Managed Forests in Climate Change Policy: Program Design Elements[1]

Authors and Participants[2]

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The individuals and organizations that participated in the development of this paper are in general agreement with the underlying principles and intent of these design elements and preferred options. Participation and consensus do not, however, indicate official adoption of these or any other climate policy options by the organizations, whose internal policy development processes must, in most cases, still be carried out. It is the intent of the participants, however, to provide a useful and thoughtful tool that all organizations, including the broader conservation and policy community, can consider as part of their internal discussions.

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[1] A study paper to identify and reach consensus on the inclusion of forests and forestry activities in public policies on climate change.

[2] The authors and organizations represented in the policy discussions are listed at the end of the paper.

Introduction

As policymakers at state, federal, and international levels seek ways to reduce greenhouse gas emissions to mitigate the effects of global climate change, the role of forests and forestry has been much discussed. Forests sequester carbon as they grow and convert atmospheric carbon dioxide (CO_2) to stable forms, such as carbon in wood and soil organic matter. Some of the wood from managed forests is converted into forest products, where it can remain sequestered for long periods.[3]

Thus forests are important environmental and economic contributors as people and nations work to constrain the growth in atmospheric greenhouse gases. As forestlands face increasing population pressures and land-use change, public policies that encourage their maintenance and sustainable management can be a significant part of global greenhouse gas mitigation efforts.

There is little controversy in the idea that forests store carbon in both live and dead trees, both above and below ground, as well as in understory plants, on the forest floor, in forest soils, and in forest products. 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). Overall, for the United States, the sequestration services provided by forests are substantial. Currently, it is estimated that U.S. forests sequester about 10 percent of the industrial emissions of greenhouse gases. This equates to more than 200 million metric tons of CO_2 equivalents per year.[4]

In addition to climate mitigation, many other environmental values are provided by well-managed forests: wildlife habitat, biodiversity, water quality protection, watershed stabilization, air quality improvement, and maintenance of rural landscapes. These ecosystem services are increasing being monetized and traded. 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 industrial firm's legal commitments to reduce emissions.

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[3] It is not the purpose of this paper to synthesize the vast and growing literature on forest carbon sequestration, its extent, accounting methods, and current trends. Some recent sources include Birdsey, R.A. 2006. Carbon accounting rules and guidelines for the United States Forest Sector. *Journal of Environmental Quality* 35: 1518-1524; Cathcart, J., and M. Delany. 2006. Carbon accounting: Determining carbon offsets from projects, 157-174 in *Forests, Carbon and Climate Change: A Synthesis of Science Findings*, Portland, OR: Oregon Forest Resources Institute. Available from http://www.oregonforests.org/media/pdf/CarbonRptFinal.pdf; Richards, K.R., R.N. Sampson, and S. Brown. 2006. *Agricultural and Forestlands: U.S. Carbon Policy Strategies.* Arlington, VA: The Pew Center on Global Climate Change; Smith, J.E., L.S. Heath, K.E. Skog, and R.A. Birdsey. 2006. M*ethods for Calculating Forest Ecosystem and Harvested Carbon with Standard Estimates for Forest Types of the United States.* Gen Tech Rep NE-343. Newtown Square, PA: USDA Forest Service, Northeastern Research Station.

[4] Helms, J.A. 2007. Testimony before the House of Representatives Select Committee on Energy Independence and Global Warming, April 26.

Many terms used in emissions and sequestration reporting have specific meanings. Throughout this paper, three terms have the following meanings:

- *Entity-wide reporting.* Reporting that includes complete greenhouse gas accounting for the entire business entity. That may include, for an entity that has forestland, accounting for the carbon sequestration on that land, which may serve to offset some of the entity's emissions.
- *Forest-wide reporting.* Reporting that covers all the forests within a forest ownership or within a defined forest management unit. For example, an owner with land in both the South and the Northeast may manage those forests separately and choose to do reporting on a regional basis.
- *Project reporting.* Reporting on the carbon stock changes within a specific project area. For example, for a tree-planting project on cropland that is part of an ownership that has other forests, the reforestation would be reported separately.

One of the major efforts carried out in the United States has been the development of guidelines to implement the Department of Energy's Voluntary Greenhouse Gas Reporting System. As part of the recent revisions of this system (known as Section 1605(b) in the 1992 Energy Act, which authorized it), the Department of Energy, Department of Agriculture, and Environmental Protection Agency worked with a variety of stakeholders to develop standard methods for measuring, monitoring, and reporting the carbon sequestration and emissions reduction capabilities of forests.

Although the Section 1605(b) program requires entity-wide reporting of direct emissions, the program design elements in this paper are not intended to support entity-wide reporting. Rather, we discuss how forest-wide and project reporting, as provided in Chapter 1, Part I of the 1605(b) guideline Appendix,[5] might appropriately be used in a climate change program.

Several of the emerging greenhouse gas reduction programs in the United States have developed or will be developing protocols under which forest carbon credits can be counted as an offset to industrial carbon dioxide emissions. This policy development stage defines how the various forms of carbon sequestered in a forest can become the legal equivalent of a greenhouse gas emissions reduction, and it is the critical step in establishing whether and how forest managers can demonstrate legal equivalency. It is imperative that forestry interests participate in the process of any forestry protocol or carbon offset policy development to establish rules that are scientifically sound and feasible for forest managers.

Design Elements

Any program that uses carbon credits as a tool to help reduce atmospheric greenhouse gases needs to address the following questions.

1. What kinds of forestry activities or projects will be eligible for creating carbon credits?

[5] Technical Guidelines for Voluntary Reporting of Greenhouse Gas Program, Chapter 1, Emission Inventories, Part I Appendix: Forestry, March 2006, page 13. Available at http://www.pi.energy.gov/enhancingGHGregistry/documents/January2007_1605bTechnicalGuidelines.pdf.

2. Which of the various “pools” of carbon in the forest can (or must) be measured to demonstrate net changes?
3. How, and how often, should those pools be estimated or measured and reported to the trading authority?
4. How are the net changes that will qualify as carbon credits to be calculated? This may be the most critical issue of all because it brings into play several important concepts:
    a. How should the baseline be established so that the reported credits meet requirements for additionality?
    b. What can ensure that the reported credits are not compromised by leakage that occurs elsewhere as a result of these forest activities?
    c. How long will these forest credits be valid—a few years, or 100 years, or longer?
    d. Are forest carbon credits equivalent to industrial emissions, and if not, should their value be discounted in the marketplace?

Project Eligibility

Concept

Only those forestry projects that can be clearly defined and transparently measured in terms of net carbon change should be included in a climate change program.

Definitions

- *Afforestation.* Planting trees after January 1, 1990,[6] on land that has been in a nonforest land use for a number of years (Kyoto uses 50 years; other programs use 10 or 20).
- *Reforestation.* Planting trees after January 1, 1990, on land that had previously been in forest but has lost forest cover and is not recovering naturally. Severely burned western forests may qualify under this definition if they show no recovery after a time period.
- *Forest management.* Managing a forest to protect and/or enhance carbon stocks. Reporting forest management normally requires forest-wide reporting.
- *Forest products.* Providing credit for harvested wood. This is usually connected to forest management and the periodic harvesting of forests.
- *Forest conservation or protection.* Preventing a land-use change that would destroy or degrade an existing forest, such as conversion to agricultural or development uses.

Current Programs (rules as of mid-2007)

Program	*Afforest-ation*	*Reforest-ation*	*Forest management*	*Forest products*	*Forest conservation*
U.S. DOE 1605(b) Voluntary Regulation (1605b)	Yes	Yes	Yes	Yes	Yes
Chicago Climate Exchange (CCX)	Yes	Yes	Yes	Yes	Yes
Northeast Regional	Yes	No	No	No	No

[6] The January 1, 1990, date was chosen during negotiations on the Kyoto Protocol. It has since been adopted by the Chicago Climate Exchange.

Greenhouse Gas Initiative (RGGI)					
California Climate Action Registry (CCAR)*	Yes	No	Yes	Optional	Yes

* Limited at this time to projects within California.

Preferred Policy Option

All five forestry practices should be included in a national program, with the following rules:

- *Afforestation.* Planting trees on suitable land that has been in another land use for 10 or more years (including riparian forests, windbreaks, mined land reclamation, etc.).
- *Reforestation.* Planting trees on former forestland where forests damaged through natural events have not begun to regenerate after two years.
- *Forest management.* Managing forests sustainably under either a sustainable forest management[7] standard or other suitable criteria (see Element: Sustainability).
- *Forest products.* Providing credit for the carbon that remains out of the atmosphere in harvested forest products at the end of 100 years. Carbon credit values and their assignment can be determined between a landowner and a timber buyer via contractual arrangements.
- *Forest conservation.* Protecting forests from land-use change with conservation easements, contracts, or other legal instruments.

Sustainability

Concept

Carbon stock accounting should recognize the significant advantages of forests managed to meet sustainability objectives.

Discussion

Sustainable forestry has been defined as managing forests to meet the needs of today without compromising the ability of future generations to meet their own needs. The development of specific methods to meet this goal, along with the identification of performance standards, measures, and indicators, has been a major undertaking that has reached all the way from the U.N. Convention on Forests to individual landowners and forest producers.

Forest certification schemes have matured since the early 1990s and have developed formal forest sustainability standards. Land managers who subscribe to these systems must commit to meet applicable performance measures and undergo periodic independent third-party audits to verify their conformance with the standards. If they meet all requirements, forest product companies can label their end products as coming from well-managed forests.

[7] Sustainable forest management is defined by participation in a recognized national or international sustainable forest management scheme, such as the Sustainable Forestry Initiative (SFI), the Forest Stewardship Council (FSC), the Canadian Standards Association (CSA), the American Tree Farm System (ATFS), or other comparable programs that have attained national recognition.

Certification of forest carbon project lands to a sustainable forest management standard provides three distinctive advantages: 1) certification assures buyers that the quality of the carbon credits is high; 2) in well-functioning forest product markets, where sustainable forest management is practiced across the entire forest ownership, leakage will be a nonissue (see : Leakage); and 3) certification audits may provide necessary verification for carbon accounting systems.

It should be noted that although certification is almost universally practiced by medium and large forest landowners, major forest products firms, and many state and local public forests, it is not suited to all situations. Federal land management agencies, for example, have found it difficult to coordinate certification standards with the public policy guidelines under which they operate. Family forest landowners, who provide much of the wood to the forest products industry, have often found the costs too high for occasional harvests of small amounts of timber.

In those circumstances, other proposed methods may indicate that harvested wood comes from forest areas that are meeting sustainability objectives. The U.S. Forest Service's Forest Inventory and Analysis (FIA) program carries out periodic forest inventories based on a huge set of fixed plots within forested regions. Measurements across time can indicate the changes in timber supply within a region. If the region's forests are stable or increasing, it can be argued that all the forest products being harvested within the region are coming from a sustainable inventory.

Contractual agreements may also be appropriate. If landowners wish to sell carbon credits into a registry, private contracts requiring reforestation and other indicators of sustainable management, such as forestry best management practices, can be utilized to meet sustainability requirements.

Current Programs (rules as of mid-2007)

- 1605(b). Forest certification is recommended but not required. If an integrated company is reporting industrial emissions plus forestland under the guidelines, proof of forest certification can be presented as evidence of *de minimis* emissions, thus relieving the company of the need to inventory and report the forest separately.
- CCX. Offset projects must be included in a forest-wide sustainable forest management certification program. Additionally, project owners need to attest to their intentions to maintain forest carbon stocks and, in a managed forest project, to manage project lands under an approved sustainable forestry standard.
- RGGI. Offset projects must be part of an approved sustainable forestry certification standard.
- CCAR. Participating forest entities owning more than 100 acres of forest must be certified by an approved sustainable forestry certification system.

Preferred Policy Option

Forest certification should be encouraged and recognized as a significant advantage within a greenhouse gas emissions reduction policy but not as a prerequisite for participation. Achieving certification is not the purpose of a carbon accounting system.

Nevertheless, many of the same data required for verification of sustainable management are also needed for carbon accounting, and certification should be encouraged. In addition to certification under a recognized standard, other methods, such as the use of regional timber inventories like FIA or the existence of legal or contractual requirements for sustainable management practices, should be allowed to demonstrate that harvested wood meets sustainable source objectives.

Inclusion of Forest Pools

Concept

All pools thought to be significantly affected should be quantified and reported as part of net carbon change.

Definitions

- *Live tree stems.* The boles of live trees, quantified from ground level to a specified top diameter, usually 2–5 inches. This differs from above-ground biomass (below) and is included because many commercial growth and yield models are set up to report only stem wood.
- *Above-ground trees.* All live tree biomass larger than 1 inch DBH, including branches, twigs, and leaves.
- *Total live tree biomass.* All above-ground biomass plus large woody roots (often called below-ground biomass).
- *Standing dead.* Trees that have died but remain sound and standing.
- *Woody debris, litter, and residues.* Dead material lying on the ground.
- *Understory vegetation.* Brush and other nontree plants.
- *Soil organic matter.* Organic material (not including large roots) in the top 1 meter of soil.
- *Harvested wood products (HWPs).* Items made from wood and other tree material, in use or in landfills. These products are considered part of the forest entity. As biomass moves from live trees to HWPs, losses are incurred from slash and other logging and mill residues. Carbon is emitted to the atmosphere as forest products decay. Depending on the product, decay rates vary as an item moves through its life cycle. Forest Service tables (in the 1605(b) guidelines) provide estimates of decay rates for HWPs.

Current Programs (rules as of mid-2007)

- 1605(b). The Technical Guidelines, Part I, list the following pools for possible forest carbon accounting: live trees (above and below ground), understory vegetation, standing dead trees, down dead wood, forest floor, soil carbon, and harvested wood. Live trees should be measured in all reports. Other pools that are expected to remain stable or increase slightly may be left out of the inventory. Pools expected to decline should be measured.
- CCX. Total biomass of the tree, including the main stem and roots, is provided by lookup tables (see Measuring and Monitoring) and should be included in model results. Soil organic matter can be measured or estimated from lookup tables for carbon credit in afforestation projects.

- RGGI. Baseline measurements less than 12 months prior to the start of an afforestation project must calculate the carbon content for live trees (above and below ground), soil, and dead organic matter and coarse woody debris unless this pool is at or near zero. Optional pools are understory (live nontree biomass) and dead organic matter on the forest floor.
- CCAR. Required pools include tree biomass, standing dead biomass, and lying dead wood. Optional pools include understory, soil, litter and duff, and harvested wood products.

Preferred Policy Option

All pools thought to be significantly affected should be quantified and reported as part of net carbon change. Pools that can be shown to be insignificant, or likely to be unaffected, can be omitted to control measuring and monitoring costs. Use 1605(b) guidelines.

Harvested Wood Products

Concept

Long-term storage of carbon in harvested wood products in use is a core value provided by the management of our forest resources. Carbon in harvested wood is transferred from the forest inventory in the year it is harvested. If it is placed into product manufacturing channels, much of the carbon is not emitted immediately, and some is not emitted for decades or centuries. Emissions reductions from the long-term use of wood should be recognized in a carbon mitigation program.

Discussion

Until recently, many registries and programs failed to recognize the valuable service provided from carbon storage in HWPs. The effect was to treat harvested wood as if its carbon were completely emitted to the atmosphere immediately upon harvest.

The 1605(b) program guidelines[8] sought to rectify that error; however, concerns over who could report these amounts have been difficult to resolve. The guidelines assume that the process of removing CO_2 from the atmosphere and sequestering it in wood takes place only in the growing forest, and that the forest landowner decides to harvest or not harvest the forest and place the wood in commercial channels. Accordingly, the guidelines assign ownership of the carbon in both long-lived forest products in use and forest products discarded to landfills to the forest owner. These guidelines also allow qualifying carbon amounts accrued at the forest level to be assigned contractually to manufacturers of forest products from the project lands.

The 1605(b) program guidelines provide for HWP accounting methods of carbon in use or in landfills at 100 years after harvest. Carbon amounts can be reported in one of two ways: 1) an annual report based on the annual decomposition rate; or 2) a single report, done in the harvest year, based on the table estimates of the amount of carbon contained in the wood-in-use and the wood products in landfills at the end of 100 years.

[8] Technical Guidelines for Voluntary Reporting of Greenhouse Gas Program, Chapter 1, Emission Inventories, Part I Appendix: Forestry, March 2006, page 13. Available at http://www.pi.energy.gov/enhancingGHGregistry/documents/January2007_1605bTechnicalGuidelines.pdf.

Current registry and carbon program rules, including the 1605(b) guidelines, do not define processes and procedures for the transferability of carbon credits beyond forest landowners and the primary manufacturers of wood products. In the future, as carbon accounting mechanisms mature, processes and procedures may be developed to capture the movement of carbon from forests to other users in the supply chain. Depending on regulatory and economic factors, other opportunities for expanded HWP accounting and transferability may also present themselves, such as carbon transfers through approved procurement systems.

Preferred Policy Option

Utilize the options for calculating carbon amounts either at the time of harvest or after the industrial products have been manufactured, as provided in the 1605(b) guidelines. The assignment of any permissible carbon credits can be determined contractually when a market transaction between a landowner and primary manufacturer occurs. Policies on the issue of HWP accounting should also recognize the potential for future innovation and the development of new mechanisms, such as including carbon transfers down the supply chain and the recognition of HWP credits transferred through approved wood procurement systems.

Measuring and Monitoring

Concept

Forest carbon stocks should be measured and monitored in a transparent, scientifically credible manner. The goal is to provide a defined level of accuracy and precision to satisfy market and regulator demands while avoiding excessive requirements that would create costs out of proportion to the value of the carbon credits.

Definitions

- *Accuracy.* The degree of conformity of a measured or calculated quantity to its actual (true) value. In individual measurements, accuracy describes the closeness of a measurement to the true value. When measurements are repeated and averaged, the difference between the mean of these measurements and the true value is the bias, with the error expressed as a percentage.
- *Precision.* The degree to which further measurements show the same result as the first. Precision is usually characterized by the interval defined by the standard deviation, called the confidence interval. The confidence level defines the trust we have in the level of error, expressed as a percentage. Accuracy and precision must be expressed together. For example, if a forest inventory has a confidence level of 95% and an error level of 10% around the average volume per acre, it can be stated that we are confident 95% of the time that the average volume per acre is +/- 10% of the true volume per acre.
- *Periodicity.* The time between measurements. Although most carbon stock changes are reported in annual increments, it is usually unrealistic to require annual field measurements. Measurements every five or 10 years are most often used to estimate annual change.
- *Methods.* Virtually all measurements depend on a sampling procedure that measures carbon stocks within plots spaced according to a sampling plan, then extrapolates

from those plot measurements to the full sampling area. Sampling protocols based on standard forestry methods are outlined in the Forestry Appendix (I) of the DOE 1605(b) voluntary reporting guidelines.
- *Lookup tables.* Average growth rates based on newly planted forests on all sites and under all management regimes in a given region. To provide general guidance on forest carbon stock changes, the Forest Service maintains lookup tables based on regional and species growth patterns as measured by the Forest Inventory and Analysis program. They may not be an accurate indication of how any one forestry project may respond.

Discussion
Lookup tables, while inexpensive and easy to use, are a reflection of average growth rates across a species and region and can be significantly inaccurate for a specific project area. Direct measurements, done by a competent forester using standard inventory techniques, are more accurate, and the more plots measured, the less the uncertainty in the growth rates. This obviously raises the issue of cost versus precision.

Another cost issue is the periodicity of required field measurements. Forests grow fairly slowly, and although it is possible to remeasure plots annually, the effort probably does not improve the quality of the inventory enough to make the expense worthwhile. Some programs call for a maximum five-year interval between measurements, others call for a final measurement at the end of the market contract, and others will approve an inventory cycle of up to 10 years. Many markets can use longer time periods between measurements by allowing participants to use validated growth models to report estimated annual carbon stock changes.

Carbon dioxide is only one of several greenhouse gases that are regulated in emerging programs. Methane (CH_4) and nitrous oxide (N_2O) are more responsible than CO_2 (23 and 296 times more, respectively) for atmospheric heat trapping,[9] but it is not clear how they can be measured at the forest or project level, since their fluxes are not reflected in the biomass stock change that is measured to estimate carbon stock changes. Additional research will be necessary before these gases can be incorporated into forestry protocols.

Current Programs (rules as of mid-2007)
- 1605(b). Forest carbon pools can be estimated by using lookup tables that provide average estimates of live tree, standing dead tree, understory, down dead tree, forest floor, and soil carbon by general forest types over forest regions. The tables should be matched closely to project conditions, or adjusted to fit. Models that have been locally calibrated can be used for greater accuracy. Most accurate are direct measurements. Measuring guidelines are provided for all pools, including HWPs. Two methods are suggested for measuring the sequestered carbon in HWPs: an annual report that tracks all products through their decomposition fate year by year, and a one-time report in the harvest year that estimates, by timber type, how much of the HWPs will still be stored (in use, in landfills, and burned for the production of energy that replaces fossil fuels) at the end of 100 years.

[9] Intergovernmental Panel on Climate Change, *Climate Change 2001: The Scientific Basis* (Cambridge, UK: Cambridge University Press, 2001).

- CCX. CCX lookup tables use the 1605(b) program tables for afforestation projects. These tables include carbon pools for live tree biomass (above and below ground) and soil organic matter. Afforestation projects where the trees will eventually be harvested can use CCX-approved growth models to quantify live tree biomass. In-field measurement or inventory accuracy and precision level guidelines are not specified. Using procedures defined in the 1605(b) guidelines, CCX has developed factors that convert the volume of harvested wood categories to long-lived carbon in use and in landfills at the end of 100 years.
- RGGI. All carbon pools are measured directly and separately, using measurement protocols and sample size "that achieves a demonstrated quantified accuracy for the combined carbon pool measurement such that there is 95% confidence that the resulting reported value is within 10% of the true mean."[10] Measurement protocols must be consistent with those contained in the 1605(b) technical forestry appendix. Measurements on afforestation projects must be made not less than every five years. HWPs are not included.
- CCAR. Estimates of biological carbon should exhibit a standard error of less than 20% of the estimated mean with 90% confidence. Deductions apply to mean estimates of the carbon pools if the sampling error at the 90% confidence interval is 5% of the mean estimate or greater. Long-term baselines should be estimated by models, seven of which are preapproved. Other models may be approved if they meet CCAR criteria. HWP measures are optional.

Preferred Policy Option

Measuring and monitoring methods and specifications should follow the guidelines set out in the 1605(b) appendices to provide a nationally consistent approach. Direct measurements should be done to a specified confidence and uncertainty level. If short-term contracts are allowed in the market, measurements should be required at the end of the contract in order to "true up" the carbon change estimates. Between measurements, carbon flux can be calculated and reported using appropriately calibrated growth models.

Reporting

Concept

Any voluntary or regulatory program must specify the data to be reported and the reporting frequency. There is a balance to be sought among full and complete reporting, transparency, and associated costs. To the extent that reporting requirements are costly, they are a disincentive to participation.

Discussion

Reporting can be staged to take advantage of least-cost methods. For example, project owners can be required to provide an annual report attesting that a forestry project is still proceeding under the initial project or management plan, and that it has not suffered any major disturbance. At intervals (such as five or 10 years), a followup forest inventory can be required to provide real-time data and "true up" the estimates made at the time of project planning. All reports can be spot-checked for accuracy by local third-party

[10] All citations to RGGI come from the Regional Greenhouse Gas Initiative Model Rule, 1/5/07 with final corrections. Available at http://www.rggi.org/modelrule.htm.

inspectors, such as public or private foresters, and verified if needed by accredited verifiers.

If a reporting or market system requires independent third-party verification of the reported forest carbon credits, forest managers operating under a sustainable forestry standard, such as the Sustainable Forestry Initiative (SFI), Forest Stewardship Council (FSC), Canadian Standards Association (CSA), or American Tree Farm System (ATFS) group certification, will have a considerable advantage. Certification already requires annual audits by accredited auditors and can include an audit of the carbon reports. This can potentially be a cost savings, since the highest cost involved with most certification schemes is the cost of bringing in an audit team for the periodic audit.

Current Programs (rules as of mid-2007)

- 1605(b). The general 1605(b) guidelines require annual entity reporting. Forestry projects, whether reported individually or as part of an aggregator's pooled report, need to be supported by full entity reports.
- CCX. Annual forestland reporting is required for integrated forest products companies that are also direct emitters and members of CCX. Nonmember forest offset projects can be brought to CCX by aggregators that include all project owner forestlands within the carbon quantification methods being proposed. All reports are required to be independently audited by a CCX-approved auditor. Integrated commercial forestry companies that have mill and forest ownerships have the option of including their forests in the quantification of the total registered emissions. Only annually verified changes in carbon can be traded. No forward selling is allowed.
- RGGI. Offset credits are given only to projects initiated on or after December 20, 2005. Forestry credits may be issued for 20 years, with two possible 20-year extensions if criteria are met. Applications for forest offset projects must be verified by an approved verifier. Regulated emitters report quarterly.
- CCAR. Forest entities owning more than 100 acres of forest are required to report all biological and nonbiological emissions annually. Projects can be reported separately or as part of entity reporting. All reporters are required to report CH_4 and N_2O by the fourth reporting year, although methodologies are not provided. Biological emissions and carbon stocks must be certified by a CCAR-approved certifier every six years.

Preferred Policy Option

Annual reporting is appropriate. Where third-party auditing is required, the carbon amounts reported should be verified by trained and approved forest certification auditors or program-trained and approved verifiers. Forest management reports should include all the forestland within the management or ownership unit (forest-wide reporting). Claims of sustainability should be supported by certification under an approved sustainable forestry certification system, or through other methods, such as the use of FIA or other regional timber inventories, or the existence of legal or contractual requirements for sustainable management practices (see Sustainability, Preferred Option). Reporting should be limited to carbon stock changes until valid scientific measurement protocols are established for other greenhouse gases.

Baselines and Additionality

Concept

Additionality is the amount of net carbon sequestered that is attributable to the project activities compared with the amount that would have been sequestered without the project activity. This means that there must be a baseline against which project carbon stocks can be compared.

Discussion

The rules for setting baselines and calculating additionality are the most important, and probably most controversial, of any of the rules for creating forest carbon credits. There are strong opinions that carbon sequestration that would (or might) have happened in any event should not be allowed to offset industrial emissions. Often referred to as the "business as usual," or BAU, this scenario applies well to industrial emissions but much less well to land-based sequestration practices, where natural ecosystem dynamics and unpredictable future human actions make any projection highly uncertain. Changing forest management objectives, markets for alternative land uses, timber prices, and ecosystem service prices (e.g., the price of sequestered carbon) all contribute to a high level of uncertainty when defining a baseline under the BAU scenario. There are no credible field methods to separate the effects of management actions on a forest from the impacts of environmental conditions over time.[11]

For example, it is often assumed that a forest will grow and add carbon naturally without human interference or management. In an unmanaged system between catastrophic natural disturbance cycles, that may be an accurate characterization, at least for some time. If that forest suffers a major disturbance, like an insect or disease epidemic or a wildfire, the assumption will not be valid.

A major uncertainty that discredits any effort at 100-year BAU projections is the potential for climate change to disrupt the underlying environmental conditions that have driven forest growth in the past. If temperature or moisture conditions change significantly, the forest growth patterns of the past may be completely altered in the future, and 100-year growth projections become highly uncertain.

Managed forests coexist with growing and increasingly demanding human populations, and their future is also uncertain. A future owner may turn a forest into a subdivision, or harvest the trees without regenerating a new forest of equal value, or establish a harvest system that reduces forest biomass significantly. All of those actions may be legal and may be more economically rewarding to the owner. To encumber the property with a long-term carbon management commitment is one way to prevent potential carbon losses, but it creates economic constraints that future owners may find difficult or impossible.

Given current trends in land-use change, any estimate of BAU should factor in the risk that the forest will be converted. Any long-term baseline should therefore include not just

[11] Ruddell, S., R. Sampson, M. Smith, R. Giffen, J. Cathcart, J. Hagan, D. Sosland, J. Heissenbuttel, J. Godbee, S. Lovett, J. Helms, W. Price, and R. Simpson. 2007. The role for sustainably managed forests in climate change mitigation. *Journal of Forestry* 105(6): 314-319.

growth estimates but also a risk assessment of the likely future forest fragmentation or land-use change.

In some states, programs to prevent forestland conversion to other uses, usually accompanied by tax incentives and high payback provisions, may reduce the risk of land conversion. Some states require reforestation following timber harvests, and a few have fairly strict forest management requirements. In those states, a case can be made that the BAU is defined by the likely forest response if the owners adhere to the existing regulations. Again, however, the likelihood of policy change over 100 years is very high.

Forests also face the risk of catastrophic wildfire, and in many places (such as low-elevation forests across much of the West) this risk has been heightened by past management actions that have changed forest condition and structure such that wildfires are more destructive than in the historical fire regime. Wildfires release huge quantities of CO_2, as well as N_2O and other greenhouse gases.[12] One study identified some 76 million acres, historically characterized by a high-frequency, low-severity fire regime, that have been changed to the point where a current fire would likely cause uncharacteristic changes to the ecosystem and its capacity to recover.[13]

Reducing wildfire risks is a major challenge to today's forest managers, on both private and public lands. Where this can be successfully done, and more normal fire regimes reintroduced to the landscape, total CO_2 emissions can be significantly reduced while many other environmental, economic, and social benefits accrue.[14] Again, however, quantifying these emissions reductions is a challenge, since it requires a credible calculation of the risk reduction achieved. With a stochastic process like forest wildfires, estimating risk reduction at a particular project level is difficult, although models are being tested.[15] With more research and experience with fire-safe forest management practices, a credible emissions reduction calculation may be feasible. If that is accomplished, a baseline calculation should include the risk of catastrophic loss, and a project that measurably reduced that risk could be eligible for emissions reduction credits.

Using a more stringent interpretation of additionality, some have proposed that a landowner prove that the financial incentive connected with forest carbon credits was essential to implementation of the forest project. This form of "financial additionality" requires a determination of future landowner intentions and financial capability—a dubious exercise. Landowners may sign a waiver saying the money was needed to do the project, but that is ripe for abuse.

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[12] Leenhouts, B. 1998. Assessment of biomass burning in the conterminous United States. *Conservation Ecology* 2(1). Available at www.consecol.org/vol2/art1/.
[13] Hardy, C.C., K.M. Schmidt, J.P. Menakis and R.N. Sampson. 2001. Spatial data for national fire planning and fuel management, *International Journal of Wildland Fire* 10: 353-372.
[14] Neuenschwander, L.F. and R.N. Sampson. 2000. A wildfire and emissions policy model for the Boise National Forest. *Journal of Sustainable Forestry* 11(1-2):289-310.
[15] Sampson, R. Neil and Robert W. Sampson. 2005. Application of hazard and risk analysis at the project level to assess ecologic impact. *Forest Ecology and Management* 211: 109-116.

All of the compounding uncertainties make BAU a very difficult concept for establishing the likely future of a forest system. Attempts to accommodate these uncertainties by constantly adjusting the baseline mean that past carbon credits may be rendered nonadditional at some future point. That uncertainty creates a disincentive to participation by forest landowners.

Foresters can measure forest carbon at one point in time, then measure it again at some future point and calculate the difference. Because those measures require no guessing about people's intentions or future actions, several carbon programs have taken this approach. A "base year" measurement is made when the carbon management project is launched. A periodic measurement is then done with the same methodology, and the difference is calculated.

What cannot be calculated, however, is the cause and effect behind those changes. Was growth enhanced by a sustained period of better-than-average weather between the measurements? Or diminished by an adverse period? How much did the silvicultural work of thinning or fertilization affect the biomass measurements? The answer to these questions, generally, is that one can guess but not calculate a certain number. This makes achieving the Kyoto Protocol's demand for measuring only "human induced" change technically impractical.

In some of the emerging climate programs, the assumption is that all the changes (both minus and plus) on a managed forest are a result of management activities. To make these estimates most valid, all of the forests under the management unit program should be included, so that the owner cannot claim carbon credits on the increasing portion of the forest while ignoring losses on any areas of decrease. The forest-wide approach captures all planting, growth, natural mortality, thinning, and harvests and provides a net assessment of the carbon dynamics in the management unit over the measurement period. This approach has been termed a "base year" approach because the carbon content of the forest in the base year is established as the baseline from which additionality is calculated.

The other advantage of the base-year approach is that it can be easily verified as needed by independent third-party auditors because it involves repeatable measurements and reviewable calculation methods. The BAU approach based on assumptions of people's future intentions or actions, as well as environmental and policy trends, by definition creates a counterfactual situation that cannot be verified: it never existed. If the baseline cannot be quantified with confidence and cannot be verified, it is difficult to argue that any changes are credible as climate mitigation benefits.

Current Programs (rules as of mid-2007)

- 1605(b). The forestry guidelines are based on stock change methods, beginning with a base-year measurement and continuing stock measurements on a periodic basis; five-year intervals are recommended.
- CCX. If CCX-approved growth models are used to quantify sequestered carbon, then the base-year approach is used for setting the baseline. CCX requires the establishment of a 20% reserve pool of registered carbon stocks to protect against a reduction in carbon stocks.

- RGGI. Carbon sequestration for afforestation projects is done on a base-year approach, where "the amount of carbon sequestered is measured as a net increase in carbon relative to the base year measurement."
- CCAR. "A biological baseline for a forest entity is a long-term projection of an entity's forest carbon stocks over one hundred years that is based on the entity's forecasted management practices and goals."[16] Baselines must be adjusted if changes to an entity's forest affect its baseline by 10% or more. The baselines for the three project types are characterized by mandatory land-use statutes and regulations, existing practices, and/or threats of land-use change.

Preferred Policy Option:
The base-year approach, as defined by 1605(b), CCX, and RGGI, is by far the most scientifically based and valid method of determining forest carbon changes. Any system that requires a prediction of future environmental, economic, social, or legal conditions is inherently uncertain, and amounts of carbon may be very difficult, if not impossible, to quantify and verify in the future.

Leakage

Concept: Leakage occurs when an activity resulting in carbon sequestration causes a reaction on other lands that alters carbon emissions. It is often referred to as an indirect or secondary effect, and it can be either positive or negative.

Definitions:

- *Activity-shifting leakage.* The effect caused when a project causes an activity to move elsewhere. For example, a project that stops land clearing for agriculture in one place causes farmers who need land to clear another forest.
- *Market leakage.* The effect caused when a project has market impacts that draw action elsewhere. For example, a large forest producer halts timber harvest in normal market conditions, so producers elsewhere respond to the increased demand and harvest more timber.
- *Internal leakage.* An effect that occurs when the carbon sequestration created in one portion of an ownership causes the owner to carry out carbon-emitting activities elsewhere.
- *External leakage.* Activity-shifting or market leakage caused when one forest owner's actions cause other owners to change their behavior.
- *Positive leakage.* An effect caused when one owner's positive actions prompt other owners to follow suit. The net result could be an indirect effect that improves carbon sequestration among many owners. Sustainable forest management may be an example.

Discussion
This may be the most difficult factor to convert into reliable measurements. It is well accepted that, all else equal, protecting one forest from conversion to development may simply move the developer to another forest, and thus the protection achieves little in terms of carbon sequestration. Similarly, if forest products are not harvested at one

[16] CCAR. Forestry Sector Protocol (September, 2007). Available at http://www.climateregistry.org/.

location, they will probably be harvested at another location, since the demand for those products remains unchanged. Recent cutbacks in harvest from U.S. forests, where environmental laws and practices are generally strong, may have shifted harvest to a foreign source where environmental protections are far weaker. As a result, the global environment is impoverished as a result of our protection efforts.

Despite general agreement on the potential for leakage, its actual measurement on a specific project has proven difficult. From a practical point of view, it is hard to demonstrate that one forest owner's decision causes other forest owners to take counter-effect actions, and then to measure the impact of those actions.

The efforts that have been made are generally theoretical; very few empirical data exist to reliably establish leakage for all of the forest offset project types (see Project Eligibility). Suggestions have been made to establish leakage (discount) rates based on one economic study[17]; that would require a leakage factor to be applied at the regional level for specific activities, and all projects within the region would then factor that discount into their calculations. That is a political decision, not a scientific one. The validity of leakage discounts rests on the assumptions made in the analyses. Much more research is required before regional leakage factors can be assigned to managed forest offset projects.

Although most leakage discussions consider project impacts that might cause other owners to increase emissions or reduce sequestration, it may also be important to prevent the "internal" leakage that could occur if an owner counted carbon on rapidly growing areas while avoiding the inventory on areas in decline, for whatever reason. The systems tend to cover this with two approaches. The first is to require forest-wide reporting so that all forests within a forest ownership or within a defined forest management unit are included in any reporting, and the second is to require that the project meet the sustainability criteria of an internationally recognized sustainable forest management standard, such as SFI, FSC, CSA, or ATFS group certification.

In discussing internal leakage as it relates to a forest project, where forest-wide reporting is required and the forest is being managed to a recognized certification standard, no activity-shifting leakage will be created. In addition, under functioning forest product markets, where sustainable forestry is practiced, market leakage should not be an issue, since a sustainable forest management plan requires a reasonably uniform level of year-to-year harvest.[18]

Current Programs (rules as of mid-2007)

- 1605(b). This program has no criteria or guidelines for measuring leakage.
- CCX. Leakage is not directly addressed. Forest-wide reporting or attestations are required. All project owner forestland under an approved quantification method must be included in the verified pool. Attestations that forest carbon will be

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[17] Murray, B.C., B.A. McCarl, and H.C. Lee. 2004. Estimating leakage for forest carbon sequestration programs. *Land Economics* 80(1): 109-124.

[18] Ruddell, S., R. Sampson, M. Smith, R. Giffen, J. Cathcart, J.Hagan, D. Sosland, J. Heissenbuttel, J. Godbee, S. Lovett, J. Helms, W. Price, and R. Simpson. 2007. The role for sustainably managed forests in climate change mitigation. *Journal of Forestry* 105(6): 314-319.

maintained past the market period are required. Rules for managed forest projects require the project to demonstrate sustainable forestry practices, such as SFI, FSC, CSA, ATFS group certification, or other approved schemes.

- RGGI. If timber harvesting is to be done on an afforestation project, the project must be certified by SFI, FSC, ATFS group certification, or other approved schemes. Leakage is not directly addressed.
- CCAR. "Activity shifting leakage that may have been created in the entity due to the project must be assessed. Reporting market leakage is optional."

Preferred Policy Option

In forestry projects where forest-wide reporting or sustainable forest management is practiced, internal leakage is minimized. External leakage should not be considered a substantial factor in the environmental effect.

Permanence

Concept

Where forest carbon credits are used to offset industrial emissions they must be equivalent in their impact on atmospheric carbon. If an emissions reduction is, for all practical purposes, permanent, then forest carbon credits must match that duration.

Discussion

The permanence challenge is complicated by the natural dynamics of forest ecosystems and the long-term social and economic forces that affect forest management. One popular approach to address this problem is to require a perpetual conservation easement on the forest project lands. In the United States and other developed countries, this may provide protection against land-use change, but it has no force against catastrophic disturbances that may destroy the forest carbon stocks. Furthermore, if conservation easements mandate prescriptive forest management practices based on current technology or requirements like mandatory reforestation, they may create future barriers for meeting additionality requirements.

A more promising approach is to enter into short-term contracts with landowners to sequester and maintain forest carbon stocks. These contracts protect the buyer of carbon credits from loss during the contract period. If the forest carbon stocks are lost, the buyer must be reimbursed for that loss. At the end of the contract, the buyer (emitter) is still liable for those emissions and must either cover those obligations by repurchasing forest credits that are still valid or find other sources of offsets.

A similar approach is to assign liability for forestland carbon stocks, both increases and decreases, to the landowner of the carbon asset being registered, not the land. The landowner can then use various options to mitigate any losses or decreases in registered forest carbon stocks and capture value from the carbon via "market mechanisms" under any future cap-and-trade carbon trading program. Forestland owners could then use one or more of the following options to address permanence:

- *Banking.* Depositing some or all of any annual carbon stock gains as a hedge against future reductions.

- *Insurance.* Indemnification against carbon stock losses, wherein the insurer would provide a payment that could be used to purchase replacement carbon reduction units (credits).
- *Pooling.* Bringing a wide variety of projects together to reduce the risk for each owner. The larger and more diverse the pool, the less likely it is that one disturbance will affect all projects.
- *Like-kind pools.* Forest carbon management units created to act as a replacement reserve. Both private and public forestland owners should participate in the development of like-kind carbon stock insurance pools pools, for mutual benefit and to reduce costs.
- *Physical risk management.* Methods to reduce the risk of fire, pests, and other *force majeure* risks. State-of-the-art sustainable forest management methods have been developed and employed with considerable success over decades or longer by many of the largest forestland owners in the world.
- Force majeure *safe harbor.* Provisions to allow carbon stock losses due to fire, wind blowdown, disease, and pest damage to be subtracted from the inventory baseline, without the recording of emissions, if the landowner regrows (regenerates) the carbon stocks to the levels equal to the amounts lost. Such increases would be considered not additional but a replacement for the lost carbon stocks. As the replacement stocks are generated, they would be added to the baseline until the full loss is replaced.[19]

CCX calculates both emissions and offset credits on a "vintage year" basis. That is, emissions in 2004 must be covered by a forest carbon credit that was valid for 2004. Once retired, that forest carbon credit must be maintained for a long time to remain valid as a 2004 offset. If the forest contract ends, the emitter is responsible for finding a new credit to continue the long-term obligation of offsetting those past emissions.

Current Programs (rules as of mid-2007)

- 1605(b). Forest reporters are required to report stock changes on an annual basis. If forest carbon is lost in a wildfire, no further carbon can be reported from that land until the forest regains its prefire size and structure.
- CCX. If CCX-approved growth models are used to quantify sequestered carbon, then the base-year approach is used for setting the baseline. CCX requires a 20% reserve pool of registered carbon stocks to protect against a reduction in carbon stocks from catastrophic loss (e.g., wildfire). Only annually verified changes in carbon can be traded. No forward selling is allowed. Payback provisions are in place if carbon stocks on registered lands are sold.
- RGGI. The project land must be placed under a legally binding permanent conservation easement requiring that it be maintained in a forested state in perpetuity and that the carbon density within the offset project boundary be maintained at long-term levels at or above the level achieved at the end of the CO_2 offset crediting period. The easement must also require that the land be managed in accordance with environmentally sustainable forestry practices.

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19 http://www.pi.energy.gov/enhancingGHGregistry/documents/January2007_1605bTechnicalGuidelines.pdf Section 1.I.3.4 Natural Disturbances, 244.

- CCAR. “At the project level a forest entity is required to secure their project with a perpetual conservation easement and permanently dedicate the land to forest use. All forest projects are required to promote and maintain forest types that are native to the project area. In addition, forest management projects must use natural forest management practices.”

Preferred Policy Option
Forest carbon credits that are used to offset industrial emissions should be maintained in place for long periods of time. Where that is not feasible, short-term (five- to 15-year) contracts that guaranteethe validity of the credits for the contract period should be considered. An emitter who purchases a short-term contract remains liable for the offsets claimed and at the end of the contract must either extend the forest credits or purchase replacements to cover the emissions liability. Market pricing in a trading system will establish the value of these short-term contracts vis-à-vis permanent offsets. An alternative is to assign liability for forestland carbon stocks, both increases and decreases, to the owner of the carbon asset being registered, not the land. This will enable the landowner to use various options, such as banking, insurance, and reserve carbon pools, to mitigate any losses or decreases in registered forest carbon stocks.

Equivalence

Concept
Forest carbon stock changes are typically derived from statistical sampling (direct measurement), reference tables, or models and are thus less accurate than gas emissions measured in a meter. Should forest carbon estimates be adjusted in some way as a result?

Discussion
This issue is closely intertwined with permanence and leakage (above). The question often prompt decisionmakers to respond by saying, “If it’s too complicated to understand or if it’s uncertain, let’s avoid it,” and also has a dampening effect on potential forest projects, such as managed forestry. Significant discounting because of uncertainty provides a disincentive, particularly at low offset prices.

Proposals have been made to discount forest credits across the board to protect against uncertainty or impermanence. Some forms of insurance or reserves have also been utilized. Most forestry project proponents have encouraged project planners to make carbon stock measurements, calculations, and projections intentionally conservative so that any imprecision is more likely to benefit the environment than to incur a deficit.

Current Programs (rules as of mid-2007)

- 1605(b). Reported amounts must be measured by methods that achieve an average grade of 3.0 across the entity report. The guidelines provide a system for grading measurement methods, on a scale of 1 to 4, based on best available measurement technology.
- CCX. Since the lookup table values are based on the Forest Service tables published in the 1605(b) program guidelines, and these values are averages across broad geographic regions, CCX requires these values to be discounted 30%. Commercial forestry carbon stocks that are based on growth-and-yield models are

discounted 20% to account for modeling error. A discount factor is applied to managed forests based on the indicated error of the inventory.

- RGGI. Net change credited for offsets is the measured net change less 10% to account for potential losses of sequestered carbon. The 10% discount is not required if the project sponsor retains long-term insurance to guarantee replacement of any lost sequestered carbon for which offset allowances had been awarded.
- CCAR. At the project level, deductions based on the level of confidence of measurement samples are taken from estimates of tree bole volume, standing dead biomass volume, lying dead wood volume, shrub and herbaceous understory volume, and soil carbon volume. Project reporting demands more accuracy in measurements because the carbon storage reported will be certified as greenhouse gas emissions reductions or emissions.

Preferred Policy Option
Let the different registries and programs set their own discount levels for afforestation projects using lookup tables based on member and market demands. For managed forest offset projects, require that forest inventories be based on sound forestry standards. Policies should encourage inventories designed to produce high levels of precision and accuracy (see definitions under Measuring and Monitoring) while balancing the economics and practical nature of inventory programs. Base the discount on the growth component of change in carbon stocks on the actual measured error of the forest inventory. If organizations want to invest in more accurate and precise inventories that provide for a lower error, they should be allowed to apply a discount that matches it. Require calibration of growth models to continually adjust the difference between the actual harvest and the planned (modeled or inventoried) harvest.

Summary

In summary, we believe that national policy to address greenhouse gas emissions should allow recognition of the offset potential in forests and forest management. If the rules or protocols that emerge from these policy debates are consistent with current forest science, forestry practice, and forest management objectives, we anticipate widespread acceptance and participation by forest landowners, foresters, and the forest products industry.

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Coordinating Organization: Society of American Foresters

Participants: Staff members of the following organizations participated in one or more of the meetings and/or conference calls that shaped the paper. The organizations are listed for reference only, as many of those organizations are still developing their internal policy positions on forests and climate change, and their inclusion here does not imply full agreement with all of the positions proposed in this paper.

American Forest & Paper Association
American Forest Foundation
American Forest Resource Council
Association of Consulting Foresters
California Forestry Association
Forecon, Inc.
Hardwood Federation
National Association of State Foresters
National Hardwood Lumber Association
Nutter and Harris
Phoenix Strategic Solutions
The Sampson Group, Inc.
Society of American Foresters
Sustainable Forestry Initiative, Inc.