, encourages the development of tax incentives for production of certified wood products. One of the possibilities specified in the report is the . . . *"reduction of capital gains and/or property taxes for landowners enrolled in forest certification programs and/or committing to a higher level of forest management and/or providing public recreational access."* Maine has already offered valuable incentives for participation in tree growth and forest stewardship programs, with positive results. **Adding compelling financial reward for carbon projects would complement selection of one of the options presented in this**

analysis, and leverage the state's investments in Be WoodsWISE to facilitate broader adoption of certified sustainable forestry.

Compatibility with existing state forest policies, including tax incentive and cost-share programs

The Forest Stewardship Program.

The Forest Stewardship Program (FSP) provides financial, technical, and planning assistance to non-industrial private forest landowners to encourage sustainable forest management practices on the ground. In consultation with the State Foresters, the USDA Forest Service developed the FSP under the umbrella of the 1990 Farm Bill. This program harnesses the collective expertise of State Foresters, biologists, and private consultants to advise landowners on the creation and implementation of Forest Stewardship Plans that most effectively advance the goals of sustainability on their forestland. Such plans must address issues related to wildlife habitat, soil and water resources, wetlands, recreation, and timber. The Cooperative Forestry Program within State and Private Forestry at the USDA Forest Service establishes the overarching national guidelines for the FSP; however, program implementation occurs at the state level, with State Stewardship Committees within each state setting more specific parameters.

Among the U.S. states there is a range in the how successful programs in forest stewardship planning have been, and therefore whether they can serve as a substantial leg-up for delivering landowners to the carbon sequestration market. At one end of the range, Wisconsin's forest stewardship plans used in their Managed Forest Law program is quite successful, and has enrolled and certified (ATFS and FSC) more than 38,000 landowners. There are far fewer forest stewardship plans in Maine. In the last year approximately 8,000 acres of the more than 9 million acres of Maine family forests developed or updated their management plans.

The opportunity to use the Forest Stewardship Program and associated cost-share support varies by state, based on the size of the FSP program and level of subscription to cost-share activities. The challenge for a state like large Forest Stewardship Program's like Wisconsin's may be one of size—i.e. how do you sequester more carbon in a well-managed land based, and then document and certify these stocks? Presently none of the management plans and inventory data for Wisconsin's participants is in electronic form—so carbon stocks may need to be documented in a different manner (e.g. look-up tables and remote techniques). At the same time, outside verification of their program may be easier, since they are already achieved forest management certification (under the American Tree Farm System) through an audit conducted by NSF-ISR, which is also accredited by the CCX and CCAR to perform carbon verification.

Maine WoodsWISE Program. In the State of Maine, the FSP and another associated landowner assistance program, called the Forest Land Enhancement Program (FLEP), are jointly administered as the Be WoodsWISE program. According to the Maine Forest Service, "the WoodsWISE program's aim is the help Maine's forest landowners make informed decisions based on stewardship principles about their forests, and thereby encourage the long-term sustainability of Maine's forests."

The Maine Be WoodsWISE Program has been revised to include management planning requirements that dovetail with management planning requirements of certification programs. However there are still some gaps between these requirements and requirements of both certification programs and carbon registries. So, for registries requiring certification some additional steps would be needed. There are elements of certification that have moved TCNF closer to eligibility with the most stringent carbon registries (i.e., VCS) and perhaps better position TCNF to offer the highest quality carbon credits. These elements include more attention to conservation reserves within the stand, and retention of a forest composition (i.e. structural complexity) that is reflected by a higher residual basal area.

Most critically, the plans do not explicitly address information that would be needed to document carbon stocks in the full range of pools addressed by existing registries. The TCNF demonstration showed that landowners whose plans meet Be WoodsWISE inventory and data requirements would need additional data collection to improve precision, and account for carbon stored in other pools.

The additional functions such as monitoring and reporting, and just the increased level of interaction with the landowners, make the certified group is an ideal platform for aggregating forestry credits. However Maine's Be WoodsWISE program gives landowners a significant leg-up for participating in strategies introduced by TCNF or another aggregating institution.

Cost-Shared Practices

Landowners in Maine working with an approve Stewardship Foresters are eligible for a range of cost-share practices. These vary from year to year, in accepted practices and funding level. In the current year (2008), the primary emphasis is on developing new or updated plans. There are other practices that can also use cost-share dollars, and a landowner can receive funding for up to 50% of the cost of many silvicultural and other land management activities. A landowner is limited to 3 approved cost-shared projects every five years.
Many of the cost-shared practices that have been offered (Table 9) in the past would benefit a landowner managing forests for any purpose, whether they are certified or not. The type of harvest simply needs to be in keeping with the WoodsWISE plan and the Maine Forest Practices Act. However several are especially suited to projects that would improve conformance with certification standards, and/or would enhance carbon sequestration. For example cost-share projects to plant riparian buffers, enhance in-stand retention, and thin saplings and release crop trees, all can directly increase on-site carbon stocks and are otherwise hard to underwrite. Most of the other practices are, in keeping with the purpose of the funding, activities that support sustainable land management. To this end they are also complementary with management needs under any certification scheme.

Table 9. Selected Be WoodsWISE cost-share incentives – *Summary of Eligible Project Practices (2006). "C" indicates generally compatible and useful to certified-managed, and "CS" indicates direct implication for carbon sequestration strategies employed by TCNF.*

High priority practices				
1.	(FH-1d)	Field assessment of current forest health conditions (in designated FH area**)	50% , 1$/ac.	C
3.	(FH-2d)	Sanitation cutting of infected/declining stands	75% $50-100/ac.	C,CS
4.	(INV-1)	Removal of invasive woody plant species	50% $100/ac.	C
5.	(FH-1)	Field assessment of current forest health conditions	50%, 1$/acre	C
Medium priority practices				
4.	(WTR-4d)	Riparian forest buffer planting (in designated watersheds)	50%, $200/ac.	C,CS
6.	(FSI-3)	Crop tree release	50%, $100/ac.	C
9.	(WLD-1)	Pre-commercial thinning of sapling stands for wildlife cover	50%, $150/ac.	C, CS
12.	(WLD-2)	Identification and marking for retention of nest or den trees	50%, $20/ac.	C, CS
14.	(WLD-4)	Mast tree release	$50, $100/ac.	C
15.	(WLD-5)	Interplanting/enrichment planting for wildlife	50%, $100/ac.	C, CS
19.	(WTR-4)	Riparian forest buffer planting	50%, $200/ac	C, CS

There is a double-edged sword though for using cost-share practices to enhance sequestration, in that most registries feel this diminishes the additionality of the carbon project (i.e., If other funds are already paying for the project how can it be said to depend on carbon dollars?). In seeking endorsement by VCS, TCNF will have to evaluate how the potential use of cost-share may jeopardize the additionality and baseline arguments that are proposed.

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Appendix I. Tables and Figures for NED-2 Model Evaluation

Table 1. Composition of stands in Maine Carbon Pilot Project. Results based on inventory data projected to a 2007 baseline.

Forest type (NED class)	Area (ha)	Basal area (m^2/ha)	Total Live Biomass (Mg/ha)
bottomland conifer	379.8	17.1	117.0
other hardwoods	227.4	14.3	106.1
hemlock hardwoods	146.1	18.1	138.0
pine hardwoods	94.6	22.6	173.9
other mixedwoods	93.1	16.4	117.0
oak northern hardwoods	52.2	20.2	182.9
oak	51.0	13.0	101.1
spruce-northern hardwoods	30.4	23.5	169.2
northern hardwoods	26.4	19.9	158.0
bottomland mixed	17.0	22.1	160.6
red maple (pure)	10.9	8.6	72.4
beech magnolia	10.1	18.9	166.8
bottomland hardwoods	8.1	4.6	33.8
hemlock	7.2	27.3	219.3
maple	5.7	17.1	134.6
eastern white pine (pure)	3.2	20.7	136.4
other softwoods	2.8	15.3	104.0
oak northern pine	1.6	17.2	145.1
arborvitae (pure)	1.2	39.0	239.2
northern red oak (pure)	0.8	6.9	71.4
Sewall class - mixed	720.7	18.6	139.2
Sewall class - hardwood	354.6	16.0	128.1
Sewall class - softwood	98.3	19.6	130.1

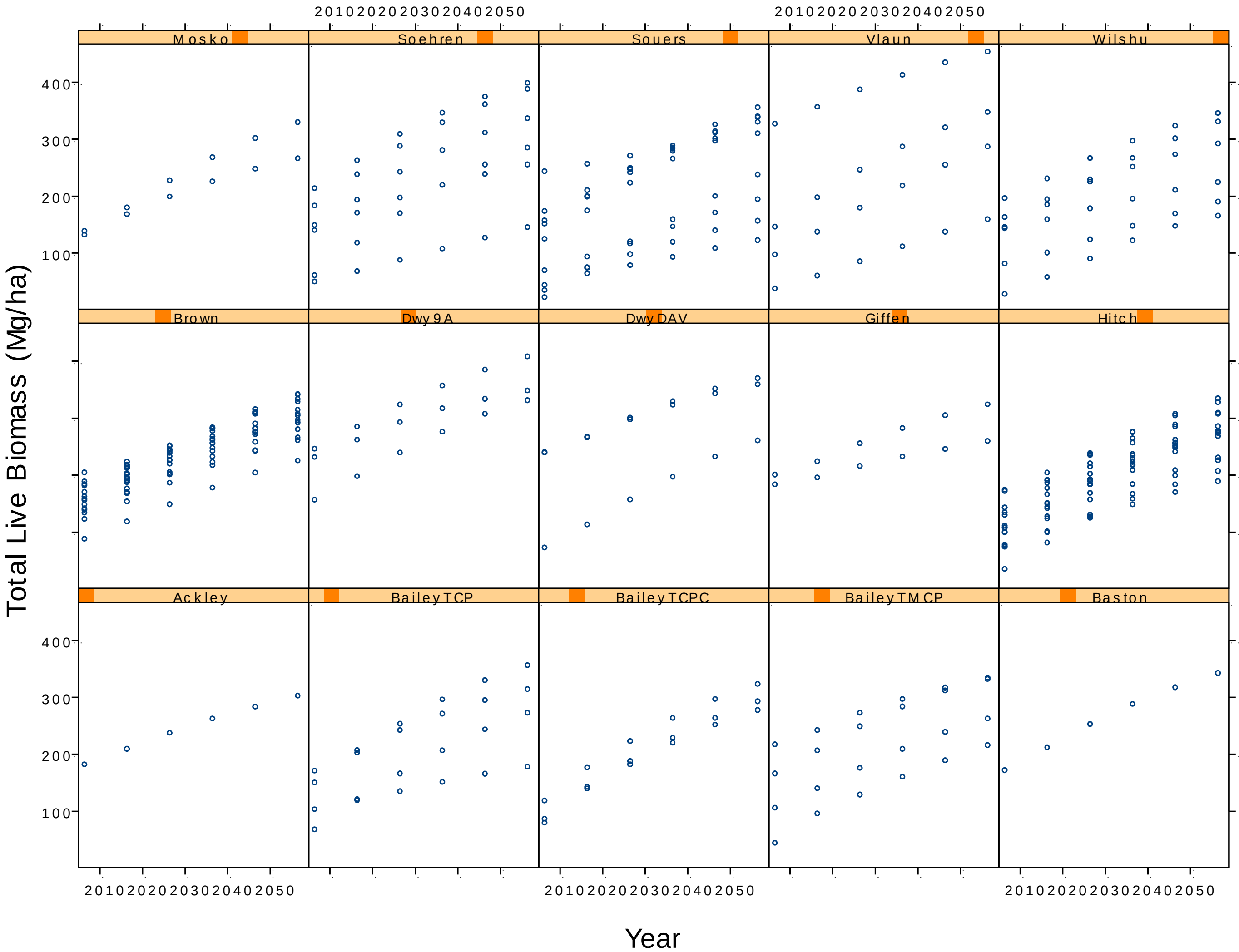

Figure 1. Trends in total live biomass increment by owner/stand between 2007 – 2057.

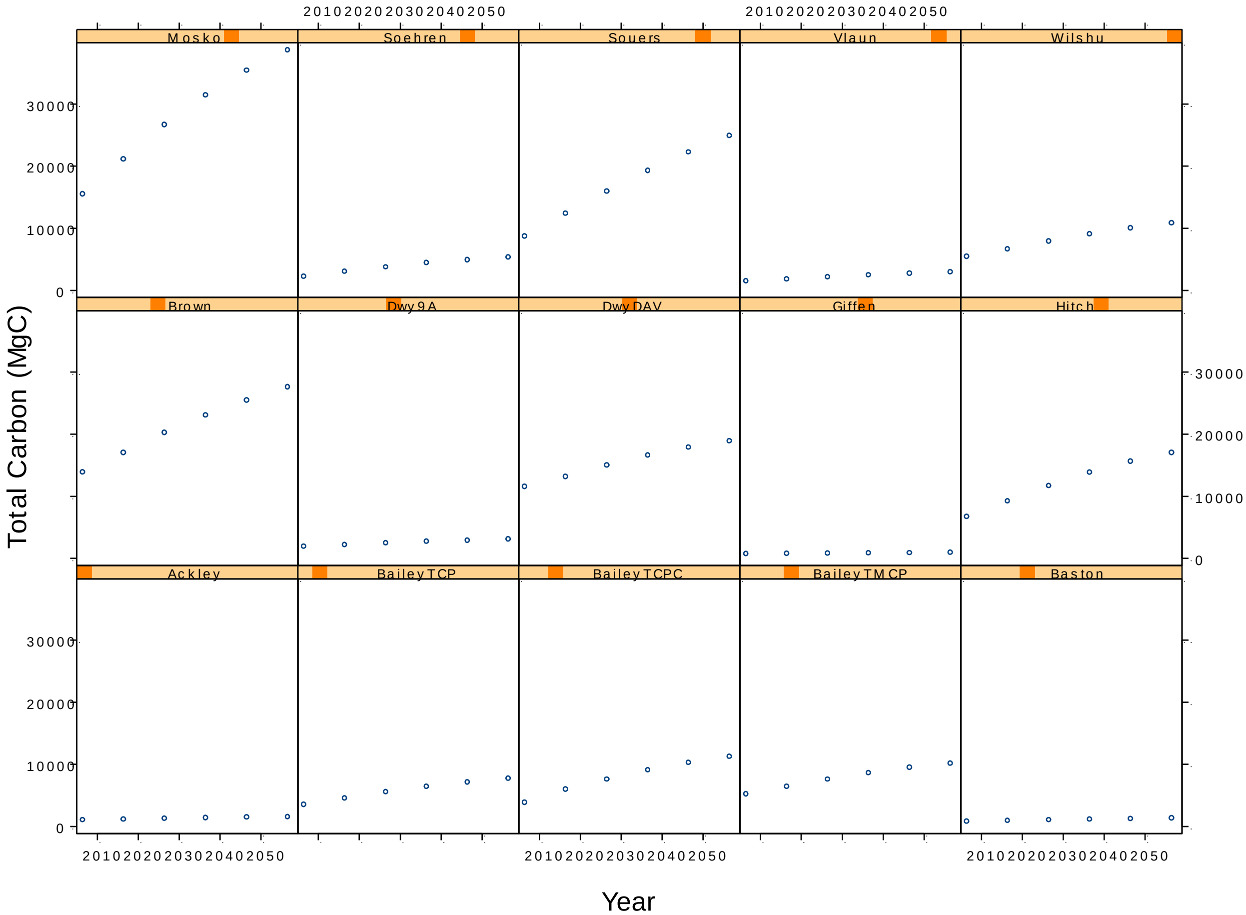

Figure 2. Trends in carbon sequestration by parcel/owner between 2007 – 2057.

Table 2. Annual biomass increment
(total live biomass) in Maine Carbon Co-op stands
Projections based on 50-yr projections (2007-2057)
using NED-2 beta (v. 2.09).

Site index	Mean Annual Biomass Increment (Mg/ha*yr)
<40	1.86
40-45	3.21
45-50	2.87
50-55	3.34
55-60	3.09
60-70	3.18
>70	1.52
Sewall class	
Hardwoods	2.64
Mixedwoods	3.09
Softwoods	3.52

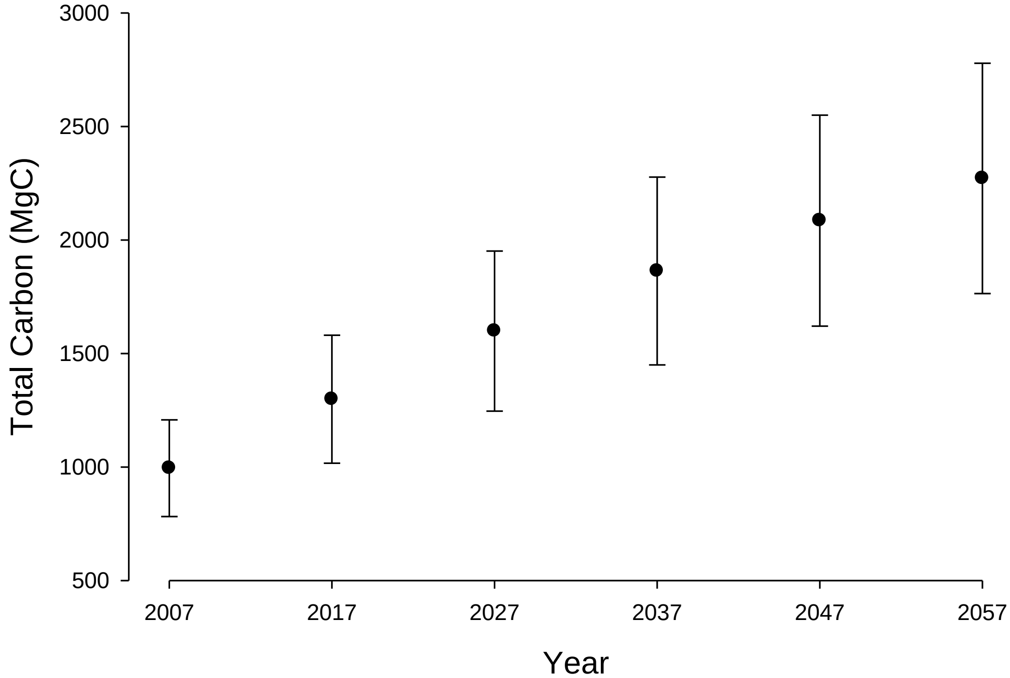

Figure 3. Total carbon sequestration from 2007 to 2057. Error bars are standard error of the means for each year (n=78).

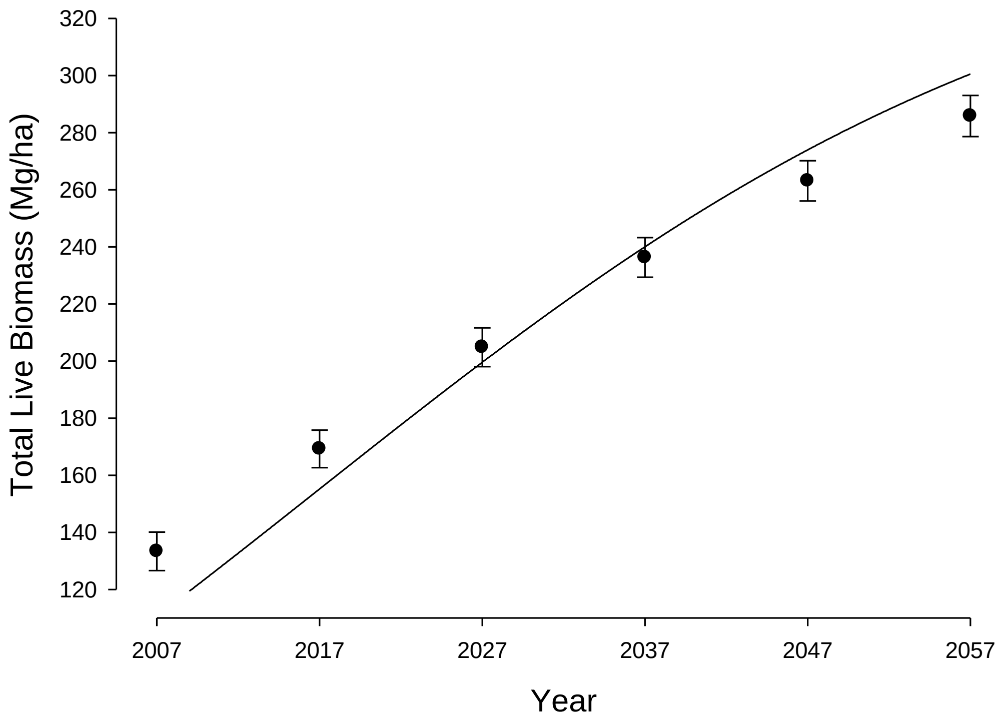

Figure 4. Mean rate of biomass accumulation for stands in the Maine Carbon Pilot Project. The circles represent mean values from the inventory (2007) and projected using NED-2. The error bars are the standard error of the mean for all stands in each decade. The line represents the fit to a logistic function accumulation rate. The logistic function was fit using non-linear regression. Logistic function was a better model of accumulation rate than either a linear or quadratic model. $R^2_{logistic} = 0.96$.

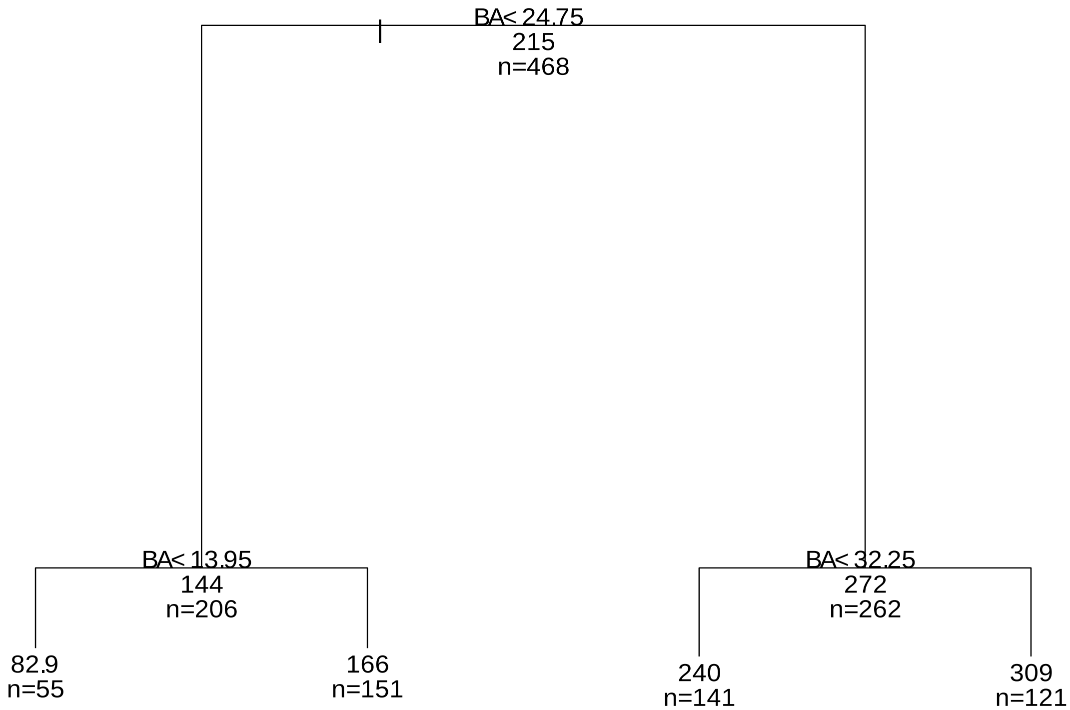

Figure 5. Final decision tree to bin biomass pools for baseline projections of stands in Maine Carbon Pilot Project. Results from regression tree analysis. Only basal area was a reliable predictor of live tree biomass. Predictors included in initial model: Sewall composition class (mixed, softwood, hardwood), basal area, NED-2 canopy cover, Sewall canopy cover class, Sewall size class, tree density, site index, site index bin, mean dbh, and median dbh. Overall relative error of final decision tree – 18%.

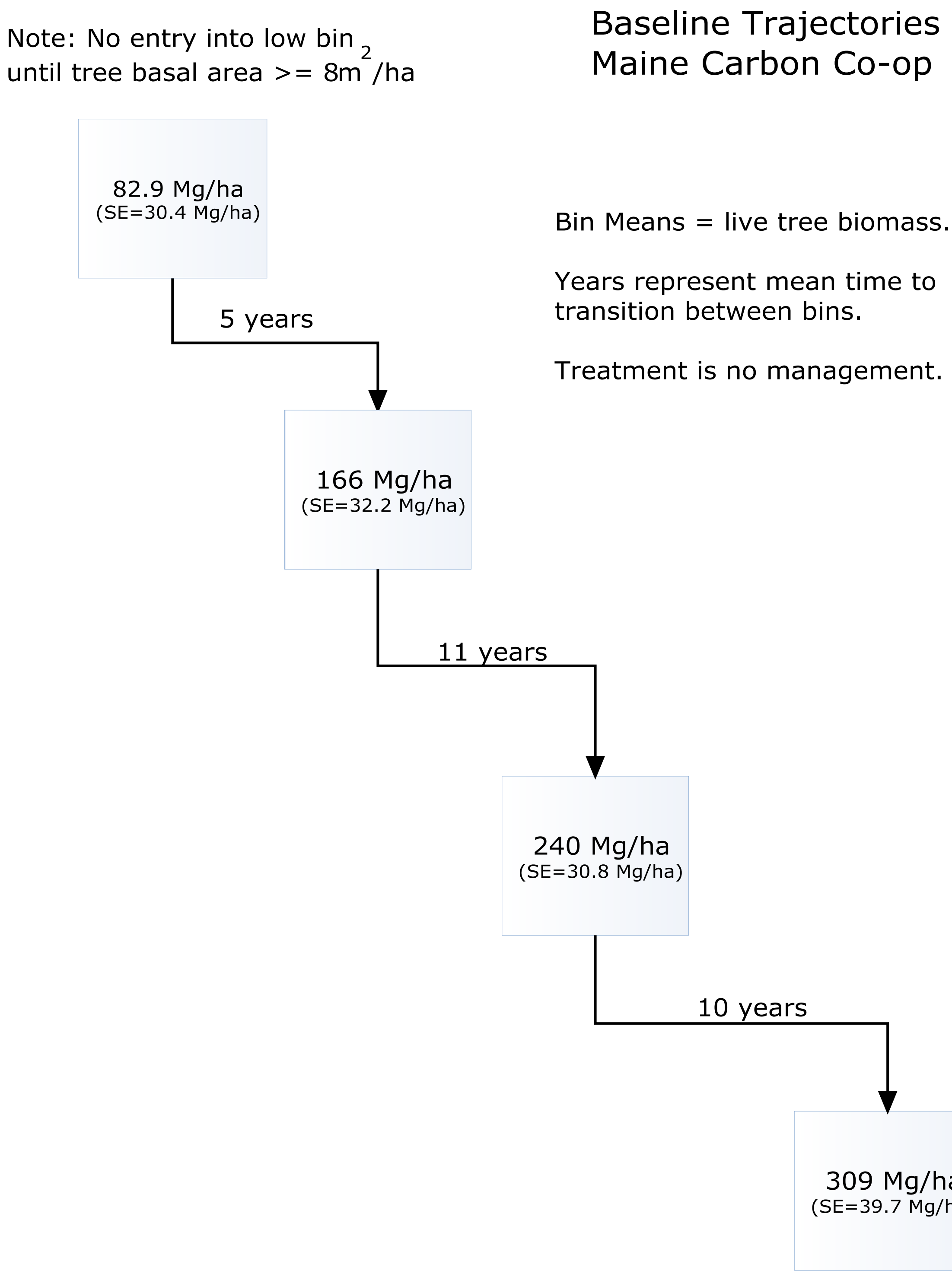

Figure 6. Baseline live tree biomass accumulation rate for Maine Carbon Pilot Project stands. Assignment of initial bin based on basal area predictors in decision tree (Figure 5).

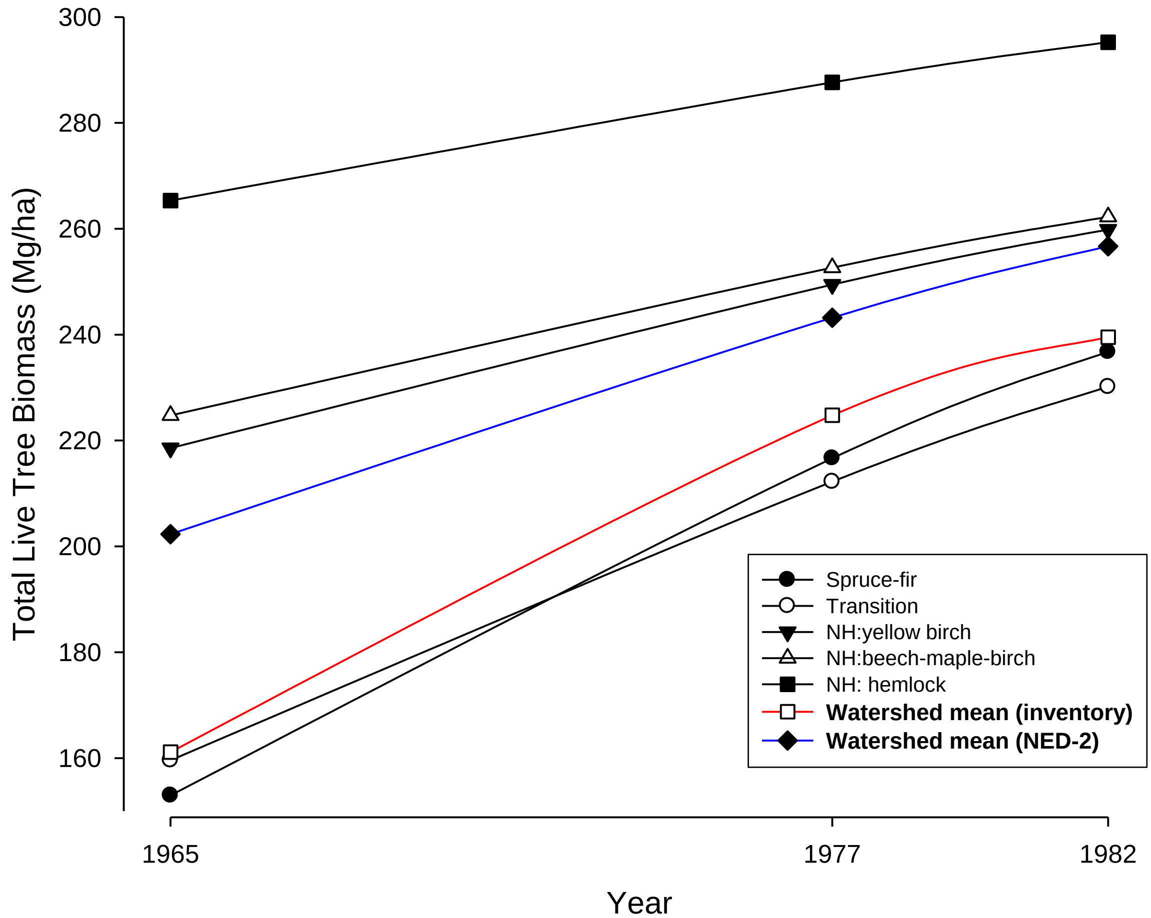

Figure 7. Projected NED-2 runs of live tree biomass accumulation for the five forest types (aka stands) in the reference watershed at Hubbard Brook Experimental Forest. The red line is the watershed average based on the inventory data; the blue line is the watershed average based on NED calculations (1965) and projections (1977, 1982).

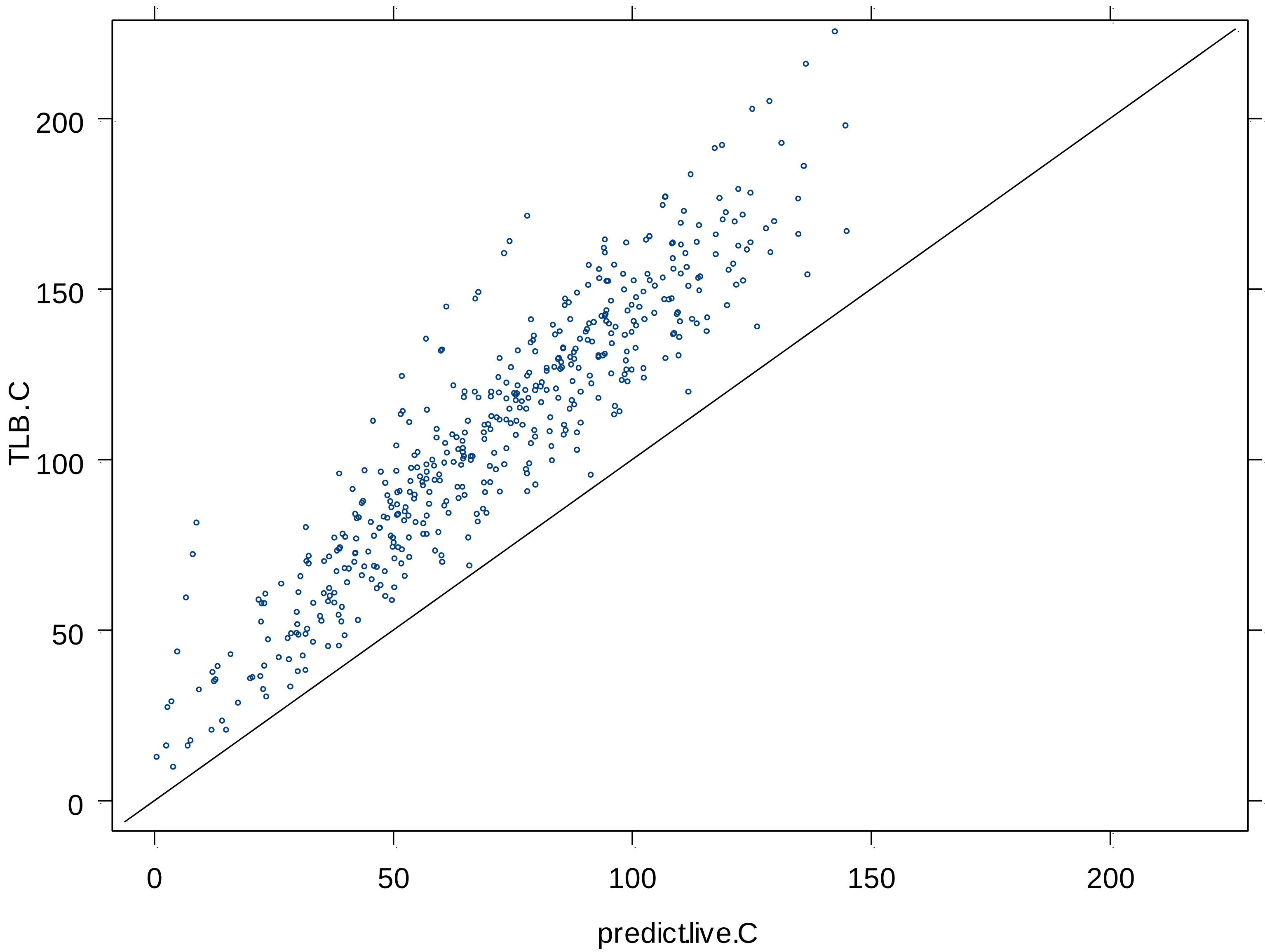

Figure 8. Comparison of NED-2 estimates of live tree carbon (TLB.C in MgC/ha) against predictions of live tree carbon (predict.live.C in MgC/ha) based on the volume to carbon look-up tables in Smith et al. 2006.

Regression equation: TLB.C = 21 + 1.21* predict.live.C, R^2=0.86, $p_{slope} < 0.001$.

Appendix II. Comparison of Carbon Protocols and Registries.

Forest carbon protocol comparison

Last edited: September 25, 2006 by Michelle Lichtenfels, Environment Northeast

Adapted from Call and Hayes. 2006. A Description and Comparison of Selected Forest Carbon Registries: a guide for states considering the development of a forest carbon registry. USDA Forest Service.

Program	**1605(b)**	**Chicago Climate Exchange**	**California Climate Action Registry**	**IPCC LULUCF**	**RGGI**	**GHG Protocol Standard***
Governance/ Administration						
Website	http://www.pi.energy.gov/enhan	http://chicagoclimatex.com	http://www.climateregistry.org/PROTOCOLS/	http://unfccc.int/methods_and_science/lulucf/items/1084.php	http://www.rggi.org	http://www.ghgprotocol.org
Relevant Document	1605b Technical Guidelines for Voluntary Reporting of Greenhouse Gas Program; Chapter 1, Emission Inventories; Part I Appendix: Forestry	CCX Forestry Carbon Emission Offsets (summary document)	CCAR Forest Sector Protocol	IPCC Good Practice Guidance for Land Use, Land Use Change and Forestry	RGGI Model Rule; Part XX C02 Budget Trading Program (Subpart XX-10: C02 emissions Offset Projects)	WBCSD/ WRI GHG Protocol for Project Accounting
Document Year	Mar-06	Jun-06	Oct-04	2003	Aug-06	Dec-05
Legal Basis?	Federal Law; Section 1605(b) of the Energy Policy Act of 1992; DOE administers	Legally binding between interested parties	California laws SB 1771(2000) and SB812 (2002); CA Registry Board administers this voluntary GHG registry	Voluntary guidelines developed by the Intergovernmental Panel on Climate Change (IPCC)	RGGI states MOU, December 20, 2005	Voluntary protocol for GHG reduction projects developed by the World Resources Institute (WRI) and the World Business Council for Sustainable Development (BCSD), two non-profits
Purpose	Voluntary registry	Voluntary and binding program Voluntary pilot GHG cap and trade program	To establish "good practice guidance" for estimating carbon emissions and sequestration for land use, land use change and forestry (LULUCF) activities; designed for creating national GHG inventories; does NOT establish a registry At project level, provides certification of GHG emission reduction; meant to create "transparent, credible and consistent accounting of GHG reductions" in the forestry sector	Guidelines for reporting national GHG inventories	Regulated program; optional offsets for electricity generators = / > 25 Mwe	To establish internationally accepted accounting and reporting standards for GHG emission reduction or sequestration projects; the Project Protocol follows the WRI/WBCSD GHG Protocol, which created standards for emission reporting
Registry	Administered by US DOE	CCX staff and advisors	Administered by CCAR; uses online reporting system (CARROT)	NA	Eastern Climate Registry (administered by NESCAUM)	NA
Eligible Jurisdictions	US	US, Canada, Mexico, Brazil	California	National level	NE signatory states	NA/ International
Reporting Level	Entity	Entity or project	Entity or project	Really designed for national-level reporting, so it is not entirely relevant for our purposes, although it does define the important carbon pools, which are essentially the same as those described in the CA protocol.	Project	Project
Activities	Reforestation, conservation and various forest management techniques are all eligible for inclusion in 1605(b)	Forest conservation eligible if in conjunction with forestation on contiguous site (avoided deforestation)	Forests projects must fall in one of three categories: 1) conservation-based forest management (where management promotes native forests comprised of trees of multiple ages and mixed species); 2) reforestation (must have been out of forest cover for minim	Land use, land use change, forest sector	Afforestation; land must be in non-forested state for at least 10 years prior to commencement of project	Not addressed; may be discussed in 2006 land use sector protocols
Forestry Cooperatives Allowed?	Not clear if recognized	Potentially in future	Does not recognize as entities	NA	Not clear if recognized	Not clear if recognized
Crediting Period	NA	Not addressed	NA	NA	Offsets awarded for initial 20 yr period. Two more 20 yr periods may be allowed, up to max 60 yrs of credits awarded	NA
Commencement	Registered reductions can start in 2003.	Forestation and forest enrichment projects on or after Jan 1, 1990 (afforestation and restoration)	Projection may start 1990 or later (after 2008 start date must be some subsequent year);	LULUCF protocols established in 2003	Afforestation projects commenced on or after Dec 20, 2005	Project protocol estb in 2005; sector protocols expected in 2006
Reporting	Annual reporting	Annual reporting	Entity: 1) submit annual monitoring reports; 2) reporting deadline August 31 year after reporting year and certification is Dec 31 after reporting year 3) complete forest inventory required over 10 year intervals Project: 1) submit annual monitoring reports; third party certification of entity over 5-yr intervals 2) reporting deadline August 31 year after reporting year; certification Dec 31 after reporting year; 3) complete forest inventory required over 10 year	Standard reporting tables supplied; Section 5.7.5 recommends what to report; no reporting timeline seems to exist	Minimum of every 5 years	Annual monitoring and GHG reduction quantification report; provides list of required reporting elements - see Chapter 11 of the Protocol
Sustainability/ Certification Requirements						
Certification Required?	Certification recommended, not required	Demonstration that entity-wide forest holdings are sustainably managed (certified by CCX-approved 3rd verification programs) Demonstration of long-term commitment to maintain carbon stocks in forestry	Third party certification required	Not explicitly required; Section 5.7.3 offers several "good practice" recommendations for verifying results	Managed in accordance with widely accepted env'lly sustainable forestry practices and that promote use of native species FSC, SFI, ATFS required if harvest is to occur	Does not address; provides transparency and reporting standards, but does not offer guidance on how to solicit or conduct third-party certification
Carbon Pools						
Above ground living biomass	None officially required but recommends the inclusion of living tree biomass for all entities	Required	Required	Required	Live above-ground tree biomass	Not specifically addressed; expected in land use sector protocol
Below ground tree biomass	Not addressed	May be included in future	Not addressed	Optional	Required	Not specifically addressed; expected in land use sector protocol
Soil	Recommended for reforestation purposes	Optional	Optional	Required	Required	Not specifically addressed; expected in land use sector protocol
Standing dead biomass	Optional	Optional?	Required	NA	Required (dead organic matter)	Not specifically addressed; expected in land use sector protocol
Lying dead wood	Optional	Optional?	Required	NA	Required	Not specifically addressed; expected in land use sector protocol

Appendix III. Draft Landowner Guide to Carbon Offset Projects

We have developed a general Family Forest Landowner Guide to Forest Carbon Offset Projects. This approach was taken rather than a detailed guide for a specific protocol. The Maine Pilot Project has not yet been approved by a recognized carbon protocol; therefore it was not useful to develop a landowner guide targeted at a specific carbon protocol. Below is the draft general guide to forest carbon offsets. TCNF is working with members of the Family Forests Alliance to refine this draft and disseminate to its members throughout the US.

A Family Forest Landowners Guide to Forest Carbon Offset Markets

It is widely recognized that family forests play a significant role in providing significant ecosystem services to people in the form of aesthetics, wildlife habitat, recreation, and forest products. There is an increasing recognition of the role these forest have in mitigating climate change through sequestration of carbon that happens during the process of photosynthesis. In fact, markets are emerging that more explicitly recognize this ecosystem service through direct payments to landowners. This is an extremely dynamic marketplace with multiple standards being developed to serve both regulatory and voluntary markets. This Guide is meant to provide an introduction to the concepts, challenges, and opportunities associated with the forest carbon offset marketplace.

There are several key elements that are emerging to define what is needed for a landowner to participate in a carbon market. (1) The landowner must demonstrate that their forests are sustainably managed. This would commonly be done through enrollment in a forest certification program such as the Forest Stewardship Council (FSC) or the American Tree Farm System (ATFS). (2) Approved methods must be used to quantify carbon stocks. This includes the collection of typical timber inventory data associated with forest management planning. (3) Demonstrate a long-term commitment to maintain carbon stocks. Conservation easements or long-term contracts recorded with a deed are typically used to guarantee that carbon stocks will be held in the forest and not lost to the atmosphere through conversion or over-harvest. (4) The carbon stocks must be verified by a third party. An auditing entity will verify that the claimed carbon is real.

There are four primary models that illustrate the likely requirements of family forest landowners

Box 1. The Language of Ecosystem Services

Baselines: What starting point is your carbon sequestration activity compared against?

Additionality: Has the project sequestered carbon from the atmosphere that wouldn't have happened anyway?

Permanence: How long will the carbon remain sequestered in the forest?

Transaction Costs: How much will it cost to: prepare a timber inventory; prepare a management plan; develop a contract; monitor changes in carbon over time; achieve third party verification of carbon; enroll in third-party forest

1

participating in forest carbon offset markets. These are defined as formal protocols:

- Chicago Climate Exchange (CCX)
- California Climate Action Registry (CCAR)
- Voluntary Carbon Standard (VCS)
- Proposed Regional Greenhouse Gas Initiative (RGGI)

These four protocols have varying requirements on how *baseline*, *additionality*, and *permanence* are defined (see Box 1). Table 1 defines in general terms what those requirements are.

The present reality for access to credible forest carbon offset markets is that a landowner will need to make a significant commitment to maintaining carbon stocks over a long period of time. While CCX is an exception at 15 years, voluntary markets want more assurances that purchased carbon will remain out of the atmosphere indefinitely. This is a high bar for most family forest landowners, but it must be recognized that the intent of these transaction is indeed to mitigate global climate change related to the buildup of greenhouse gases such as CO_2.

Table 1. Carbon Protocol Requirements

Carbon Protocols	Baseline	Additionality	Permanence
CCX	Base Year	Net Accumulation (i.e., Growth – Mortality and Harvest)	15 years
VCS	5-10 Years Prior Inventory and Practices	Practices different from prior history on same property	100+
CCAR	Regulatory	Practices different from Regulatory Baseline	Permanent Easement
RGGI Proposed	Average Stocking	Difference from Average Stocking in landscape	99 years

Resources Available for Family Forest Access to Carbon Markets:

- **Cost-share.** Stewardship programs such as the Maine Forest Service's Be WoodsWISE program provide cost-share for two critical elements of carbon projects – inventory and management planning.
- **Group Certification.** Family forest landowners will only likely be able to participate in carbon markets if their carbon is aggregated with other landowners. This is necessary to reduce *transaction costs*. Likewise, the certification requirements of carbon offset protocols are best achieved through an aggregation of landowners. More information on Group Certification can be found at www.familyforestsalliance.org.
- **Carbon Aggregation.** The Trust to Conserve Northeast Forestlands has initiated a project to aggregate family forest landowner carbon credits in conjunction with its FSC group certificate. Visit www.tcnef.org for more information.

The Trust to Conserve Northeast Forestlands (TCNF) is a 501(c)3 organization formed by the Professional Logging Contractors of Maine in 2003 to administer the Northeast Master Logger Certification program with the broader goal of "enhancing the health of the working forest through exceptional accountability" throughout the Northern Forest region.

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