



Center for
Clean Air Policy
Dialogue. Insight. Solutions.

CENTER FOR CLEAN AIR POLICY
California Program Office
5400 B Street
Sacramento, CA 95819
916-452-5422
<http://www.ccap.org>

DATE: May 6, 2008
TO: California Air Resources Board and Climate Action Team
FROM: Gordon Smith, Stacey Davis & Suzanne Reed, CCAP
RE: Capping Greenhouse Gas Emissions from California's Forests

Climate scientists tell us that to avoid substantial climate change we need to reduce anthropogenic greenhouse gas emissions by more than 70% in the next few decades—and perhaps we need to reduce emissions 90%. Achieving these reductions requires major technological and structural changes in many sectors of our economy, including reversal of the global loss of carbon stocks from forests and soils. Globally, forests and soils are estimated to produce more than 20% of anthropogenic greenhouse gas emissions.

Cap-and-trade programs have been shown to be effective at finding lower cost emission reductions and stimulating development of new, lower emission technologies. California is considering cap-and-trade programs that encompass several economic sectors. However, in its June 2007 report to CARB, the Market Advisory Committee recommended excluding forests from mandatory limits on emissions, due primarily to concerns over monitoring, despite the availability of cost-effective mitigation actions from these sectors.

Economic analysis shows that under voluntary purchase programs for forest and soil carbon sequestration the amount of sequestration that would be achieved would be a fraction of the amounts that could be sequestered before biological and physical limits are reached (Lewandrowski et al. 2004). Further, even at the highest price analyzed (\$34 per metric ton carbon dioxide equivalent, CO₂e) a soil sequestration program that pays only for sequestration without requiring landowners to pay to emit stores only half as much carbon and costs five times as much per ton of carbon stored as a program where landowners both get paid for sequestering and must pay for their emissions. In other words, a cap on soil carbon emissions is ten times as effective as a voluntary program.

that only pays for sequestration. The model in this study did not look at reversal of forest carbon sequestration but presumably a cap on forest emissions would also be much more effective than a voluntary offset program.

Under a cap, a landowner who clears forest must either acquire and surrender allowances for emissions from clearing, or must increase carbon stocks on other portions of the ownership to sequester amounts equal to emissions from clearing. In fact, analyses have found that a requirement to acquire and surrender allowances for emissions from forest clearing provides a noticeable disincentive to deforestation. Using the average California forest carbon stock of 160 metric tons CO₂e per acre (Birdsey and Lewis 2003), at a price of \$20 per metric ton CO₂e, it would cost \$3,200 per acre to acquire allowances needed to clear land.¹

To achieve more of the potential emissions reductions from the forestry sector and lower the overall cost of complying with AB32, California regulators should consider limiting net emissions from the forestry sector via cap-and-trade. California has the data and expertise necessary to develop a forest emission cap system. If successful, California's precedent could have important consequences for US policy and for international control regimes.

The following is a review of a handful of key design issues and options for creating a workable cap-and-trade program for the California forestry sector. Specifically, we look at the issues of comprehensiveness, ownership size, baseline, cap level, quantification methods, temporal flexibility, and relation to a larger state cap-and-trade program.

Comprehensiveness

To be most effective and minimize emissions leakage (where decline in market share stemming from a state cap-and-trade program is made up by new production outside the state), a cap-and-trade program should strive to include a majority of the targeted industry sector. In general, all lands suitable for forests should be included in the cap-and-trade program except for federal lands² and lands zoned as urban areas. Land types not suitable for forests (e.g., desert) would be excluded based on mapping done by the Fire and Resource Assessment Program (FRAP) of the California Department of Forestry and Fire Protection.

¹ This illustrative example assumes average carbon stock, and uses the simplifying assumptions that all carbon in woody vegetation and the forest floor is released on clearing, and no soil carbon is lost.

² Federal lands should be excluded because states can not sue and enforce court judgments to hold the federal government responsible for sequestration commitments. Another reason to exclude federal lands is that it appears that "business-as-usual" management of federal lands is resulting in restoration of carbon stocks that were reduced by logging in the 20th century, and some parties object to gifting credits to the federal government for actions that were begun years ago for non-climate reasons.

Emissions Baseline

An emissions baseline refers to expected business-as-usual emission levels absent an emission control program. A baseline year that represents emissions levels prior to the start of an emission control program (either historic or future, and based on site specific data or land type averages) can be used as a reference point, or yardstick, to measure subsequent emission shifts. An emissions cap, defined below, can be set at, above, or below the baseline.

Developing an emissions baseline that changes over time requires knowledge of major trends affecting a given industry, including projected changes in demand and production. Even with good data, a baseline is at best an educated guess as prices, markets and economies can change dramatically from projections. Specifying a baseline that extends into the future and changes over time both requires a lot of analytic effort to construct and usually will not match what actually comes to pass.

A simpler approach to setting baselines is for the baseline to be set equal to the carbon stock present on each owner's lands at a specified historic before the start of the mitigation program, or future date. Using a historic date has the advantage of avoiding most gaming that could result from landowners cutting down trees before the program start date to get a lower baseline. However, the forest inventory data required to establish a historic baseline may not be available or may not be of the same quality of data that could be collected now.

If the baseline is set as the carbon stock present at the time the cap is first implemented (instead of the business-as-usual projection of the average stock for the forest type and site productivity, as described below), there could be a mechanism landowners can use to receive a lower baseline, if they have a high carbon stock because of past deferral of harvest. A landowner should be able to conduct a forest carbon inventory and if the carbon stock is more than a specified percentage above the average for the forest type and site productivity (as would be the case if most of the ownership were near or above rotation age) the landowner should be able to receive a baseline that is somewhere between the carbon stock present on the property at the start of the forest cap and the average for the forest type/site productivity.

Setting a baseline year with a future date allows time to collect data needed to construct an accurate emissions inventory, if more data are needed. While gaming is a possibility, opportunities for gaming forest baselines are very limited in California because of state minimum rotation age requirements. Further, the high costs of wood and wood products is a much stronger driver of management choices than the relatively modest sales price of carbon sequestration credits.

For example, the current California State Board of Equalization harvest value for mid-sized Douglas-fir logs in the northern California Sierras is \$310 per thousand board feet (sawlog prices are currently low because of the depression in the housing market). A landowner could thin trees that are not yet at harvest age, to reduce the carbon stock.

However such a thinning typically removes less than three metric tons CO₂e of on-site carbon stock for every thousand board feet of wood that would be eligible for clear cutting in a few years. Projections are that carbon prices could be \$20-40/metric ton CO₂e after an emission cap is in place. Using the high emission price and a high estimate of reducing the baseline 3 tons CO₂e per thousand board feet, a landowner who lowers the baseline to gain an extra \$120 of revenue over several decades, would give up \$310 in revenue some time in the next few years. It is our sense that setting the baseline date as a future date is likely to cause only modest amounts of additional harvesting by landowners seeking to lower their baseline carbon stocks.

Another approach to setting forest carbon baselines for ownerships is to set the baseline at the average carbon stock for the forest type and site productivity. These averages could be calculated from existing Forest Service Forest Inventory and Analysis data and Natural Resources Conservation Service National Resources Inventory data. The reason to use this approach to baseline setting is to not penalize landowners that have deferred harvesting in the past, and not penalize small land owners that have only one stand of trees that is approaching harvestable age. These owners who have increased their carbon stock in the past would not be penalized with a baseline carbon stock that is much higher than a neighbor who has harvested recently. Using land type averages, owners that have carbon stocks below the average could be given a number of years (up to half a rotation) to bring their carbon stocks up to the average.

Under this approach to baseline setting using average carbon stocks, it is not clear that enough combinations of forest type and site productivity could be analyzed so that the effects of variations of site productivity within the class do not have more effect on carbon stock than management and harvesting. For example, the heights of 50-year old Douglas-fir trees on King's Site Class 3 ground range from 95' to 115'. Tree height is only a very rough proxy for carbon stock; carbon stock often changes exponentially with respect to height. At a given age, an area at the low end of the Site Class range would have trees about 10% shorter than the average for the entire site class. Presumably carbon stock on a site at the low end of the productivity range of the Site Class would be more than 10% less than the average, and the lower quality stand would have to be several years older than an average quality stand to attain the carbon stock of average stands.

The Center for Clean Air Policy recommends that the feasibility of the average carbon stock baseline methodology be tested by implementing it for two common forest types within the state, one commercial forest and one type dominated by non-commercial tree species. The test should calculate a baseline carbon stock for each site productivity class. Site class ratings may not exist for the non-commercial forest type and the test should examine whether an alternative method should be used to separate high and low productivity sites, such as a soil productivity value, precipitation, or a combination of factors. The productivity categories should be mapped onto ownership boundaries and variability of carbon stocks on different parcels within a single productivity class should be calculated. For lands with carbon stocks below the average, the length of time necessary for these lands to come up to the average carbon stock should be estimated.

Considering the results of this analysis, the testers should conclude whether or not it is feasible to implement this baseline methodology statewide. If the testers conclude that the average carbon stock methodology is not feasible, they should recommend an alternative means of setting carbon stock baselines.

Cap Level

The cap is an absolute limit on emissions that can be set at the desired level of emissions reductions (net sequestration) from the forestry sector and reflects that sector's contribution to the 2020 statewide emission limit. The cap could allow growth in emissions from this sector, but more likely would require net emissions to remain constant or decline. The chosen cap level might consider opportunity for cost-effective sequestration as well as notions of equity (such as the degree of susceptibility to international competition, expected business-as-usual changes in sequestration and the degree to which carbon prices are likely to affect production).

Recent calculations indicate that aggregate forest carbon stocks in California are increasing (California Energy Commission 2006, Birdsey and Lewis 2003).³ Under a scenario where business-as-usual sequestration is increasing, a constant cap would allow this sector to sell "anyway tons" – reductions that would have occurred anyway absent a climate policy. This business-as-usual trend might argue for a cap that requires increased sequestration that is at least equal to projected carbon stock increases. Under this scenario, the forestry sector would be allowed to earn new revenues from every additional ton of carbon sequestered beyond sequestration that was likely to occur anyway.

Some people argue that forest landowners should be required to increase sequestration or carbon stocks beyond business-as-usual projections, just as operators of electric power generation facilities will be required to reduce net emissions. Under this scenario, the sequestration cap would be set to rise faster than the projected increase in sequestration--an analog to industry being required to make significant reductions before having credits to sell.

While it is desirable to have all major sectors contribute to the climate solution, a key difference is that the forestry sector is not a major polluter. Under the "polluter pays" framework, it makes sense that all emitters contribute to the solution. However, in the case of forestry, we are asking the sector to do more of a good thing—terrestrial sequestration. There is not the same responsibility for past actions as there is for other sectors and it may not be fair to saddle the sector with the same payments. One way to address this concern is through substantial free allocation of allowances in lieu of an auction.

³ This increase in sequestration is due to a range factors, including reduced harvesting on federal forest lands, implementation of other environmental protections imposed on private forest lands, and variation in rates of logging across the past several decades.

Another concern is the difficulty and cost of discerning increases in carbon stocks required by a forest carbon cap that rises over time. Assessing whether growth in carbon stocks rises faster than a growing cap would require frequent measurement to determine whether the land is in compliance and determine the number of allowances that would need to be purchased.

In contrast, under a system where the cap is fixed, landowners would only be required to remeasure their carbon stocks if they harvest wood, clear land, or want to receive sequestration credits. If a landowner does not harvest for a number of years, that landowner has the option of not spending money to inventory their carbon stocks during the years that they are not harvesting.

From a political viability standpoint and to limit transaction costs, it may make sense to apply a cap that remains constant over time.

Addressing Planned and Unplanned Reversals of Sequestration

Forest carbon sequestration can be reversed: carbon that is stored by growing trees can be reversed by cutting down the trees and burning them or letting them rot, emitting the stored carbon back into the atmosphere.

On land ownerships where forestry is practiced, carbon stocks will rise and fall with the net of growth, harvesting, and decomposition of logging slash. In addition, all forests face a small but real risk of wildfire.

The larger and more diverse the forest ownership, the more the carbon stocks tend to approach the average. However, because of historical harvesting most ownerships have carbon stocks different from the average. Small ownerships might harvest only once every couple decades, with resulting swings in carbon stocks that last for decades.

From a GHG accounting perspective, there are two categories of reversal of sequestration, and these categories have different accounting implications. When reversal of sequestration is above the baseline, it can reverse allowances based on the sequestration. If even more loss of forest carbon occurs, carbon stocks can dip below the baseline. Carbon stocks going below the baseline could trigger an obligation for the landowner to acquire and surrender allowances. Paragraphs below address each of these two accounting situations.

Several approaches are available to assure emission accounting integrity if sequestration credits are reversed. A percentage of sequestration credits can be held back as an insurance reserve. This reserve is more robust if it is spread across many ownerships. The state could require that a percentage of all issued forest sequestration credits are transferred to a public insurance account that covers accidental reversals. Commercial insurance of credits has been discussed but commercial insurers probably will not be

willing to take on long-term obligations to replace credits for a single up-front fee, unless the insurance fee approaches the total value of the credits.

When reversal of sequestration causes a landowner's carbon stock to drop below the baseline, the obligation of the landowner can depend on whether the landowner is harvesting wood products. If the landowner is harvesting wood products, it must measure its carbon stocks and acquire and surrender allowances (or offsets) to cover any shortfall of carbon stock below its baseline. If the reversal occurs as a result of a non-anthropogenic cause, such as wildfire, and the landowner is not harvesting, the landowner has no obligation to inventory the carbon stock and no obligation to surrender allowances. If California creates a forest sequestration credit reserve to replace reversed credits, the State could consider whether losses of carbon below an entities baseline would be covered by the reserve. Alternatively, the State could create a credit bank where landowners document that their carbon stocks are above their baseline, and then are able to harvest and reduce their carbon stocks below their baseline, up to the number of ton-years that they have banked. For the first years of a forest emission cap, it may be desirable to allow limited borrowing of credits to cover deficits caused by harvesting that follows an approved forest management plan.

Wildfire losses might be addressed by the same reserve used to cover fluctuations in carbon stocks resulting from periodic harvesting, or might be covered by a separate insurance program. It is infrequent that wildfires cause a large reduction in carbon stock across an entire ownership. Even stand-replacing fires leave much of the biomass carbon in the trunks and roots of trees. If landowners are concerned about carbon losses from wildfire, an insurance program could be created where a landowner can pay a portion of the credits they are due and in exchange is insured against carbon losses caused by wildfire.

If the carbon loss occurs as a result of intentional action by a landowner (e.g. timber harvest), and the landowner does not remedy the shortfall, presumably the state would seek legal remedies.

Ownership Size and Transaction Costs

While all forested land holdings should be subject to cap-and-trade regulation, the costs of regulation relative to business size will differ for large, medium and small holdings. It may be desirable to treat large, medium, and small land ownerships differently to account for these differences.

We do not specify a particular threshold of what should be classed as a large land owner, but we envision large ownerships being entities that harvest during most years, have minimal year-to-year change in carbon stocks, and are large enough to keep periodic inventory costs down to cents per acre per year. The threshold of what constitutes a "large" ownership would probably be between 5,000 and 30,000 acres. "Small" ownerships should be small enough that forest management is ancillary to the main land

use, which may be residential or agricultural use. The determination probably would be made by property size, not by area of forest. We envision the upper size limit of "small" ownerships as being somewhere between 20 and 500 acres. Medium size ownerships would be smaller than large ownerships and larger than small ownerships. Policy makers should work with CDFPP and forest stakeholders to define appropriate thresholds.

Large ownerships should be required to maintain forest inventories if they conduct harvesting or clearing that requires a CDFPP permit. If the inventories show a decline in carbon stocks, the landowner should be required to acquire and surrender emission allowances equal to the amount of emissions, in carbon dioxide equivalent (CO₂e).

Medium ownerships that clear or harvest below a de minimus amount could be allowed to estimate emissions from harvesting or clearing using carbon tables promulgated by CDFPP. When tables are used to estimate emissions, tables could be accepted for estimating sequestration by growing trees. Above a specified amount of clearing or harvesting, medium sized ownerships should be required to conduct carbon inventories, like large ownerships.

Small ownerships should be allowed to estimate emissions from harvesting or clearing using tables promulgated by CDFPP. Small ownerships should be allowed to use carbon inventory methods similar to those required of large ownerships, should they choose. The forest carbon cap for small ownerships could be administered through local agencies that issue building permits as much of the forest clearing in California appears to be for development.

Upon submission of carbon inventory reports that show increasing carbon stocks above the cap, large landowners should be given serialized forest carbon sequestration credits that may be sold and used like emission allowances. Small ownerships should be able to apply and receive forest carbon sequestration credits based on tables promulgated by CDFPP. Medium sized ownerships might be allowed to receive up to a specified tonnage of credits based on tables and above that amount be required to submit inventory reports showing sequestration to receive more credits.

Quantification Methods

The climate change literature includes a great deal of discussion of using satellite imagery and national data sets to quantify forest carbon stock change. Forest Service Forest Inventory and Analysis data and satellite imagery would be important components of analysis that sets baseline carbon stocks and default emission rates for small ownerships. However, ground-based data collection remains the most reliable and cost effective approach to collecting forest inventory data for tracking carbon stocks on individual large and medium ownerships.

Forest inventories may be based on well-established timber inventory methods, but should include live trees down to approximately 3" in diameter at breast height (threshold

to be specified by regulation), include standing dead trees, and include coarse woody debris. Inventory methods and methods for converting inventory data to carbon stock are described in Smith et al. (2007).

Sequestration and emission tables should be promulgated for common forest types. Tables may be per acre, or per tree, or tables may be promulgated for both metrics.

For large ownerships it is economically feasible for inventories to have 90% statistical confidence that the predicted amount of carbon sequestration is accurate to +/-10%. Sampling for inventories should be unbiased. In statistics, being unbiased means that errors are randomly distributed around the true value, which means that when many measurements are made the errors will largely cancel each other. Equations for converting tree species and size to carbon stock are relatively well tested for the main species of trees in California. Although tests have found that for a particular tree of a specific size these equations often give numbers that are wrong by 5% or more, these errors should substantially cancel each other across different tree sizes and species.

Tables are usually inaccurate and experience has shown that actual amounts of carbon sequestration are often 30-50% different from amounts given in tables. Possibly these errors can be decreased by increasing the specificity of carbon tables, having more tables for different species and site productivities. It is not likely that reliable tables could be developed uneven aged management. Therefore, use of tables should be limited to small ownership classes and de minimus levels of deforestation by medium-sized ownership classes.

Single versus Multiple Credit Markets

A cap-and-trade program for forestry could be combined with a larger state-wide cap-and-trade program. Alternatively, the forestry cap could be maintained under a separate, parallel trading program. Under this approach, a predetermined share of the total reductions needed to meet the 2020 limit would be met from the forestry sector.

There are important advantages to joining the forestry program with the broader cap-and-trade program, including the potential to achieve the lowest cost emissions reductions by taking advantage of the lowest cost mitigation opportunities both inside and outside of the forestry sectors. Separate programs would lead to higher compliance costs in at least one of the markets, depending on the chosen cap levels and the relative cost of emissions reductions.

The advantage of having separate, parallel trading programs include limiting the amount of reductions that will come from the forestry sector as a hedge against the possibility that less accurate quantification methods and reversal of sequestration will reduce the certainty of meeting the overall cap.

One option would be to have a pilot parallel program that achieves a relatively small share of additional reductions from this sector for a limited period of time, say, 5 years. This could provide an opportunity to test the measurement and other aspects of the program and recommend changes to improve the credibility of the emissions reductions/increased sequestration before linking the two systems.

Conclusion

Capping emissions from California forests is tractable and would provide a pilot program that could serve as a model of U.S. and international programs that are important to achieving the overall amounts of emission reductions needed to avoid significant climate change.

References

Birdsey, RA and GM Lewis. 2003. *Carbon in U.S. Forests and Wood Products, 1987-1997: State-by-State Estimates*. General Technical Report GTR-NE-310. USDA Forest Service, Northeastern Research Station.

California Energy Commission. 2006. *Inventory of California Greenhouse Gas Emissions and Sinks: 1990 to 2004*. Staff Final Report. CEC-600-2006-013-SF. 132 p.

Lewandowski, Jan, Carol Jones, Robert House, Mark Peters, Mark Sperow, Marlen Eve and Keith Paustian. 2004. *Economics of Sequestering Carbon in the U.S. Agricultural Sector*. U.S. Department of Agriculture, Economic Research Service. Technical Bulletin No. 1909. 68 pages.

Smith, Gordon R., Bruce A. McCari, Changsheng Li, Joel H. Reynolds, Roel Hammerschlag, Ron L. Sass, William J. Parton, Steven M. Ogle, Keith Paustian, James Holtkamp, and Wiley Barbour. 2007. *Harnessing farms and forests in the low-carbon economy: how to create, measure, and verify greenhouse gas offsets*. Edited by Zach Willey and Bill Chameides. Raleigh, NC: Duke University Press, Nicholas Institute for Environmental Policy Solutions. 229 p.