Emerging Ecosystem Service Markets

Carbon Sequestration in the Hofmann Forest, Onslow County, NC

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Abstract

A four-member group of graduate students in a natural resource management course at North Carolina State University modeled two scenarios to determine the feasibility of managing for carbon on a section of the Hofmann Forest. The study compares the financial and ecological tradeoffs between "business as usual" (BAU) and two scenarios: 1) the current voluntary carbon market, and 2) a compliance carbon market. The analysis concludes that under the first scenario, there are minimal financial gains associated with managing for carbon. Under the second scenario where cap-and-trade legislation regulates greenhouse gases, a lucrative situation exists for the Hofmann Forest.

Introduction

The current amount of CO_2 sequestration in United States forests and croplands offsets is approximately 12-15 percent of total CO_2 emissions from the energy, transportation and industrial sectors (EPA, Carbon Sequestration in Agriculture and Forestry, 2009). Some estimates indicate that U.S. farms have the potential to mitigate as much as 40 percent of the nation's total climate impact due to green house gas emissions (Group, 2009). In most cases, managing for carbon in the U.S. is not financially beneficial for farmers and land managers. If the U.S. adopts cap-and-trade legislation, the U.S. carbon market is likely to experience a significant increase in carbon credit prices. This potential price increase may make carbon sequestration a lucrative option for land managers.

The emerging carbon offset market offers an opportunity to develop a new revenue source for Hofmann Forest. What are the economic and ecological impacts of managing the southwest portion of Hofmann Forest for carbon sequestration compared to current business as usual?

Carbon Offset Market

The global carbon market emerged as a result of the Kyoto Protocol environmental treaty adopted in 1997 that went into effect in 2005, to reduce emissions of global greenhouse gases (GHGs). The Kyoto Protocol is a cap and trade program where entities buy carbon offsets in order to comply with caps on the total amount of carbon dioxide they are allowed to emit. The European Climate Exchange (ECX) trades carbon credits within the compliance markets of the Kyoto Protocol.

The United States did not sign the Kyoto Protocol, citing concerns about unrealistic goals and the exclusion of developing countries (Walsh, 2006). In the United States, since 2003 the Chicago Climate Exchange (CCX) has been trading as a voluntary, legally binding trading system to reduce emissions of all six GHGs. Members can either reduce their own emissions or purchase carbon offset credits from others who make emission cuts. Between 2003 and 2009, emission reductions and project-based offsets for the CCX's 400+ members exceeded 500 million metric tons of CO2.

The CCX has developed standardized rules for issuing carbon offsets for GHG reductions and sequestration. A carbon offset is a financial instrument representing a reduction in GHGs. Carbon offsets are measured in metric tons of carbon dioxide-equivalent (COxe). One carbon offset equals the reduction of on metric ton of carbon dioxide, or its equivalent in other greenhouse gases. Credits are traded on the basis of Carbon Financial Instrument (CFI) contracts with owners or aggregators.

Management Area

Hofmann Forest comprises nearly 80,000 contiguous acres near the North Carolina coast spanning Jones and Onslow Counties, NC. It is the largest outdoor laboratory for the NCSU College of Natural Resources. The land is private and managed by the NC Forestry Foundation (Dept. of Forestry and Environmental Resources, 2009). This study analyzed 12,046 acres in the southwest portion of the forest for its suitability to be managed for carbon. The largest land use is pocosin which comprises 4,428 acres of the study area. It is followed in size by natural timber with 3,421 acres, pine plantation with 2,517 acres, and agricultural fields with 902 acres (see Figure 1).

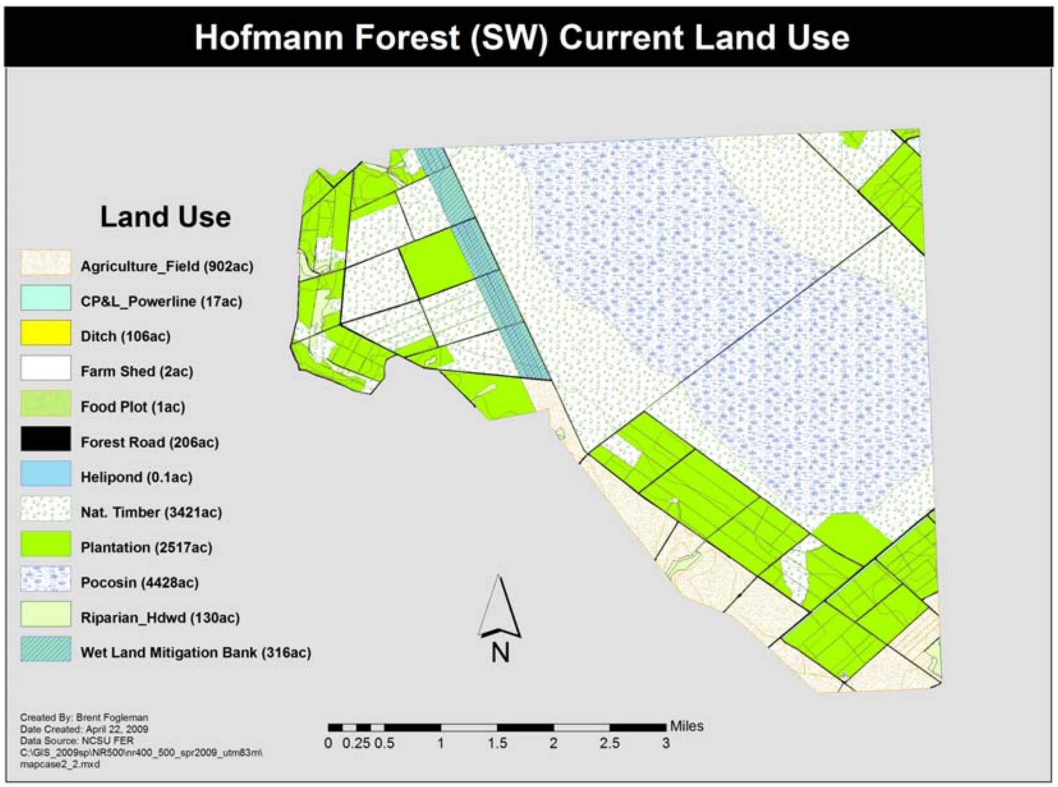

Figure 1. Hofmann Forest land use.

Baseline Assessment

In order to determine the financial effects of managing land for carbon credits, a comparison to the baseline business-as-usual model must be conducted. Currently there are three practices that turn a profit, Agricultural Leases, Loblolly Plantations, and Longleaf Plantations. The SEVs of each practice are determined. A detailed review of the calculations can be done by referencing Appendix A, which contains Excel spreadsheets.

Agricultural land is leased at a price of $38.34/acre/year. No apparent costs are incurred from this management option. The SEV per acre is $677.69.

The two pine plantations were challenging to quantify in terms of SEV. The trees were planted at various years from 1973-2010. In order to determine the SEV/acre of a stand, the SEV of the normal rotation must be determined. This SEV is discounted by the age of the stand. This discounted SEV is added to the NPV of the remainder of the rotation of the trees in stands of that year (see attached spreadsheet: Longleaf BAU SEV).

Every stand planted in a different year had a different SEV/acre, and the acreage of each stand differed. Therefore, in order get the BAU data for all of the SEVs, the acreage needed to be taken into account. The results are in the Pie Chart below.

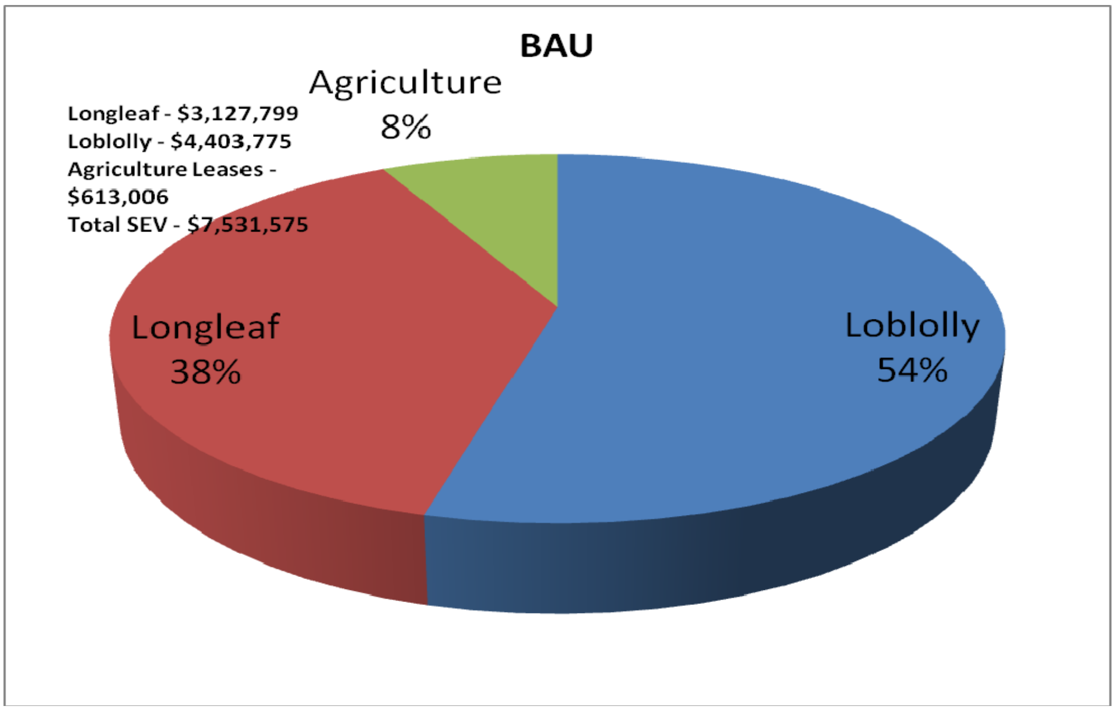

Figure 2. Business-As-Usual

The non-discounted net revenues of Loblolly, Longleaf, and Agriculture for the next 51 years are also determined. Figure 3 is a snapshot of BAU income by activity over the 51-year period.

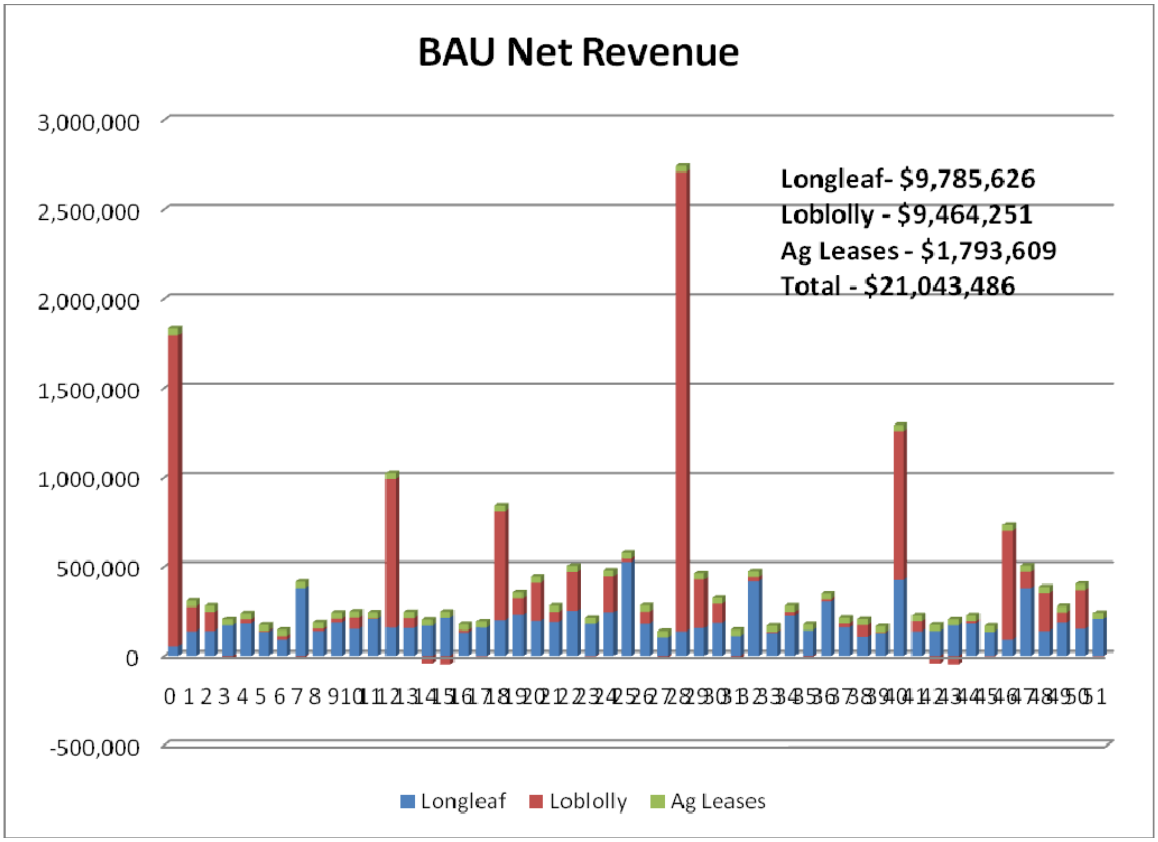

Figure 3. Business-as-usual net revenue

The same methods used to create these Business As Usual models were used for calculations of carbon credit options. The differences between the carbon models and the BAU models are due to the sale of carbon credits only.

Managing for Carbon

Two land use management options

Modifications of two current land uses were analyzed for their potential to sequester carbon: agricultural fields and pine plantation. The group reviewed managing the existing agricultural fields (902 acres) for carbon using one of two practices. One practice entails leasing the land at the current lease rate, with the stipulation that only conservation tillage be exercised. The other practice is afforestation, where the agricultural land is converted to forest. The second land use change is to manage existing pine plantations (2,517 acres) for carbon through management practices that allow the land to be certified "sustainable" by the Forest Stewardship Council.

Two price scenarios

In this analysis, financial characteristics of managing agricultural fields and forests for carbon are determined the two price scenarios. The difference between the scenarios is that one uses carbon price projections from the current U.S. voluntary carbon market, CCX, and the other uses the higher carbon price projections from the ECX, which operates under a cap-and-trade program. Calculations in both scenarios account for the land lease, timber, and carbon credit revenues minus aggregator, management and verification fees.

Projected future prices

It is assumed that the price of carbon credits increases with time. The average CCX and ECX prices/month (2003-2009) were determined (see figures below).

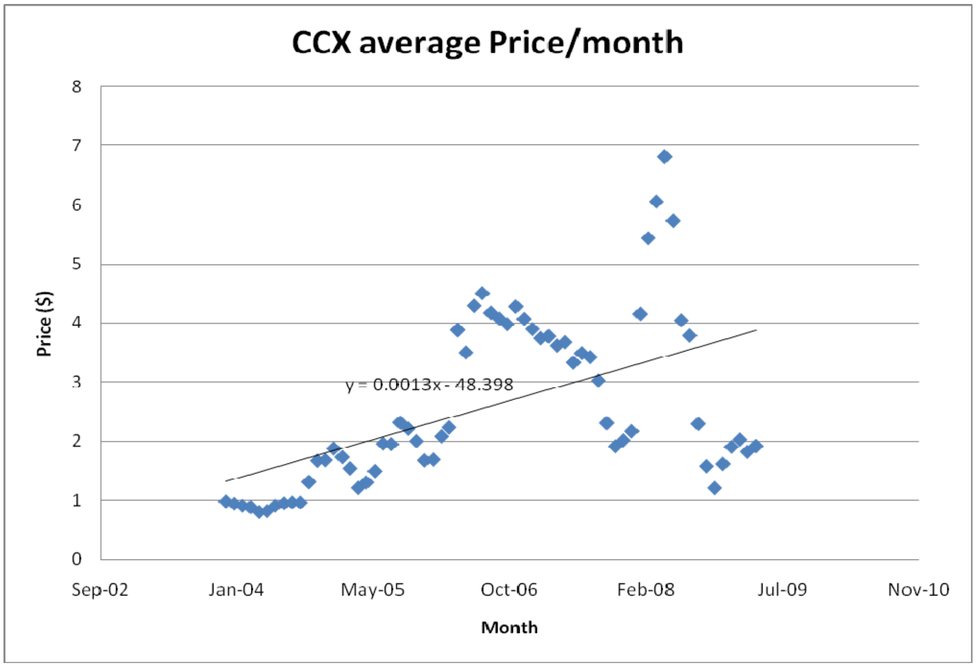

Figure 4. CCX Average Price per Month

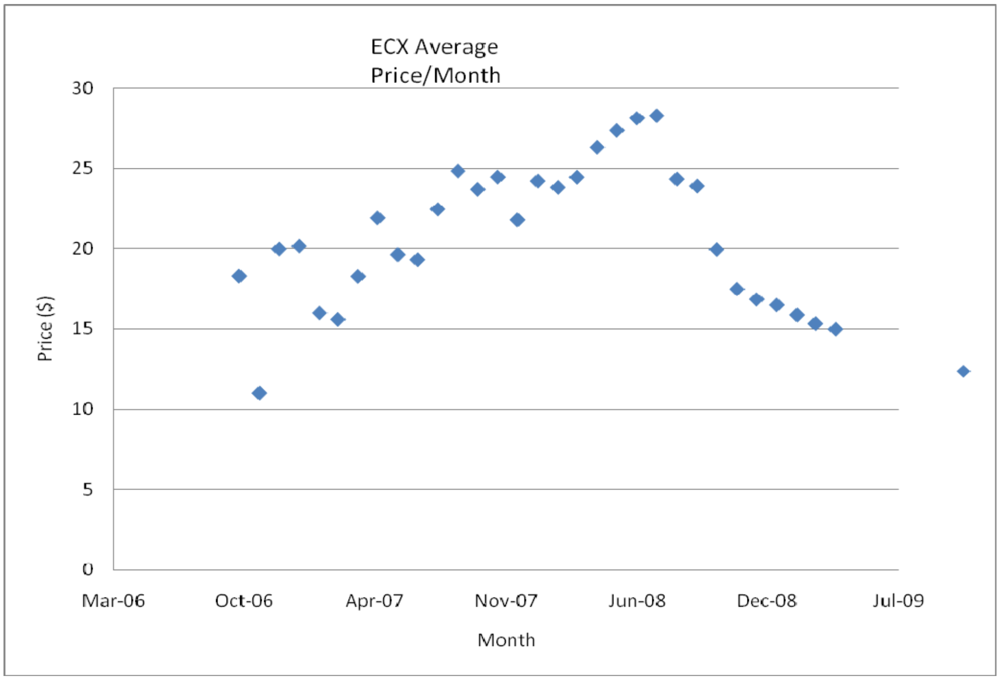

Figure 5. ECX Average Price per Month

Using these values, the nominal interest rate for the increase in price over time was determined for CCX and ECX. The inflation rate over the last 10 years was determined to be 0.02499323. The real interest rate was determined and used to predict the CCX and ECX values for the next 51 years. Due to the current recession, carbon prices have decreased. When the current market values were used to predict future carbon prices, the predictions were too low to be feasible. When the prices before the recession were used, the future predictions were too high to be feasible. The average price of CCX and ECX over the span of the markets was determined. These averages encompass the high and low points of each market. When those values were used to predict future carbon prices, the values seemed reasonable (see Table 1 below).

Year	year	CCX Price	ECX Price
2009	0	2.59	27.17
2010	1	2.627617	28.00941
2011	2	2.665779	28.87475
2012	3	2.704497	29.76682
2013	4	2.743776	30.68646
2014	5	2.783626	31.6345
2015	6	2.824055	32.61184
2016	7	2.865071	33.61937
2017	8	2.906682	34.65802
2018	9	2.948898	35.72877

2019	10	2.991728	36.8326
2020	11	3.035179	37.97053
2021	12	3.079261	39.14361
2022	13	3.123984	40.35294
2023	14	3.169356	41.59963
2024	15	3.215387	42.88483
2025	16	3.262086	44.20974
2026	17	3.309464	45.57558
2027	18	3.35753	46.98362
2028	19	3.406294	48.43516
2029	20	3.455766	49.93155
2030	21	3.505957	51.47417
2031	22	3.556877	53.06444
2032	23	3.608536	54.70385
2033	24	3.660945	56.3939
2034	25	3.714116	58.13617
2035	26	3.768059	59.93226
2036	27	3.822786	61.78385
2037	28	3.878307	63.69263
2038	29	3.934634	65.66039
2039	30	3.99178	67.68895
2040	31	4.049756	69.78017
2041	32	4.108574	71.936
2042	33	4.168246	74.15844
2043	34	4.228784	76.44953
2044	35	4.290202	78.81141
2045	36	4.352512	81.24626
2046	37	4.415727	83.75633
2047	38	4.47986	86.34395
2048	39	4.544925	89.01151
2049	40	4.610934	91.76149
2050	41	4.677902	94.59643
2051	42	4.745843	97.51895
2052	43	4.814771	100.5318
2053	44	4.884699	103.6376
2054	45	4.955643	106.8395
2055	46	5.027618	110.1403
2056	47	5.100638	113.543
2057	48	5.174719	117.0509
2058	49	5.249875	120.6671
2059	50	5.326123	124.3951
2060	51	5.403478	128.2382

Table 1. CCX and ECX Future Carbon Prices

Managing for Carbon: Agricultural CO_2 Reductions

Conservation tillage is an approved project for managing soil for CO_2 sequestration under the CCX rules. Conservation tillage is defined as no-till or strip-till. In each case, CCX requires that the farming practice leaves at least two-thirds of the soil surface undisturbed and at least two-thirds of the residue remaining on the field surface. This management practice allows soils to move carbon dioxide from the atmosphere (harmful carbon) to agricultural soils (improves soil health). To meet CCX requirements, a minimum five-year contractual commitment to *continuous* conservation tillage on enrolled acres must be made.

CCX CFI contracts are issued for *continuous* conservation tillage at a rate between 0.2 and 0.6 metric tons CO_2 per acre per year. The different offset issuance rates reflect the carbon sequestration ability of the soils—carbon absorption rate. North Carolina is in Zone A which equates to a rate of 0.6 metric tons CO_2 per acre per year (see Figure 6).

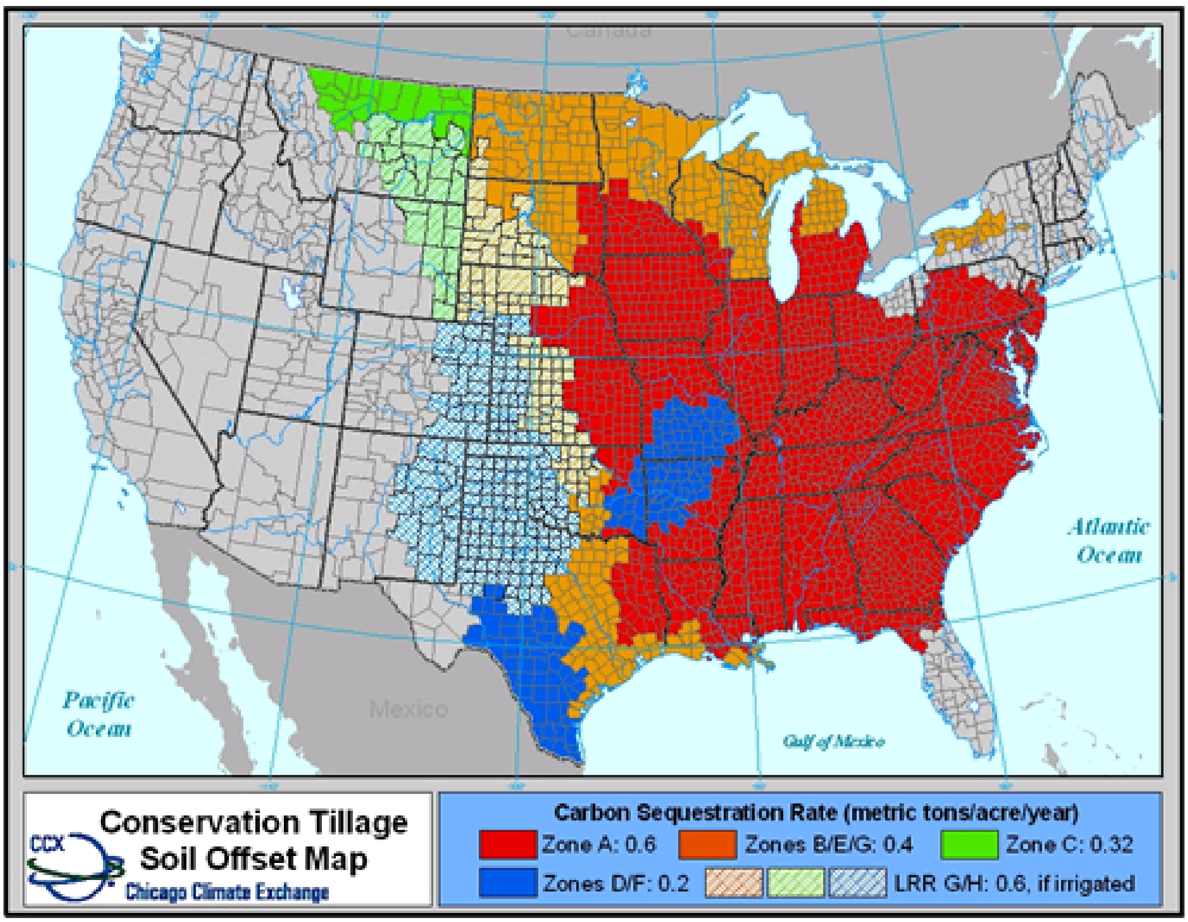

Figure 6. Carbon sequestration rates in the United States.

Assumptions were formulated to predict the future financial outlook for these scenarios in this emerging market. Although a risk aversion assessment was not conducted, it is assumed that farmers will pay a discounted lease rate ($38.24 per acre) and accept the stipulation that conservation tillage is required. The 2008 lease rate for NC crop land is $55/acre (NCDA&CS, 2008). The lease rate is held constant for all calculations to demonstrate the significance of added revenue due to managing for carbon. Increased carbon market trends are assumed per the figures below.

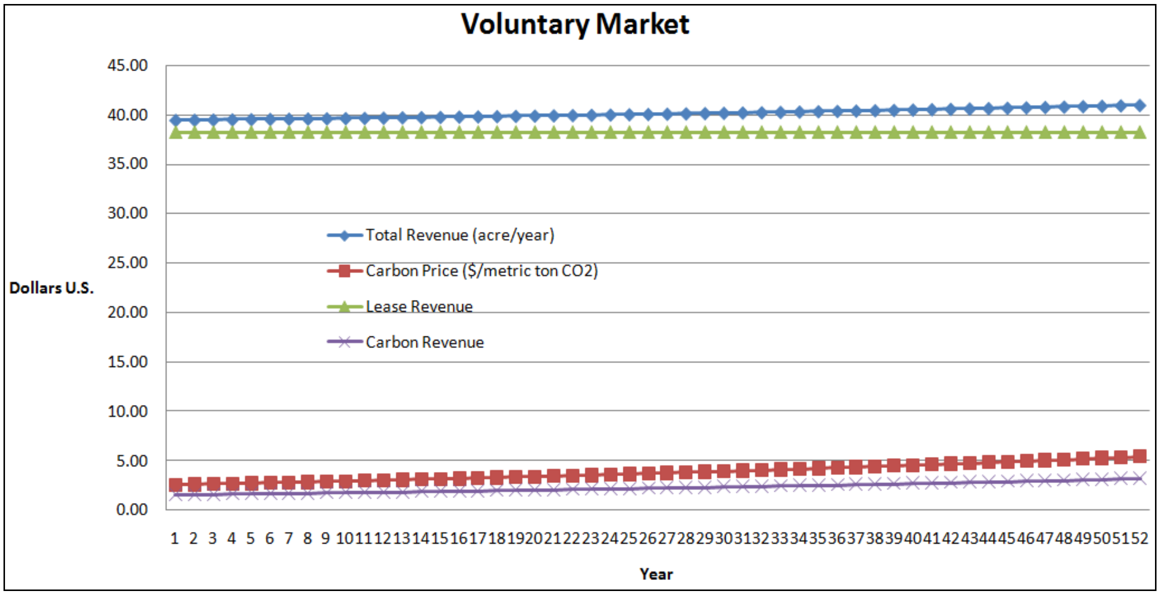

Figure 7. Under the current voluntary market, the portion of revenue from carbon credits is minimal.

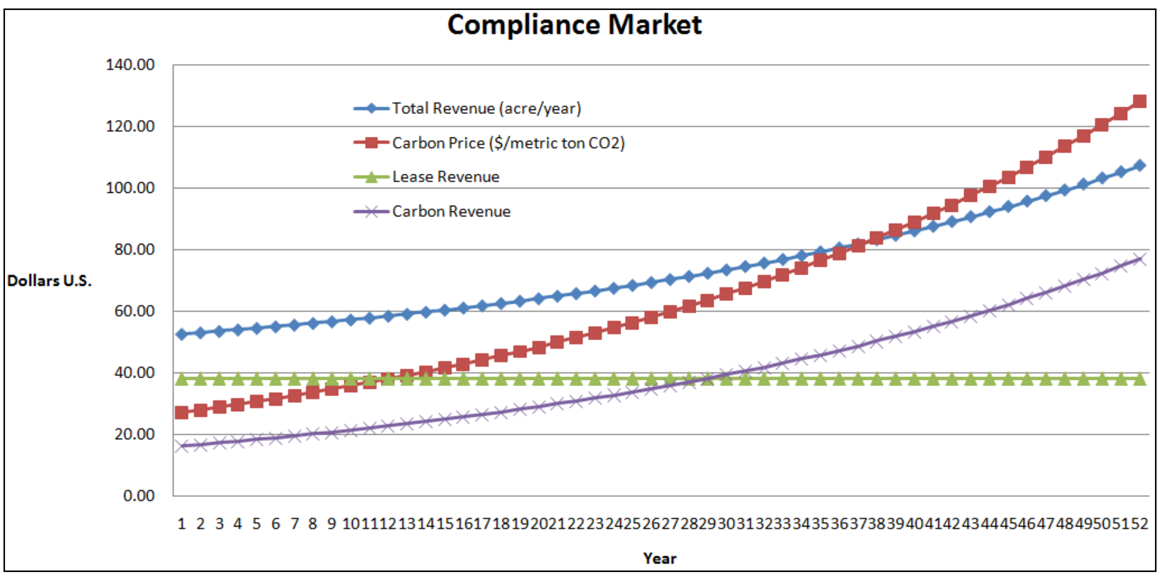

Figure 8. Under a compliance market, the portion of revenue from carbon credits exceeds the revenue from the lease after year 28.

Managing existing agricultural fields for carbon is financially beneficial under both scenarios and more lucrative under a compliance market. Net revenues after fifty years should continue to rise steadily under both scenarios. If cap-and-trade legislation is not passed in the U.S., and carbon stock prices do not change, the agricultural fields will still be profitable through lease revenues. Even if the carbon stock market crashes, lease rates are expected to increase over the life of the agricultural fields. If cap-and-trade legislation is passed, carbon stock prices are expected to increase. Even if the carbon stock market attains a glass ceiling price, the carbon value combined with the lease revenues make the operation a financial success.

The additional costs associated with managing for carbon above BAU are minimal compared to the added revenue. Additional costs incurred are from aggregator fees, account management fees and verification fees. The average fee per acre per year under the voluntary market is $0.40, which equates to a total amount per acre of $20.80 over a 51-year period. The average fee per acre per year under the compliance market is $3.95, which equates to a total amount per acre of $205.46 over a 51-year period. To put it in perspective, the costs are only 2.95 percent of the Soil Expectation Value (SEV) under the voluntary market and 18.63 percent of the SEV under the compliance market.

In summary, the option to manage for carbon through agricultural CO_2 reductions is financially beneficial. Under the current voluntary market, land managers could increase the SEV by $24,886 and their annual net present value by $23,271.60 for the 902 acre plot over BAU. Under a compliant market, land managers could increase the SEV by $383,566.48 and their annual net present value by $362,748.32 for the 902 acre plot over BAU. See Table 2 below for a comparison between the activities. A detailed analysis by year can be reviewed in Appendix A.

Value / Activity	**BAU**	**Voluntary Market**	**Compliance Market**
Avg annual revenue per acre	38.24	39.34	71.30
Total avg annual revenue (902 ac)	34,492	35,485	64,313
SEV per acre	677.69	705.28	1102.93
Total SEV (902 ac)	611,300	636,194	994,885
NPV per acre	640.89	666.99	1043.05
Total NPV (902 ac)	578,113	601,656	940,874

Table 2. Financial comparison of different price scenarios for managing agricultural fields for carbon.

Managing for Carbon: Afforestation of Agricultural Land

Another option for the agricultural land is to convert it to forest land. In this analysis, comparisons were made between of the income streams from afforestation, agricultural BAU, and managing agricultural fields for carbon.

Afforestation is the planting of new forest on lands, which historically, have not contained forests. Under CCX requirements, the owner must commit to maintaining the property as forest for at least 15 years, with no harvesting, thinning, or other removal of tree biomass. The rules do however; allow for the conversion of afforested projects to managed forestry projects for harvest. Owners enroll in the CCX through carbon offset aggregators, requiring a description of the activity, pre-forest conditions, and supporting documents.

Carbon offset credits are based on the annual increase in carbon stocks. Trees accumulate carbon until maturity, with carbon accumulation rates varying over time and tree type. Carbon accumulation in forest biomass and soil is calculated using the CCX Carbon Accumulation Tables (CCX 2009A) or other approved methods. The CCX Carbon Accumulation Tables contain carbon accumulation coefficients, categorized by region, species, and age. These are conservative estimates but this is offset by the fact that landowners do not incur costs for measuring trees to determine carbon accumulation. Other methods that employ growth and yield models result in higher carbon estimates, but require field measurements for which the landowner incurs additional costs. Under both methods, CCX requires the landowner to set aside of 20% of the credits in a carbon reserve pool at the beginning of the contract to manage catastrophic losses. Assuming no losses, the credits are returned to the owner at the end of the contract. One-hundred percent of reserves are assumed to be returned in this financial analysis.

The CCX Carbon Accumulation Tables for North Carolina, included in the Southeast Region, lists carbon accumulation for five species of trees (see Table 3). Two of these species, loblolly-shortleaf pine and longleaf-slash pine, are suitable for an afforestation project at Hofmann Forest. Loblolly-shortleaf pine will be planted for this afforestation project as it accumulates carbon at a higher rate of 2 to 2.5 metric tons of CO_2/acre/year. The CCX table only projects carbon accumulation for 30 years. Since Loblolly pine continues to grow for up to 150 years, the U.S. Forest Service Carbon Online Estimator (COLE) was utilized to project carbon accumulation for an additional 20 years.

Appendix 9.2Ai CCX Carbon Accumulation Tables for Afforestation Offset Projects

Section 2: Regional Estimates of Tree Annual Carbon Accumulation in Live trees and Soil Organic Carbon for Afforestation (Metric tons CO_2/ acre/ year age of tree)

Region	Species	1 through 5	6 through 10	11 through 15	16 through 20	21 through 25	26 through 30
Southeast	Loblolly-shortleaf pine	2.367	2.472	2.303	2.136	2.261	2.135
Southeast	Longleaf-slash pine	1.173	1.644	1.957	2.061	2.281	2.239

Table 3. Carbon Accumulation Tables for Afforestation Offset Projects in North Carolina . (CCX 2009c)

Revenues from the carbon credits for the afforestation project are calculated under both the voluntary CCX and compliance ECX market price projections. Expenses include the initial forest planting costs plus the aggregator fees (10% of carbon credit revenue), verification costs ($.10/metric ton CO_2), and CCX enrollment and trading fees ($.20/metric ton CO_2) (Ruddel 2007).

A comparison of three agricultural land uses is used to determine the most financially beneficial option: Ag BAU, Ag Carbon Sequestration, and Afforestation Carbon Sequestration. The option to convert the agricultural land to forest land is financially beneficial only under a compliance market. Under the current voluntary market, afforestation would result in a negative SEV and NPV due to the low carbon revenues and the high costs of planting trees. In the current voluntary market, agricultural carbon sequestration is the preferred land use. Under a compliance market, afforestation produces higher revenues than the other two options. Afforestation increases the SEV by $483,477 for the 902 acre plot over BAU, which is also $99,892 greater than the SEV of the Ag compliance market option. Under a compliance market, afforestation would result in a higher profit than Ag BAU and Ag Carbon Sequestration.

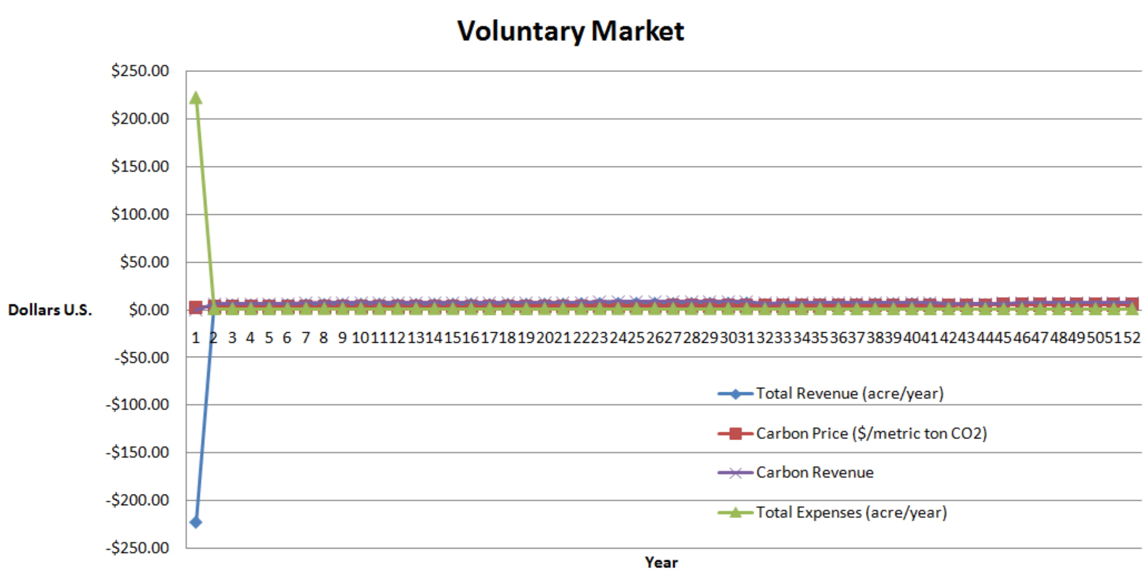

Figure 9. Afforestation in the current voluntary market.

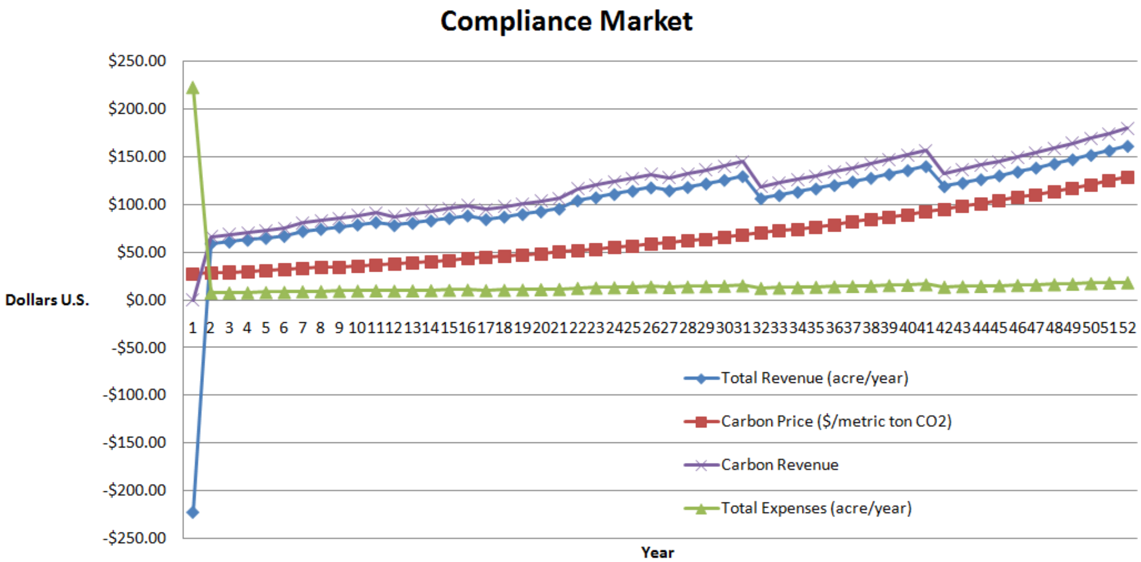

Figure 10. Afforestation in a compliance market.

The following table provides a comparison between the land use and price scenarios. A detailed analysis by year is included in Appendix A.

Value / Activity	**Ag BAU**	**Ag Voluntary Market**	**Ag Compliance Market**	**Afforestation Voluntary Market**	**Afforestation Compliance Market**
Avg annual revenue per acre	38.24	39.34	71.30	7.17	117.65
Total avg annual revenue (902 ac)	34,492	35,485	64,313	6,471	106,121
SEV per acre	678	705	1102	-140	1,214
Total SEV (902 ac)	611,300	636,194	994,885	-125,854	1,094,777
NPV per acre	641	667	1043.05	-132	1,148
Total NPV (902 ac)	578,113	601,656	940,874	-119064	1,035,496

Table 4. Financial comparison of different land use and price scenarios.

Managing for Carbon: Managed Pine Plantations

The CCX has protocols for all project types including forest plantations. Forest plantations must first be certified under an accredited certification scheme, such as the Forest Stewardship Council or Sustainable Forestry Initiative. After this, the project must be submitted and verified by a CCX-accredited verifier. Projects can then register with the CCX as Providers if they produce enough credits independently; if not, they must register their credits with an aggregator, who collects an aggregation fee. The aggregator then takes responsibility for the sale of the credits. CCX forestry credits are committed for 15 years, after which they must be renewed.

The requirements for Chicago Climate Exchange managed forest projects, facilitated keeping most of the extant profit-gaining mechanisms for the managed pine plantations in place (for instance, these forests can still be harvested and sold in much the same way as they were before). To calculate the profits from carbon crediting, we established linear projections of price increases on two different markets, to stimulate how price would rise over time. Then, using estimations by Birdsey (1996), we found that Southern pine plantations sequester about 1 metric ton of carbon per acre per year, averaged across their life span. Because tree carbon is not the same as CO_2, these figures must be multiplied by a factor of 3.67 to account for this difference; these figures can then be used to determine total CO_2 sequestered, and the price for the total by multiplying by the price projection in the relevant year.

Additional costs are incurred in several ways. For instance, to qualify for CCX credits, forestry projects must be certified as sustainable by an accredited organization like the Forest Stewardship Council or the Sustainable Forestry Initiative, which must be renewed every 15 years. Using quantitative figures from Cubbage et al. (2003), the cost is estimated as $2.30 per acre every fifteen years if the forest is certified by the Sustainable Forestry Initiative. In addition, the project incurs fees from the CCX's verifiers, aggregators, and a trading fee every year. Using Ruddell (2007), we estimated these costs annually to be $.10/ton for verification; 10% of the total credit profit as aggregator costs, and $.20/ton for the trading fee. This presentation also addressed the cost of inventory, changing practices for certification, and project preparation as $.28/acre in the first year as a one-time cost. In addition, the CCX requires that 20% of credits that could be earned be set aside as a buffer against disaster like disease, catastrophic weather events, or other events that would destroy trees. However, this 20% is gained back at the end of the year if no such event occurs. Thus, to simplify calculations, we did not subtract this amount.

The business-as-usual figures for the managed plantations are as follows, in total SEV by type:

Total SEV for All Acres	**Loblolly** Pine	**Longleaf** Pine	**Total**	**Total/Acre**
Business as Usual (BAU)	$4,403,775	$3,127,799	$7,531,574	$2,907
Chicago Climate Exchange (CCX) (Voluntary Market)	$4,721,539	$3,236,182	$7,957,721	$3071
European Climate Exchange (ECX) (Compliance Market)	$9,069,657	$4,859,020	$13,928,677	$5376

Table 5. Pine Plantation BAU SEV

This table shows the increase in dollars over BAU in either scenario, once again for total SEV:

Increase in SEV over BAU	**Loblolly Pine**	**Longleaf Pine**	**Total**	**Total/Acre**
Voluntary Market	$317,764	$108,383	$426,147	$164
Compliance Market	$4,665,882	$1,731,221	$6,397,103	$2469

Table 6. Pine Plantation Carbon SEV

Thus, under any scenario, there is some profit associated with using a carbon crediting scheme, and the profit is quite significant under a compliance market price scenario.

Results of Selling Carbon Credits on the Current Agriculture Leases and Pine Plantations.

The following models depict managing agricultural fields for carbon sequestration and managing existing pine plantations for carbon.

Voluntary Market Prices

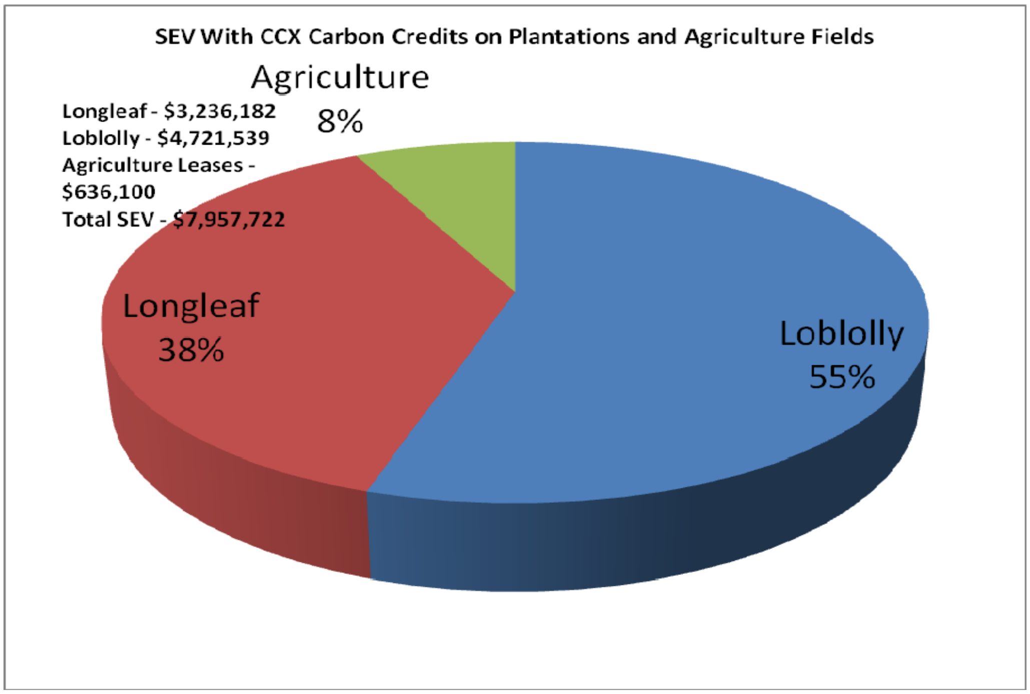

Figure 11. CCX Carbon Credit SEV for Pine Plantations and Agriculture

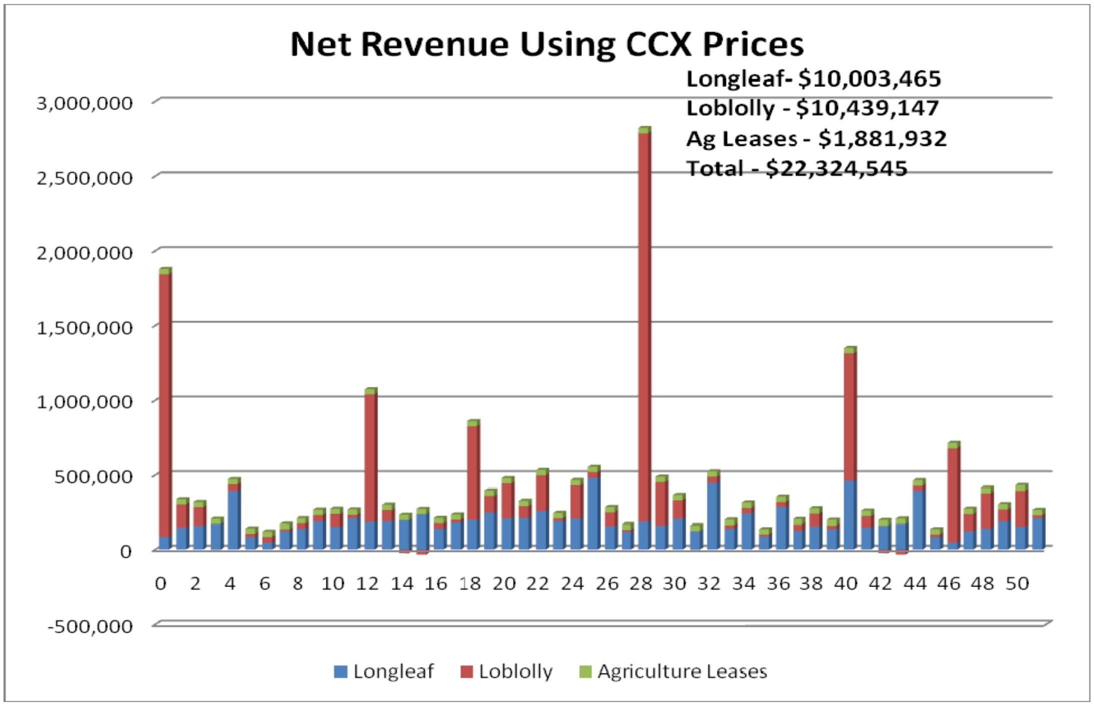

Figure 12. CCX Carbon Credit Net Revenue for Pine Plantations and Agriculture

Compliance Market Prices

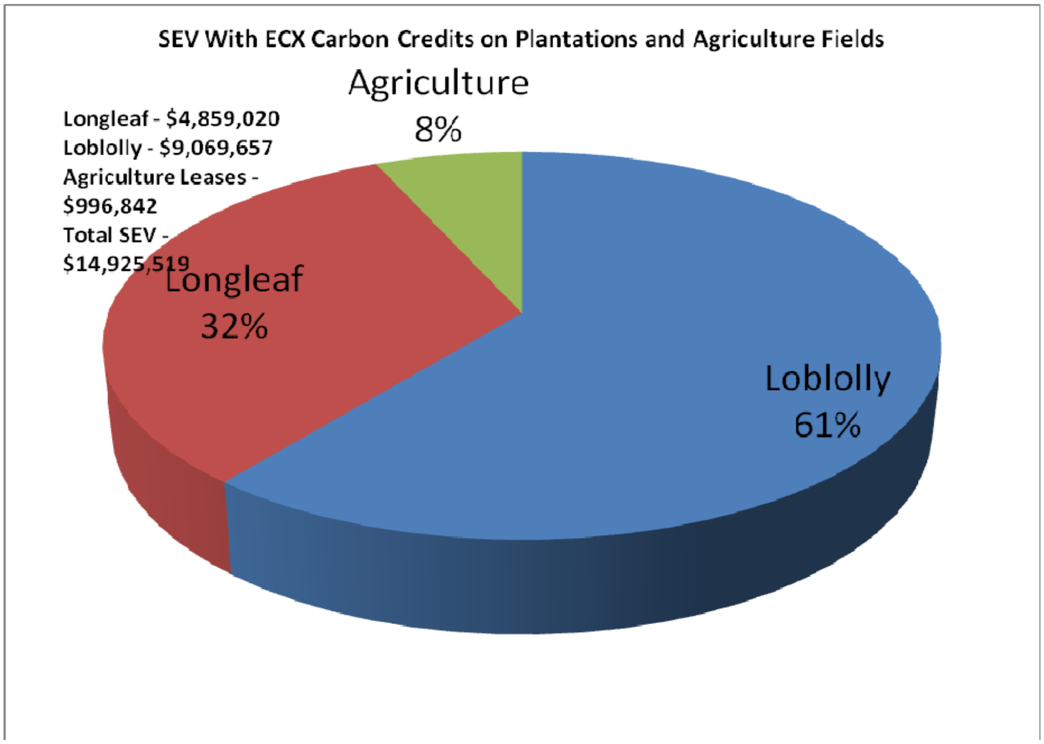

Figure 13. ECX Carbon Credit SEV for Pine Plantations and Agriculture

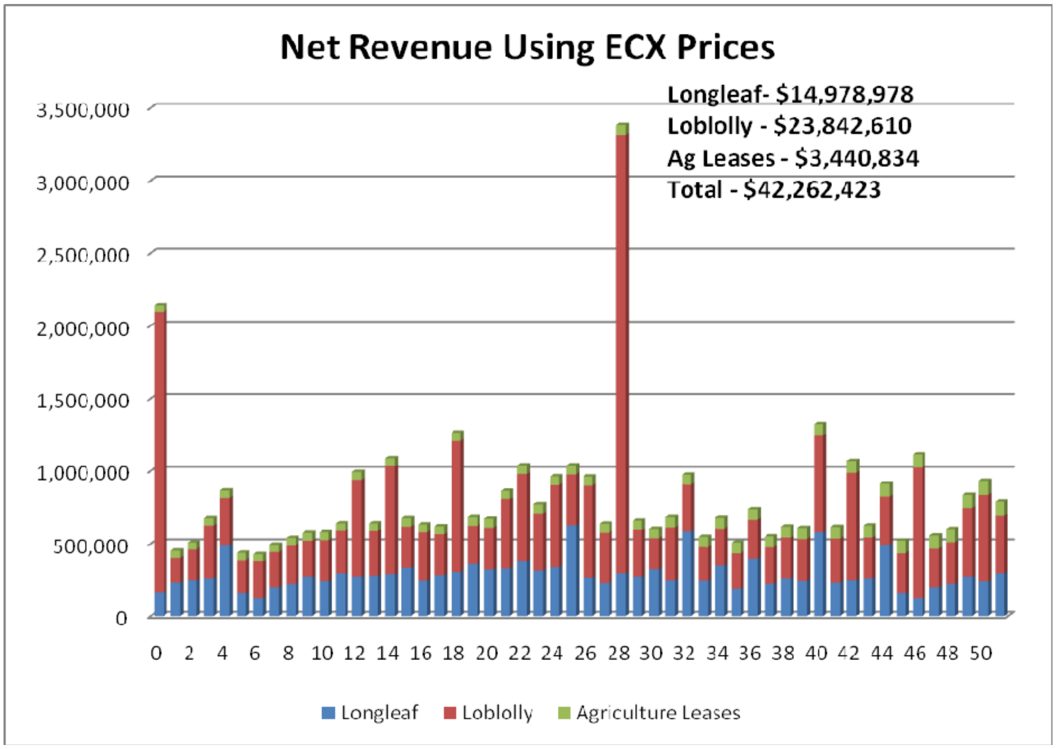

Figure 14. ECX Carbon Credit Net Revenue for Pine Plantations and Agriculture

Ecological Benefits

The ecological tradeoffs experienced by changing management practices in order to sequester carbon are generally positive.

The ecological impacts of managing agricultural fields for carbon are positive. Not only does conservation tillage facilitate carbon sequestration, it has other realized benefits:

- Reduced run-off by 75 percent
- Reduced sediment loss by 98 percent
- Reduced nitrogen fertilizer losses in run-off by 95 percent
- Reduced phosphorus run-off by 92 percent
- Reduced pesticide losses by 80 percent
- Increased populations of beneficial insects
- Ability to farm more acreage due to less time and labor inputs
- Reduces amount of nutrients and pesticides reaching surface and ground water (Naderman, 2004)

The ecological impacts of managing afforested acreage for carbon are positive. Benefits of new forest areas include:

- Provide habitat for wildlife
- Result in increased wildlife populations
- Provide corridors to connect fragmented habitats
- Increase biodiversity of flora and fauna
- Forested riparian buffers reduce run-off, control erosion, and control flooding
- Buffer strips are effective in removing soluble nitrogen and phosphorus by up to 99 percent. Reduce pesticides and other chemicals from reaching water sources.
- Create desirable landscape aesthetics
- Recreational benefits due to increased wildlife populations: hunting, bird-watching

The ecological impacts of managing pine plantations for carbon are neutral to slightly better than business-as-usual. The required sustainability certification promotes:

- Forest health and productivity
- Long-term forest and soil productivity
- Protection of riparian zones
- Protection of special habitats

The Hofmann Forest already manages the pine plantations in a manner that works towards these goals with quick reforestation times, riparian buffers, longleaf pine stands, and leaving the pocosin intact. Thus, carbon crediting for the pine plantations as a whole is unlikely to provide significant ecological benefit or detriment over the BAU, although it may have a marketing advantage.

Adaptive Management

Adaptive management principles have been addressed in our management plan by the inherent requirements of carbon crediting systems. Adaptive management relies on constant monitoring to assess current conditions in order to change management practices in response to changing conditions. This kind of monitoring is required by the verifiers of carbon crediting agencies, who assess the areas being managed for carbon once a year at the least and must report the results. Thus, no additional funds are necessary for monitoring. This constant updating of information will allow property managers to track progress on the Hofmann and change the management schemes if they are not meeting their goals. It should be noted, however, that adaptive management must tread carefully in this situation. Because of the certification and management requirements for this management option, there are a limited number of changes managers can make before they invalidate their crediting schemes and must move to a completely new plan. In addition, carbon credits are legally committed for a set number of years, limiting the amount of changes one can make without risking legal prosecution or losing profits. Thus, managers can use adaptive management, but must realize that this carries the risk of starting completely over from scratch; there is very little room for receiving “partial” benefits from carbon crediting.

There are several scenarios in the future which could lead to this management plan being changed, particularly in regard to the agricultural land. Currently, agriculture is more economically feasible. However, high carbon prices in the future and the possibility of converting afforestation lands to managed timber (or additional credits from long-lived timber products) means that, at some point, afforestation could become more lucrative. One could also gain benefit from hunting leases or even an unquantifiable benefit from additional wildlife habitat in general. Argument can also be made about the negative sociological effect on rural communities from loss of farmland, or the benefits from keeping foodsheds local and sustainable. These are options that land managers now can consider while keeping in mind the baseline achieved by these calculations. Change has less effect on the managed forest land. The use of carbon crediting requires ecological sustainability via certification, meaning that there is an environmental benefit to using carbon crediting; social benefits are unlikely to change. Thus, the profitability of using crediting is likely to be the most relevant factor in determining whether it continues.

Beyond the inherent difficulties of using true adaptive management in a carbon crediting framework, we have tried to include adaptive management principles as much as possible. By including several different management options under two different price scenarios, we can inform managers of some likely courses the carbon market will take, allowing them to minimize some of the uncertainty they might face and make decisions with the probable futures in mind. By exploring an option that turned out to be less optimal (afforestation on agricultural land), we have also ensured that managers are informed about their alternatives and that no assumptions have gone into planning. Because of the monitoring inherent to carbon crediting procedures and the tentative baseline set up by this report, managers will have the opportunity to accurately re-evaluate costs and benefits of using various options as the project goes on. Managers can also use these numbers as a jumping-off point to look at other aspects of these choices which may be harder to quantify. Entities like the relative social value of forests or farmland and the ecological value of forests or farmland are hard to put a dollar value on, but these numbers illustrate the monetary cost of choosing one over the other, helping one partially quantify the tradeoff. Ultimately, this is how this plan allows one to practice adaptive management. By establishing reasonable baselines under various likely scenarios, managers have a reference point for when new information is gathered or situations change, allowing them to make informed decisions.

Summary

The U.S. carbon market is currently a voluntary market. There is uncertainty in the current market as the CCX agreements ends in 2010, although it is assumed that the CCX will be renewed. While U.S. agricultural and forestry projects are not currently eligible under ECX and current compulsory standards, it is safe to assume that these projects will remain eligible, because the CCX is an existing and established platform for carbon transactions.

The future of the market is dependent upon Federal leadership and legislation. According to an analysis from the USDA Forest Service, “The absence of long-tem regulatory carbon constraints have kept buyers unmotivated in carbon markets, slowing the development of the required capital needed to sustain these markets. A well-defined, transparent, and credible federal cap-and-trade compliance program for reducing GHG emissions in the U.S. will help create clear price signals that are needed to attract the level of capital required to sustain a U.S. carbon market.” (Ruddel 2006)

It is unlikely that the U.S. will sign the Kyoto Protocol agreement which imposes global mandatory greenhouse gas reductions. However, several proposals in the U.S. legislature are under serious consideration for implementing mandatory cap-and-trade programs. GHGs have been declared a category pollutant in the U.S. And because the current administration is pursuing legislation to enact a mandatory cap-and-trade program, it is very likely that one of these proposals will be approved in the near future and greenhouse gas reductions will become mandatory in the U.S.

Under the current voluntary market, managing for carbon sequestration is not always profitable due to low prices and the additional costs required for enrollment and verification. However, under mandatory cap-and-trade legislation, the U.S. market prices for carbon credits would likely increase from the current \$2.59/mt CO2 to a price similar to the European compliance market price of \$27.17/mt CO2. At this time it is not certain how closely the U.S. market prices would match the ECX prices or how quickly this would occur after mandatory GHG emission reduction legislation is enacted. However, it is certain that higher carbon credit market prices would result in more serious consideration of alternative carbon sequestration management practices due to increased revenue opportunities.

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Appendix A: Financial Calculation Spreadsheets

Business as Usual (BAU)
- BAU loblolly (not printing out – similar to longleaf)
- *BAU longleaf (longleaf 2009)

Agricultural
- *BAU
- *CCX
- ECX

Afforestation
- *CCX
- ECX

Managed Pine Forest
- Loblolly CCX
- Loblolly ECX
- *Longleaf CCX (longleaf 2009)
- Longleaf ECX

CCX-ECX Prices
- CCX-ECX Price Predictions
- CCX Prices
- ECX Prices

* Indicates this spreadsheet is printed in the appendix.
The other spreadsheets are included on the enclosed CD.

Team Member Contributions

(In alphabetical order)

Brent Fogleman

- Initial draft of class Powerpoint presentation and merging team research
- GIS (spatial analysis and maps)
- Researched agricultural carbon sequestration
- Initial AG SEV under two price scenarios
- Wrote the final paper sections: abstract, introduction, agricultural proposal w/ ecological trade-offs

Deborah Hoffbeck

- Researched afforestation carbon sequestration
- Initial afforestation-SEV calculations under two price scenarios
- Researched expenses of carbon offsets for the team
- Outline for final paper, merging and editing sections
- For final paper: introduction to carbon markets, afforestation proposal w/ecological benefits, summary with future forecast.

Anne Riddle

- Wrote up the interim team summary
- Researched forest managed for carbon
- Wrote the final paper sections: Managed forestry proposal w/ ecological trade-offs, adaptive management

Joe Sullivan

- For class presentation and final paper, created math and charts
- SEV calculations for the timelines with income/expenses and carbon market price projections.
- For final paper: business as usual charts and descriptions, and excel spreadsheets.