Beyond the 10% Solution: Promoting Family Forest Management through Carbon Trading[1]

MoCARB: The Missouri Forest Carbon Working Group[2]
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[1] A study paper to develop a plan of action to facilitate enrollment of Missouri family forests in the Exchange Forestry Offsets program of the Chicago Climate Exchange.
[2] The author and participants in the planning study are listed at the end of the paper.

Preface

The existence of voluntary carbon trading markets in the United States reflects both the participants' desire for such a service and their anticipation of its eventual necessity. Some have questioned whether carbon trading is a "license to pollute". It is, but that license will become increasingly restricted when mandatory cap-and-trade of carbon emissions occurs. Market mechanisms are imperfect, but combined with some regulation, they worked to quickly and efficiently reduce sulfur dioxide emissions by electric power plants. For these reasons, the Introduction of this study discusses the philosophy and economics of carbon trading as it relates to forestry offsets.

Because the Kyoto Protocol recognized only afforestation and reforestation as legitimate forestry offset programs under its principle of additionality, managed forests were initially excluded from enrollment in the voluntary offset programs in the U.S. This situation has been redressed with the recent modification of the Chicago Climate Exchange's (CCX) Rulebook to offer Exchange Forestry Offsets (carbon credits) for managed forests. Vigorous efforts are underway to ensure that managed forests are included in the Lieberman-Warner Climate Security Act and similar legislation.

Regardless of its ultimate efficacy in mitigating global warming, carbon trading offers an unprecedented opportunity to promote sustainable forest management of family forests (nonindustrial private forests). It does this by its potential to offer economic incentives sufficient to offset the short-term profitability of liquidation and high-grade harvests. Current carbon prices alone are too low to achieve this, but that is expected to change when cap-and-trade occurs.

Because of the multiple social and economic benefits and ecosystem services of managed forests, we should prepare to take advantage of this opportunity by acting to facilitate the enrollment of family forests in carbon offset programs even now when the costs do not yet justify the economic returns. Arkansas has already initiated a statewide program through the joint efforts of the Arkansas Forestry Commission, University of Arkansas-Monticello, Natural Resources Conservation Service, and the Delta P2/E2 Center.

This study's objective is to identify the barriers to enrollment of Missouri's managed small (<200 ac) family forests in the CCX's carbon offset program and to develop a plan of action to minimize those barriers. The CCX was selected as the most accessible of rule-based carbon markets for managed forests. Nymex has recently announced its intention to trade carbon globally, and will likely be followed by other exchanges.

Afforestation, reforestation, and large managed forest projects are also eligible for the CCX's forestry offsets and clearly have value for carbon sequestration. Such projects are relatively easy to implement and therefore are not considered here.

It is not this study's purpose to address any perceived shortcomings in the rules of the CCX, but rather to work with what is available. The rules for managed forests were held up for months by discussion of how to discount uncertainty in the estimation of carbon sequestration. We can do much with what we now have.

While recognizing the particular environmental benefits of single-tree selection for crop tree management, consideration of the relative merits of even- and uneven-aged silvicultural methods for carbon sequestration is outside the scope of this study. The rules for enrollment of managed forests in the CCX's carbon offset program require persistent, sustainable, professional forest management. That is a considerable improvement on the present situation and worthy of promotion.

Summary

No other carbon sequestration activity can mitigate climate change with all of the other positive ancillary benefits that managed forests provide society. Clean water, air quality improvement, watershed stabilization, biodiversity, esthetics, wildlife habitat, wood products, maintenance of rural landscapes, and recreation are some of the valuable benefits provided by sustainably managed forests.

Among other factors, entry costs (mainly for a baseline inventory and management plan) and currently low carbon prices are barriers to participation of family forests in an offset program. When a federal cap-and-trade limit on carbon emissions occurs, carbon prices will rise to a level that will make sustainable forestry economically competitive in the short term with liquidation and high-grade harvests. In other words, market forces will create sufficient financial incentive to encourage broad and enthusiastic landowner participation in sustainable forestry.

Enrollment in a forestry offset program inherently requires sustainable forest management involving professional foresters and harvesters, improved harvest practices including adoption of Best Management Practices, and moderation of clear cuts to avoid carbon debits. The benefits and need for sustainably managed forests in Missouri are so great that public subsidy is justified to facilitate early participation by small landowners in the managed forestry offset program that is newly available on the Chicago Climate Exchange.

The following task list summarizes our analysis of what is needed to accomplish this mission; it should be do-able within six months.

- Assess the feasibility of reducing enrollment costs of family forestry offset projects with subsidies from carbon credit payments for state forests and the Ameren settlement paid to the Conservation Commission

- Increase the allocation for the EQIP practice Prescribed Forestry which pays for inventory-based forest management plans

- Conduct a study to select a cost-efficient and accurate forest inventory design for family forests

- Obtain software to estimate statistical confidence of volume estimates in MDC forest inventories at plot level

- Jump-start the assessment of ImageTree's ForestSense™ technology for baseline inventory of upland hardwoods with funding from the Ameren settlement

- Bundle provision of Forest Stewardship Planning and Missouri Tree Farm Group Certification, arrange mutual recognition, and implement group certification by creation of a Missouri Woodland Owners Association following review by MoFRAC

- Accelerate development of a Master Logger Certification program in Missouri with an independent, national board for final review

- Require forest or logger certification, as applicable, for receipt of any public funds

- Select approved aggregators for forestry offset projects subsidized by public funding

- Implement a campaign to educate family forest owners about the benefits and responsibilities of enrollment in a forestry offset project

Introduction

Forests and the carbon cycle

Carbon is added to the forest ecosystem as plants grow, and it is emitted as they die and decompose or burn. A portion of the carbon stored in forests is emitted when timber is harvested; another remains stored in the harvested wood. Carbon is moving in and out continuously, and the change in the net total of carbon in the system determines whether the forest is a source (net emissions to the atmosphere) or a sink (net sequestration from the atmosphere).[3]

Overall, for the United States, the sequestration services provided by forests are substantial. Forests accounted for 84% of carbon sequestration in the U.S. in 2005, compared with just 2% for agricultural soils.[4] U.S. forests sequester about 200 million metric tons of carbon each year, offsetting about 10% of annual U.S. emissions from burning fossil fuels. Meanwhile, deforestation worldwide contributes 18% of all CO_2 emissions.[5]

No other carbon sequestration activity can mitigate climate change with all of the other positive ancillary benefits that managed forests provide society. Clean water, air quality improvement, watershed stabilization, biodiversity, esthetics, wildlife habitat, wood products, maintenance of rural landscapes, and recreation are some of the valuable benefits from forests that are not found in other sequestration projects.[6]

Trading ecosystem services

Goods extracted from ecosystems have long been traded in markets. The services provided by ecosystems have been used for just as long but have remained extra-market and largely unpriced. To some extent, the environment and natural resources have been susceptible to an open access problem, whereby resources with poorly defined property rights (including forests, water, or grasslands), if not regulated in their use, can be accessed by all and used until exhaustion.[7]

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[3] Sampson, N., S. Ruddell, and M. Smith. 2007. Managed forests in climate change policy: Program design elements. Unpublished study paper. Not available online.
[4] Executive summary of the 2007 Draft U.S. greenhouse gas inventory report, available at http://epa.gov/climatechange/emissions/usinventoryreport07.html.
[5] Ruddell, S., R. Sampson, M. Smith, R. Giffen, J. Cathcart, J. Hagan, D. Sosland, J. Godbee, J. Heissenbuttel, S. Lovett, J. Helms, W. Price, and R. Simpson. 2007. The role for sustainably managed forests in climate change mitigation. J. For. 105: 314-319. Available at http://www.safnet.org/policyandpress/climate_change_mitigation.pdf.
[6] Smith, M. 2007. Carbon market opportunities for forest landowners, available at http://www.foreconinc.com/ecomarket/docs/CarbonMarketOpportunitiesForForestLandowners.pdf.
[7] Robbins, A. 2005. Ecosystem services markets. University of Washington, College of Forest Resources, Northwest Environmental Forum, Seattle, WA. Available at https://digital.lib.washington.edu/dspace/bitstream/1773/2244/1/tp12.pdf.

But just as in any market, an emerging scarcity can make ecosystem services potentially subject to trade. Major state, regional, national, and international scientific studies in recent years have shown how specific forest carbon changes qualify as fungible credits that can be used for meeting an entity's legal commitments to reduce carbon emissions.[3]

The European Union Emissions Trading Scheme was created in January 2005 in response to the adoption of the Kyoto Protocol. Using a cap and trade model, the EU expects to reduce overall carbon dioxide emissions by 12.5% by 2010.[7] Since adopting the Kyoto Protocol, Europe has experienced a growth in carbon markets. In June 2005, the Times of London reported that the city of London alone saw its daily trading in carbon emissions reach roughly US $71 million, with the price of carbon peaking at U.S. $51 per metric ton of CO_2 equivalent ($MTCO_2e$).[7,8]

Even though the decision not to sign the Kyoto Protocol has precluded U.S. participation in the rapidly developing greenhouse gas programs overseas, considerable progress has been made domestically. Across the country, federal, state, and other entities have worked to develop various greenhouse gas registries, cap and trade programs, and other market mechanisms. Registries provide the means to calculate, track, and report changes in GHG (greenhouse gas) emissions or increases in carbon storage over time. Carbon markets are a combination of the rules set from a registry and the platform on which carbon offset credits (usually $MTCO_2e$) are traded, or marketed to consumers.[6]

Markets for forestry projects internationally are very modest. Currently, the ability of forestry to participate within international markets outside the United States is severely constrained by Kyoto Protocol rules that apply only to afforestation and reforestation projects. Due to the absence of a comprehensive GHG regulatory regime mandating emission reductions, e.g. cap-and-trade legislation, U.S. carbon markets have been voluntary. Demand for forestry offset credits for afforestation and reforestation and managed forest projects has mainly been driven by voluntary markets developed by a wide variety of non-governmental organizations. These organizations work with established registries and buyers to market forestry offset projects.[9]

Despite the absence of mandatory emission reductions, GHG emissions trading in the U.S. has been actively occurring since December 2003 through the Chicago Climate Exchange (CCX). The CCX runs the world's first and North America's only comprehensive GHG trading program requiring its members to take on a legally binding GHG reduction commitment. As of September 2006, CCX's 210+ membership have traded volumes of over 12 million $MTCO_2e$. The CCX program is significant considering that the underlying emissions baseline registered in the CCX makes it second only to Germany's active CO_2 emission trading program.[9]

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[8] http://business.timesonline.co.uk/tol/business/article552446.ece.

[9] Ruddell, S., M.J. Walsh, and M. Kanakasabai. 2006. Forest carbon trading and marketing in the United States, available at http://www.foreconinc.com/ecomarket/docs/ForestCarbonTradingMarketing102306.pdf.

Potential value of Missouri forest carbon

In the absence of mandatory emission reduction requirements or knowing the price of carbon that may be obtained, the financial incentives to register direct emission reductions or sequestered carbon will remain elusive.[9] Nevertheless, it is useful to estimate the potential value of Missouri's forest carbon market to demonstrate the value of promoting its development.

Missouri's public and (generally unmanaged) private forests and their wood products sequestered 10.3 million $MTCO_2e$ annually.[10] At December 2007 carbon prices on the CCX, this would be worth more than $20 million. At the minimum $15 per $MTCO_2e$ expected when federal cap-and-trade legislation is implemented, sequestered carbon from Missouri's forests would be worth more than $150 million annually. This exceeds the stumpage value of saw timber in 2003 by 25%.[11,12] Harvested hardwood lumber contains carbon worth $42 per thousand board feet at a carbon price of $15 per $MTCO_2e$.[13]

Is forest carbon trading legitimate?[6]

Many stakeholders and policy groups argue that a sustainably managed forest is carbon neutral in the long term. These groups suggest that sustainably managed forests eventually reach an equilibrium condition where growth is very close if not equal to harvest plus mortality. This is conceptually correct. Domestic carbon markets however are not currently requiring indefinite commitments to the maintenance of carbon stocks.

As a result, one could argue that any landowner or managed forest carbon project owner that is willing to commit to a positive net flow of carbon from their ownership during the predetermined commitment periods associated with the current market opportunities should be allowed to access the market platform with legitimate credits. This is the ideology that has resulted in the base-year approach to additionality.

The base-year approach requires that a baseline estimate of total carbon stocks be developed in the first year of participation, after which net change is tracked annually. Any positive net flow of carbon on the project after the initial enrollment is considered a result of direct management choice and is therefore additional. The project owner may choose to either market or bank the resultant carbon credits

[10] Birdsey, R.A. and G.M. Lewis. 2003. Carbon in U.S. forests and wood products, 1987-1997: state-by-state estimates. U.S. Department of Agriculture, Forest Service, Northeastern Research Station, Newtown Square, PA. Gen. Tech. Rep. NE-310. 42 p. Available at http://www.fs.fed.us/ne/newtown_square/publications/technical_reports/pdfs/2003/gtrne310.pdf.
[11] Treiman, T.B. and R.J. Piva. 2005. Missouri timber industry—an assessment of timber product output and use, 2003. U.S. Department of Agriculture, Forest Service, North Central Research Station, St. Paul, MN. Resour. Bull. NC-250. 74 p.
[12] Missouri Department of Conservation. 2003. Missouri timber price trends. Quarterly Market Report 13(2), available at http://mdc.mo.gov/documents/forest/products/prices/20030401.pdf.

from year to year. Conversely, any negative flow of carbon on a registered project is also considered, resulting in a requirement to compensate the market.

Forest policy objectives

Two key policy objectives for the forestry community and policymakers should include (i) keeping forests in forests and (ii) sequestering more carbon through sustainable forest management. Achieving these objectives can result in powerful new incentives for landowners to maintain forests and manage them sustainably.[5]

Resource values drive investments. A basic principle of forest resource economics is that forest ecosystems will remain forested as long as the values (wood products, clean water, clean air, and biodiversity) gained are greater than the opportunity costs of converting the forest to an alternative land use.[5]

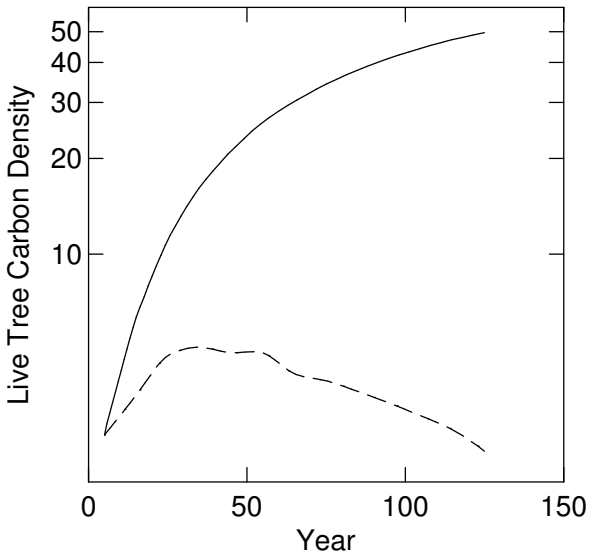

Figure 1. *Carbon stocks in live trees (total above-ground plus coarse roots) for oak-hickory stands on forest land after clear-cut harvest in the Northern Prairie States.[13] Cumulative (solid line) and incremental (dashed) carbon sequestration (metric tons C per acre) at decadal intervals are shown. A logarithmic scale on the vertical axis better displays temporal trends in incremental sequestration. Annual carbon sequestration peaks after 35 years and then falls off even as carbon stocks continue to accumulate for 125 years.*

Stand growth dynamics tell us that any unmanaged forest will eventually stop sequestering additional net carbon as it reaches biological maturity, where sequestered carbon equals emitted carbon through decay (Figure 1).[13] If a forest is sustainably managed past the point of biological maturity, then harvesting can be an effective tool for improving forest health while sequestering more carbon than an unmanaged forest.

[13] Smith, J.E., L.S. Heath, K.E. Skog, and R.A. Birdsey. 2006. Methods for calculating forest ecosystem and harvested carbon with standard estimates for forest types of the United States. U.S. Department of Agriculture, Forest Service, Northeastern Research Station, Newtown Square, PA. Gen. Tech. Rep. NE-343. 216 p. Available at http://www.fs.fed.us/ne/newtown_square/publications/technical_reports/pdfs/2006/ne_gtr343.pdf.

Limiting deforestation is particularly important as deforestation releases more carbon than forestation sequesters in terms of discounted quantities.[14] In all cases, forestation of an equivalent area of land would sequester two to nine times more carbon over a 30-year period than the emissions avoided by the use of various biofuels grown on converted forestland.[15]

Of the biofuel sources examined, only conversion of woody biomass might be compatible with retention of forest carbon stocks. By harvesting from standing forests, soil and above-ground carbon stocks may be built up in parallel with sustainable biomass extraction for fuel production.[15]

Cost of carbon sequestration

In the environmental context, opportunity cost is a measure of the value of whatever must be sacrificed to prevent or reduce the chances of a negative environmental impact. Opportunity cost typically does not coincide with monetary outlays—the accountant's measure of costs. This may be because out-of-pocket costs fail to capture all of the explicit and implicit costs that are incurred, or it may be because the prices of the resources required to produce an environmental improvement are themselves an inaccurate indication of the opportunity costs of those resources. Hence, the costs of a climate policy equal the social benefits that are foregone when scarce resources are employed to implement that policy, instead of putting those resources to their next best use.[14]

A systematic, normalized comparison of sequestration supply estimates in the forestry sector from eleven national studies produced a range of $9 to $27 per $MTCO_2e$ for programs sequestering 500 million tons of carbon annually. The comparison included only those studies that estimated sequestration costs associated with modified management of existing forests or conversion of agricultural land to forests or agroforestry.[14]

A 500-million-ton-per-year sequestration program would be very significant, offsetting approximately one-third of annual U.S. carbon emissions. At this level, the estimated costs of carbon sequestration are comparable to typical estimates of the costs of emissions abatement through fuel switching and energy efficiency improvements.[14]

Forest management to increase carbon sequestration has substantially lower marginal costs than afforestation of pasture or agricultural management.[16] This

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[14] Stavins, R.N. and K.R. Richards. 2005. The cost of U.S. forest-based carbon sequestration. Pew Center on Global Climate Change, Arlington, VA. 40 p. Available at http://www.pewclimate.org/docUploads/Sequest_Final.pdf.

[15] Righelato, R. and D.V. Spracklen. 2007. Carbon mitigation by biofuels or by saving and restoring forests? Science 317: 902.

[16] Walker, S.M., S. Grimland, N. Sampson, B. Sohngen, J. Winsten, J., and S. Brown. 2007. Comparison of terrestrial carbon mitigation options in the northeast United States. Ch.6 *in* Terrestrial carbon sequestration in the Northeast: Quantities and costs. Winrock International, The Nature

should make forest management an attractive option to policymakers outside the forestry community.

CCX enrollment requirements and implications

Offset projects involving less than 10,000 $MTCO_2e$ per year must be registered and sold on the CCX through an offset aggregator.[17] This will require aggregation from about 17,000 ac of upland hardwoods in numerous family forests in Missouri.[18]

The offset aggregator will be responsible for performing necessary audits, arranging their verification, and performing the necessary transactions on the Exchange for a fee to be withheld from the carbon credit payment. Therefore, the following discussion focuses on the enrollment requirements that must be met by the owners of family forests, and their implications, especially in terms of up-front costs. Findings of special relevance to develop an action plan for facilitating participation of family forests are italicized.

Approach to additionality

The CCX has adopted a baseline approach to additionality which credits net changes in carbon stocks in living trees above and below ground (coarse roots only) after the baseline value is established on enrollment. The net change in carbon stocks is defined by the equation:

> Net change in Carbon Stocks = (increases in Carbon Stocks due to growth) minus (the quantity by which Carbon Stocks decreased due to harvest, pest, fire and adverse weather events).[19]

Quantification of net changes in managed forest carbon stocks must involve a model based accounting approach to qualify for credits with the CCX. *The field inventories required for compliance are expected to be among the most expensive of the enrollment requirements for small family forests to participate in a carbon offset program.*

Two accounting approaches are permitted by the CCX: (i) baseline forest inventory data processed by an approved growth and yield model (GYM) to estimate annual changes in biomass which are then converted to carbon equivalents and (ii) annual

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Conservancy, and The Sampson Group. Report to: US DOE-NETL Cooperative Agreement DE-FC26-01NT41151. Available at http://conserveonline.org/workspaces/necarbonproject/The%20Report/Part%206%20-%20Northeast%20Carbon%20Opportunities.

[17] http://www.theccx.com/content.jsf?id=23.

[18] Becker, P. 2008. Sample size requirements for estimation of carbon sequestration in Missouri's managed family forests. Unpublished report.

[19] Chicago Climate Exchange. 2006-07. CCX rulebook Chapter 9: Offsets and early action credits, available at http://www.theccx.com/docs/offsets/CCX_Rulebook_Chapter09_OffsetsAndEarlyActionCredits.pdf.

inventories from which changes are calculated by measured differences between years.[19]

The GYM approach is the only practical method at this time for family forests because annual inventories are too expensive for small acreages.[18] The GYM method requires just a single inventory, but if biomass volume is substantially reduced by a harvest or other event, the forest must be inventoried again to re-set the GYM.

The GYM approach was the basis of proposals submitted to the CCX for managed forests in Michigan and Arkansas.[20,21] The Forest Vegetation Simulator[22] (FVS) is an example of a CCX-approved GYM.

Note that credit is given only for net increment of carbon, not for starting stocks. If a net decrease in carbon occurs, the account is debited. Although allowing harvest can increase the cost of carbon sequestration,[14] this may be justified by forest management or other considerations. *If an excessive harvest occurs, the landowner will owe the aggregator carbon offsets, which will require a cash purchase or return of forestry offset credits to satisfy. To a degree, the aggregator can mitigate such expenses by controlling the timing and degree of harvests.*

Not all of the carbon in harvested wood is debited. A portion (30% for hardwood saw logs and pulpwood in the North Central Region) of carbon in long-lived wood products produced from sustainably managed forests is credited.[19] *Because the landowner and ultimately the aggregator are responsible for carbon lost during harvest, it is important that contracts stipulate that the landowner retains ownership of carbon in all harvested wood products. This is also relevant in the context of renewable energy credits.*

The carbon debit incurred during harvest places a strong constraint on the amount of clear cutting or intense harvesting tolerated for managed forests in an offset program. The carbon sequestration rate in Missouri's oak-hickory forests is just over 1% of the standing carbon stock that would be removed by a clear cut, after allowing for the (undebited) portion allocated to long-lived wood products.[10,18] Thus, for every clear-cut acre, 80 unharvested acres would be required to assure net zero carbon loss. This corresponds approximately with the rotation cycle for even-aged management, and therefore would guarantee sustainability of production. Profitable carbon trading, however, would require substantially less clear cutting.

20% of earned Exchange Forestry Offsets (XFOs = carbon credits) must be placed in a Forest Carbon Reserve Pool which remains the property of the project owner. All XFOs not terminated by CCX (in the event of a catastrophic loss) will be released

[20] The Delta Institute. 2007. Michigan forest carbon offset and trading program: Enrollment instructions, available at http://www.p2e2center.org/documents/WorkingForestsEnrollmentPackage.pdf.
[21] The Delta Institute. 2007. Arkansas working forest carbon offset and trading program: Enrollment instructions. (G. Rheinhardt, Arkansas NRCS, pers. comm., 7 Nov. 2007).
[22] http://www.fs.fed.us/fmsc/fvs/.

to the Project Owner during 2010. Should CCX extend beyond 2010, the Forest Carbon Reserve Pool will be maintained for projects that elect to remain enrolled in CCX.[19] *The reserve pool requirement means that payment for a substantial portion of earned carbon credits will be delayed.*

Retroactive enrollment back to 2003 is possible for managed forest projects. The methods by which this will be determined are subject to approval by the CCX Forestry Committee.[23] *This allows substantial carbon credits to be earned, provided that the GYM or some other procedure is capable of back-growing and handling possible harvests between 2003 and the baseline inventory.*

A relative diameter growth model has been developed to allow prediction of both future and past growth rates with negligible bias in the northeastern U.S.[24] The model uses a minimum amount of field-collected data (DBH, crown ratio, and an indicator of mortality), thus keeping data acquisition costs low and facilitating its use in retroactive estimation of carbon sequestration rates.

Discounting estimation error

To account for the lower precision of the GYM estimates, the carbon change estimate is discounted for the GYM approach, but not for the annual inventory method. Thus, according to the CCX Rulebook, growth and yield model estimates of net annual changes in carbon from a forestry project will be discounted to account for variance in model estimates by the lesser of 20% or two times the reported statistical error of the baseline inventory data, where statistical error is defined as the two-tailed, 90% half-confidence interval divided by the mean.[19,23,25]

Based on observed variation in forest inventories and practical sampling intensities, family forests of less than 300 ac. are likely to incur the maximum discount of 20% with a corresponding economic loss.[18] Quantification of baseline and net change in carbon stocks must be accounted separately for each project owner at the stand level within a registered pool of managed forest projects.[19] However, *CCX rules do not prohibit calculation of the statistical error at the pooled project, rather than the individual project level. This would likely reduce the discount ten-fold.*[18]

The current version of software employed by the Missouri Department of Conservation for forest inventories calculates timber volume at the stand level by averaging the plot volumes, which are not archived. This makes it impossible to estimate the statistical error, as required under CCX rules. Also, the 10-basal area factor prism plots commonly used by public and private foresters are probably less accurate than 20-factor plots, and this matter needs to be resolved in the context of identifying the most efficient sample design.[18]

[23] J. O'Hara, Chicago Climate Exchange, pers. comm., 21 Dec. 2007.
[24] Westfall, J.A. 2006. Predicting past and future diameter growth for trees in the northeastern United States. Can. J. For. Res. 36: 1551-1562.
[25] J. O'Hara, Chicago Climate Exchange, pers. comm., 11 Dec. 2007.

Sustainability and commitment

Upon registration, forest offset providers or offset aggregators must present to CCX an attestation that the carbon stocks in the managed forest project will be subject to long-term maintenance in a manner deemed acceptable by the CCX Forestry Committee. This includes a contractual agreement between the aggregator and each participating landowner to maintain the enrolled land in an approved sustainable certification program for at least 15 years from enrolled date and a signed letter of intent from each registered landowner.[19]

Certification programs approved by the CCX are American Tree Farm System (ATFS) Group Certification, Sustainable Forestry Initiative (SFI), and Forest Stewardship Council (FSC). *Of the CCX-approved programs, ATFS certification is economically the most attainable for family forest owners because it is subsidized by the American Forest Foundation and foresters who donate their time.*

ATFS is in the process of obtaining endorsement for both its individual and group certification schemes by PEFC.[26] PEFC (Programme for the Endorsement of Forest Certification schemes) is a global umbrella organization for the assessment of and mutual recognition of national forest certification schemes developed in a multi-stakeholder process.

ATFS is working with ANAB to set up an accreditation system for certification bodies.[26] ANAB (ANSI-ASQ National Accreditation Board) accredits management systems certification bodies for ISO 9001, ISO 14001, and national/international standards in the U.S. Once complete, all group certification audits and Tree Farm program audits will have to be done by an ANAB accredited certification bodies (essentially the same auditors accredited to do SFI audits).

Compliance with PEFC and ANAB standards will require periodic third-party audits of ATFS-certified forests. Passing the cost of these audits on to individual landowners will be a decision of the ATFS group, but individual certification will remain free of charge. Identical criteria will apply to group and individual certification, and ATFS will work out approval of its individual certification scheme with the CCX.[26]

Managed forests are not required to be placed under a conservation easement, nor does the latter preclude enrollment in a forest offset project.[27]

[26] L. Sandler, American Tree Farm System, pers. comm., 7 Jan. 2008.
[27] Land Trust Alliance. 2004. Land trust standards and practices. Land Trust Alliance, Washington, DC. 19 p. Available at http://www.lta.org/sp/land_trust_standards_and_practices.pdf.

Just around the corner

Remote sensing break-through

A recent combination of remote sensing technologies promises to transform forest inventories and management. This system has been proven on coniferous plantations, and efforts are underway to extend it to hardwood forests. ImageTree's patented ForestSense™ inventory system includes:

- Collecting images through remote sensing- LiDAR and Color Infrared
- Defining stands by analyzing these images
- Assessing every visible tree crown in the stands with software
- Correlating tree crown images with random ground sampling
- Extracting key forest inventory analysis data and combining it with biometric models to determine key inventory information like diameter breast height, species, grade, volume and trees per acre on a statistically sound basis
- Reporting forest data by acre, stand and/or property that is used to make the site-specific forest management decisions required for precision forestry[28]

An application has been made to the CCX for approval of this inventory system's use in forestry offset projects, and a positive response is expected.[29] Laser data alone were able to detect a significant volume growth in coniferous forest over a two-year period although the predictions were biased and the precision was low.[30]

It remains to be seen whether the ForestSense™ system can detect annual growth changes in upland hardwood forest, but at a minimum it seems likely to provide baseline biomass inventory data for estimation of carbon sequestration at an initial cost of $5-10 per acre.[29] *This compares very favorably with the per acre cost of traditional inventories of 100-ac. family forests.*[31] The ForestSense™ price includes annual updates for five years which could detect harvests and greatly simplify monitoring of forestry offset projects.

ForestSense™ could replace or usefully supplement a ground-based Continuous Forest Inventory and would facilitate harvest and other forest management planning.

[28] http://www.imagetreecorp.com/faq.html.
[29] C. Anderson, ImageTree Corp., pers. comm., 18 Dec. 2007.
[30] Næsset, E. and T. Gobakken. 2005. Estimating forest growth using canopy metrics derived from airborne laser scanner data. Rem. Sens. Environ. 96: 453–465.
[31] T. McAbee, Clearwater Forest Consultants, LLC, pers. comm., 13 Dec. 2007.

Master Logger Certification

Maine has a Master Logger program that was the first to offer third-party certification of logging companies' harvesting practices. The certification system is built around standards that have been cross-referenced to all major green certification systems and local Best Management Practices.[32]

Field verifiers visit actual harvest sites to determine whether candidates are meeting and exceeding certification standards. Their findings are submitted to an independent, national board that makes the final decision on whether a company will be certified.

To remain a Maine Master Logger, each company must be recertified every two years. There are also random audits between recertifications, a continuous improvement process for upgrading skills within the company, and an attitude of partnership with other forest professionals and their associations.

In 2002, Maine's pioneering effort in designing and implementing the Master Logger Certification Program was unanimously adopted as the national model for logger certification by the 27 state associations in the American Logging Council. As of July 2006, seven states (Wisconsin, Massachusetts, Minnesota, Michigan, Rhode Island, Vermont, and Connecticut) and three Canadian provinces (New Brunswick, Nova Scotia, and Prince Edward Island) are implementing Master Logger programs based on the Maine model.

Logger certification is not required for forestry projects enrolled in the CCX, but it would simplify the responsibilities of the forest owner and offset aggregator to ensure sustainability when harvests occur in such projects. Logger certification would have numerous additional benefits extending beyond forestry offset projects by offering a cost-efficient mechanism for third-party audits of biomass harvests and generally improving the quality of harvest practices and the professionalism of loggers.

Action plan

Reduce entry costs

In aligning the interests of private parties with those of government, it is generally most cost effective to provide outcome-based incentives. In this context, that means rewarding actual increases in carbon sequestration rather than, for example, practices that might be more or less correlated with increased sequestration. By rewarding outcomes, government maximizes the incentive for individuals to innovate and select practices that match local conditions. Conversely, policies that

[32] http://www.masterloggercertification.com/.

depart from directly rewarding carbon sequestration are likely to create inefficiencies and will therefore be less cost-effective.[14]

Forest offset projects enrolled in the CCX are inherently known to have increased carbon sequestration. By lowering entry costs for family forest owners, direct payments targeted at landowners interested in management aimed at increasing carbon uptake could help facilitate their immediate participation in the carbon trading market and the attendant benefits of sustainable forest management.[7]

The main expense faced by landowners will be for the baseline forest inventory and management plan. There are also fees to be paid to the aggregator and the CCX. Although payment for retroactive carbon credits could result in a high initial return, 20% of all payments will be postponed until completion of the contract to meet the reserve pool requirement. Estimated expenses and returns for a medium sized family forest are shown in Table 1.

Table 1. *Net Present Value (NPV) in 2008 for a 100-ac family forest enrolled in the CCX's offset program under two scenarios.[33] The near-term scenario assumes the current carbon price and an inventory and management plan prepared by an agency forester at no cost. The intermediate-term scenario assumes a low carbon price under mandatory cap-and-trade and commercial costs[31] for inventory and plan prepared by a consultant forester in 2008. Both scenarios assume a carbon sequestration rate of 0.6 $MTCO_2e$/ac/yr,[18] a 10% aggregator's fee, a \$0.25/ $MTCO_2e$ verification fee, no charge for forest certification, and a 5% hurdle rate. No allowance is made for a possible discount of carbon sequestration proportional to statistical uncertainty in the baseline estimate of beginning carbon stock. The contract runs eight years from 2003 through 2010 with annual payments and a balloon payment in the final year when the Forest Carbon Reserve Pool is sold.*

	Near-Term	Intermediate-Term
Payment ($/MTCO2e)	2.00	15.00
Inventory Cost ($/ac)	0.00	12.00
Mgmt Plan Cost ($/ac)	0.00	18.00
Average NPV ($/ac/yr)	0.89	4.45
Total NPV ($)	700	3600

At current carbon prices, family forest enrollment in the CCX is barely profitable when inventory and planning is free. However, the CCX's Exchange Forestry Offsets can be banked until prices rise, and they can also be deregistered if other markets offer a higher price. Given all the non-economic benefits associated with enrollment in a managed forestry offset program, there is every reason to facilitate immediate enrollment.

In a grant-funded pilot program, the State of Michigan Department of Natural Resources and the Delta P2/E2 Center established a revolving Technical Assistance Fund to pre-pay enrollment expenses of private forestry projects. The loans to

[33] Based on a spreadsheet prepared by T. McAbee, Clearwater Forest Consultants, LLC, pers. comm., 11 Jan. 2008.

landowners from the revolving fund will be reimbursed by withholding from the initial carbon credit payments.[20] To keep the fund going, landowners are required to sell their carbon credits in the year earned even though the price may be unfavorable.

An alternative proposed at a stakeholder meeting for revision of the State Forestry Law in June, 2007 was for MDC to enroll its forestland in the CCX and use the new earnings to pay for enrollment of family forests. This would require a commitment to earmark the carbon credit payments, which must be paid into the general fund under current policy. It would also take advantage of MDC's intention to obtain SFI and FSC certification of state forests.

Another issue raised by this proposal is whether MDC's enrollment would trigger an emission reductions requirement. As a rough guide, the CCX allows organizations with less than 10,000 $MTCO_2e$ of annual emissions to register as offset providers without having to undertake an emissions reduction commitment.[23]

A potential, one-off source of funds is the $6 million awarded to the Conservation Commission by the Taum Sauk settlement with Ameren UE. Just one-sixth of this would pay for forest inventories of one thousand 100-ac family forests by forest consultants, and help to invigorate this private forestry sector. The multiple benefits of sustainable forest management should facilitate inter-Division cooperation on this matter.

Prescribed Forestry is a newly created EQIP (Environmental Quality Incentives Program) practice that pays for an inventory-based forest management plan. Interest was strong in this practice during the 2007 signup, but only a third of all forestry practice applications were funded and less than $80,000 was allocated to Prescribed Forestry.[34] An argument could be made that funding for forestry practices should be preferentially allocated to Prescribed Forestry and that the overall allocation to forest management should be increased.

Other potential funding sources for forest inventories and management plans include the Missouri Farm Bureau and the Missouri Farmers Union with their broad farmer membership. Once funding sources to subsidize enrollment costs have been identified, it will be necessary to decide whether payments should be cost-share or a loan. If a loan, then the timing of repayment will need consideration in the context of carbon prices.

Improve forest inventory design

Based on available information, the most cost efficient and accurate forest inventory design for family forests is likely to be 20-BAF (basal area factor) prism plots.[18] This would require conversion from the predominant usage of 10-BAF plots by both public and private foresters.

[34] G. Sallee, Missouri NRCS State Office, pers. comm., 28 June 2007.

Fixed area plots of 24-ft radius are nearly as cost efficient as 10-BAF plots, and might be more suitable for measuring sub-commercial size classes.[18] Pole-sized trees are expected to sequester 20% or less of above ground carbon.

A comprehensive study is required to settle these questions before settling on an inventory design for family forests. Existing data from the MOFEP (Missouri Ozark Forest Ecosystem Project) acorn plots will be used for an initial study of trees at least 5 in. in diameter.[35] The results would also aid the design of a Continuous Forest Inventory being explored to meet certification requirements for state forests[36] and a statistically sound management system for the Mark Twain National Forest.[37]

MDC's forest inventory software does not provide an estimate of statistical error (coefficient of variation of tree volume at plot level)[18] as required for enrollment of forestry offset projects in the CCX. This needs to be addressed either by purchase of commercial software or modification of the existing program.

Although ImageTree's ForestSense™ technology is unproven for upland hardwoods, it is very promising and its developers are highly motivated to make this happen by the recent eligibility of managed forests for carbon credits. Rather than waiting for a grant to fund this process, the Ameren settlement money offers a unique opportunity to quickly assess the suitability of this technology for baseline inventories and other forest management and monitoring activities.

Such a project would provide an opportunity for collaboration between MDC's Forestry and Resource Science Divisions on a ground breaking project of national significance. The MOFEP area might prove especially suitable because of its intensive ground inventories during the past two decades, and the cost of covering its 100,000 ac.[38] with continuous north-south flight paths would be less than $1 million.

If the ForestSense™ technology proves suitable, it would not be cost efficient if applied to individual family forests. Economies of scale could be achieved through inter-agency cooperation to simultaneously contract for large blocks of imaging.[29] Thus, MDC, Forest Service, and possibly NRCS would pay for imaging of areas of interest and the interstices comprising private forest land could be processed on an as-needed basis for enrollment of family forests in offset programs. This could greatly reduce inventory costs for family forest owners and facilitate monitoring of offset projects by aggregators.

[35] T. Nichols and R. Jensen, MDC, pers. comm., 18 Jan. 2008.
[36] L. Barnickol, MDC, pers. comm., 30 Nov. 2007.
[37] M. Schanta, Mark Twain National Forest, pers. comm., 21 Dec. 2007.
[38] B. Fisher, MDC, pers. comm., 21 Dec. 2007.

Facilitate certification

MDC foresters prepare the majority of inventory-based Forest Stewardship Plans and perform the majority of Missouri Tree Farm certifications.[39] These activities can and should be bundled, and receipt of any public funding for forestry practices should be contingent on forest certification or at least tied to an opt-out system.

To complement this integration, Missouri Tree Farm should formally recognize Forest Stewardship Plans as meeting its criteria for a management plan and should implement the newly created ATFS Group Certification.[40] The recently proposed statewide Missouri Woodland Owners Association[41] would be a logical vehicle for this process, which should be reviewed by the Missouri Forest Resource Advisory Council (MoFRAC) because of its comprehensive nature.

The process of developing a Master Logger Certification program in Missouri should be accelerated because it will improve harvest practices generally and better assure compliance with forestry offset project requirements. It is essential that an independent, national board be established for final review to ensure credibility. Again, any public funding, including tax credits, should be contingent on certification.

Select aggregators

If public funding is used to reduce costs to enroll family forests in a forestry offset project, then only those aggregators registered with the CCX and able to provide a CCX-approved GYM capable of back-growing and allowing for harvests should be approved for participation in such projects. Approved aggregators should also have a detailed plan to compensate for carbon loss due to harvests in pooled projects.

Approved aggregators should estimate statistical error at the pooled project, rather than the individual project level to reduce the discount of carbon credits to project owners. They should indicate their willingness to deregister XFOs on the CCX if other markets paying higher carbon prices become available. Contracts should stipulate that the forest owner retains ownership of carbon in all harvested wood products, absent any agreement to the contrary in the harvest contract.

Educate forest landowners

Mature carbon markets will help to maintain forest lands in family ownership by providing immediate economic benefits. A survey of 260 offspring of Wisconsin forest owners ranked payment for ecosystem services second only to tax relief in this regard.[42]

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[39] M. Jones, MDC, pers. comm., 16 Oct. 2007.
[40] http://www.treefarmsystem.org/cms/pages/26_19.html.
[41] http://agebb.missouri.edu/agforest/archives/v11n4/gh4.htm.
[42] C. Mater, The Pinchot Institute, pers. comm., 29 Jan. 2008.

A broad and intensive campaign to educate family forest owners about the benefits and responsibilities of enrollment is a forestry offset project should be initiated. It is especially important to advise forest owners about the implications of a harvest, which could result in carbon debits, rather than credits. Such a campaign could usefully combine participation by state and federal land management agencies, university extension, the forest products industry, and forest landowner groups.

Thinning from below increases merchantable volume production rates 50% over unthinned hardwood stands while maintaining equivalent carbon sequestration rates.[43] Thinning from above (high-grade) decreases merchantable volume and reduces carbon sequestration. Carbon sequestration by pole-sized and smaller trees in unharvested MOFEP control plots in upland oak-hickory forest is effectively zero due to competition-induced mortality.[44] Landowners will benefit from education about the consequences of different management practices for timber production and carbon sequestration.

Execute task list

The following task list summarizes the above analysis and should be do-able within six months.

- Assess the feasibility of reducing enrollment costs of family forestry offset projects with subsidies from carbon credit payments for state forests and the Ameren settlement paid to the Conservation Commission

- Increase the allocation for the EQIP practice Prescribed Forestry which pays for inventory-based forest management plans

- Conduct a study to select a cost-efficient and accurate forest inventory design for family forests

- Obtain software to estimate statistical confidence of volume estimates in MDC forest inventories at plot level

- Jump-start the assessment of ImageTree's ForestSense™ technology for baseline inventory of upland hardwoods with funding from the Ameren settlement

- Bundle provision of Forest Stewardship Planning and Missouri Tree Farm Group Certification, arrange mutual recognition, and implement group certification by creation of a Missouri Woodland Owners Association following review by MoFRAC

[43] Hoover, C. and S. Stout. 2007. The carbon consequences of thinning techniques: Stand structure makes a difference. J. For. 105: 266-270. Available at http://nrs.fs.fed.us/pubs/jrnl/2007/nrs_2007_hoover_001.pdf.
[44] J. Kabrick, USDA Forest Service, pers. comm., 16 Jan. 2008.

- Accelerate development of a Master Logger Certification program in Missouri with an independent, national board for final review

- Require forest or logger certification, as applicable, for receipt of any public funds

- Select approved aggregators for forestry offset projects subsidized by public funding

- Implement a campaign to educate family forest owners about the benefits and responsibilities of enrollment in a forestry offset project

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