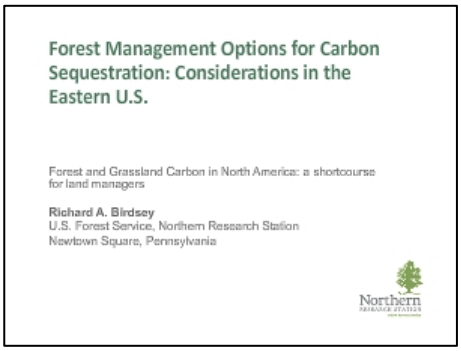
Forest Management Options for Carbon Sequestration: Considerations in the Eastern U.S.

Richard Birdsey*

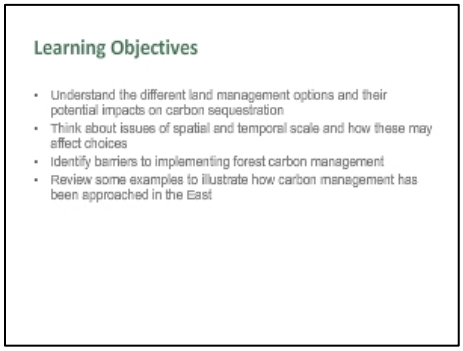
Go to presentation

Slide 1. Forest Management Options for Sequestration



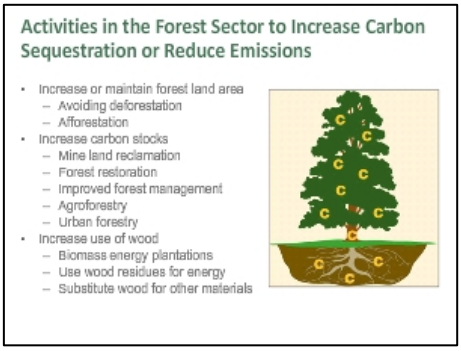
Hi, my name is Rich Birdsey. I'm a scientist with the Northern Research Station of the Forest Service, and I'm going to talk a little bit about forest management options for carbon sequestration with a particular interest in considerations for the eastern United States.

Slide 2. Learning Objectives



I have four objectives for my talk. I hope everyone will understand a little more about the different management options and their potential impacts on carbon sequestration. I'd like to think a little bit about issues of spatial and temporal scale and how these may affect the choices that land managers might make. I want to place some emphasis on the barriers to implementing forest carbon management. And finally, during the talk will review a few examples to illustrate how carbon management has been approached in the East.

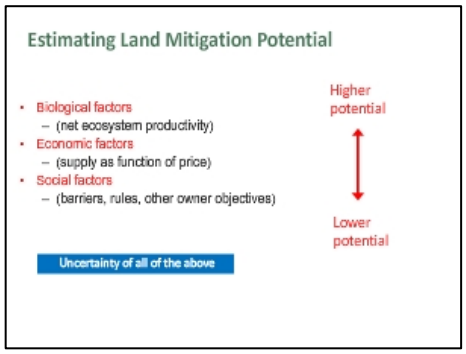
Slide 3. Activities in the Forest Sector



I'd like to start off by mentioning there's a lot of different activities in the forest sector that have been considered for increasing carbon sequestration or reducing emissions. They generally fall into three broad categories of increasing or maintaining the forestland area by either avoiding deforestation or afforestation. There are different kinds of opportunities to increase carbons stocks. I've listed several here on the slide. I'm not going to mention them all but forest restoration, or improving forest management, agroforestry are examples of ways that we might consider increasing carbons stocks. And the last category is increasing the use of wood, which may involve biomass energy plantations, using wood residues for energy, or substituting wood for other materials that may require more fossil fuel to produce.

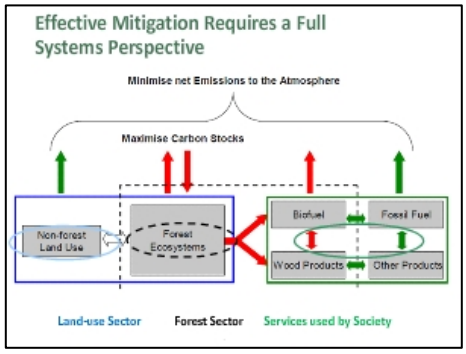
** This document transcribes the presentation given by Dr. Birdsey. The presentation is part of General Technical Report NRS-93, "Forest and grassland carbon in North America: A short course for land managers." The full report, comprised of 15 presentations, is in DVD format and can be obtained at http://nrs.fs.fed.us/pubs/order/40110. The presentations and related materials can also be accessed at http://www.fs.fed.us/ccrc/carboncourse/*

Slide 4. Estimating Land Mitigation Potential



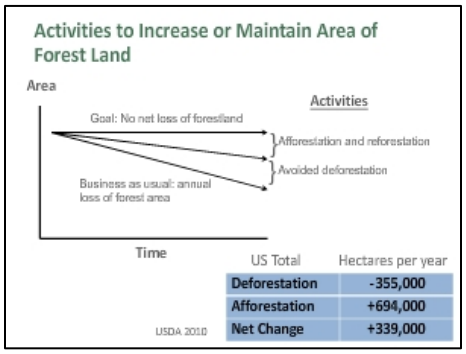
Estimating the potential for land to mitigate the amount of CO_2 in the atmosphere is a lot more complicated than just thinking about the biological factors. Biological factors are obviously incredibly important, but economic factors and social factors tend to change the potential outcome and generally foretell a lower potential. These factors usually reduce the potential that may occur. Finally, the uncertainty of all of these factors is in and of itself an important factor. Many companies, for example, fail to act when they might otherwise act if the future is a little bit too uncertain. They like to know what the rules are going to be, they like to know what the outcomes are going to be, and when all these factors are uncertain, it becomes difficult for them to make a decision.

Slide 5. Effective Mitigation



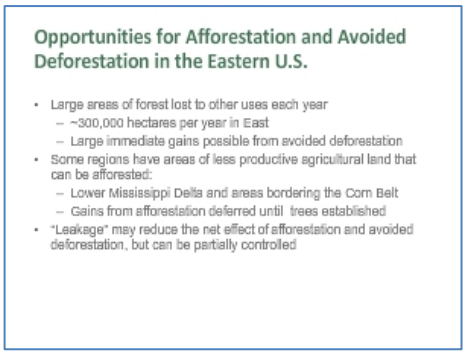
Effective mitigation requires a full systems perspective. Our overall goal is to minimize the net emissions to the atmosphere, and the only way we know we can do that is if we really take a complete accounting of all the different sectors that a forestry project or activity may involve. Often we think primarily of the forest sector, which is shown in the black box in the middle of this diagram, the black dotted line. There are several components in there, the forest ecosystem, the biofuel, and the wood products. And that's a valuable part of the system that we need to understand and quantify, but it's not the whole picture. We also need to think about how activities in the forest sector affect other land uses, and so therefore, the impacts of a forest product let's say on an alternate use for agriculture, we need to think about how that might affect emissions. We also need to look at the substitution of wood products for other products that also use or emit fossil fuels. That then gives a full systems perspective and the most complete accounting for how a project might affect carbon dioxide in the atmosphere.

Slide 6. Activities to Increase or Maintain Area of Forest Land



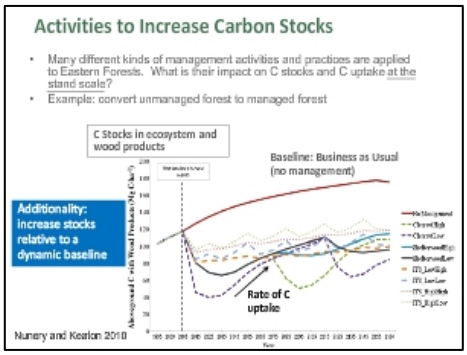
Turning now just to take a little closer look at activities to increase or maintain the area forestland. These are usually considered to include afforestation/reforestation and avoided deforestation. Under a business as usual scenario, in this example there may be an annual loss of forest area to other land uses that would have lower carbon stocks. However, there may be a goal that would involve no net loss of forestland, and so you can take the avoided deforestation plus the afforestation/ reforestation and together use those two activities to maintain the area of forest land in an area. This is an issue that's a little bit more important than is sometimes thought about in the United States. We often think of deforestation, for example, as a problem in the tropics, but in fact, as these figures show, we lose about 355,000 hectares per year of forestland in the Unites States. This deforestation is more than balanced by a larger area of forest that comes back to forest from nonforest use, so the net change in forestland is positive. Nonetheless, deforestation has the ability to take away a lot of carbon in a very short time. Think about the forests that have already built up large carbon stocks. Once these are lost they can be lost very quickly, whereas it takes a lot longer for afforestation to recover the carbon that was lost.

Slide 7. Opportunities



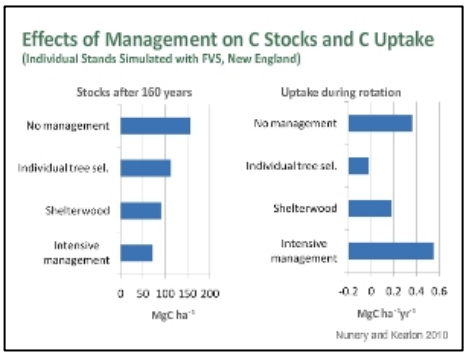
A lot of the deforestation in the United States occurs in the eastern United States where population is higher, on average, and there are some large immediate gains possible by avoiding deforestation. On the other side of the land use change coin, some regions have areas of less productive agricultural land that can be afforested. These include areas in the lower Mississippi Delta and other areas bordering the Corn Belt in the Midwest. However, the gains from afforestation, while substantial, do take a fair bit of time to accrue, and so you have to wait a little bit before that benefit will be realized. A particular issue with afforestation is leakage. Leakage refers to an effect that occurs outside of the project area that may have an opposite impact. In this case an example might be if deforestation is avoided say in one county of a state, it may simply be moved to the next county over and the deforestation would take place there. There are ways to partially control for that. One way is to do the measurement and monitoring at a larger scale, say the whole state rather than the county, and that way you've controlled the movement of the activity from one place to another.

Slide 8. Activities to Increase Carbon Stocks



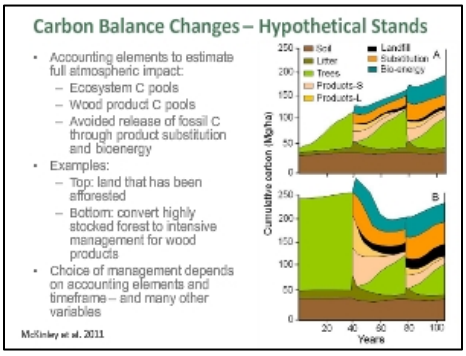
Activities to increase carbon stocks. As I mentioned on the earlier slide there are quite a few activities listed here. Many different kinds of activities and practices applied in the East. I'd like to take a quick look at their impacts on carbon stocks and carbon uptake and emphasizing at the stand scale at the moment. And I'm just going to use one example here which is to convert an unmanaged forest to a managed forest. An unmanaged forest in this example has a fairly high stock of carbon, and the baseline or the business as usual case is to continue without any active management, and that's shown by the upper line here in the graph. And this includes an accounting of carbon stocks in the ecosystem and in the wood products. Now normally most registries or markets require a demonstration of additionality, that is your action should increase the amount of carbon stocks relative to a dynamic baseline. In this case, conversion of a fully stocked forest to an intensively managed forest is almost inevitably going to reduce the amount of carbon stocks for a significant period of time. This graph, there's a lot of lines there and they show a whole bunch of different management practices, all of which result in lower carbons stocks for more than a century in this example. If you can imagine running this out perhaps two or three centuries, eventually the buildup of carbon in the wood products will cause the managed forests to more closely approach the unmanaged forest. So at some point there may be a benefit, but it may take a very long time for that to happen. I also note on this graph another way of looking at this is to look at the rate of carbon uptake rather than the carbon stocks, and you can see there are parts of the curves under the top line there where the rate of uptake will be higher than the rate of uptake in the unmanaged forest. And so there are situations where it does make sense to focus on the rate of carbon uptake and not the total carbon stocks, and we'll go into this a little more in the next few slides.

Slide 9. C Stocks and C Uptake



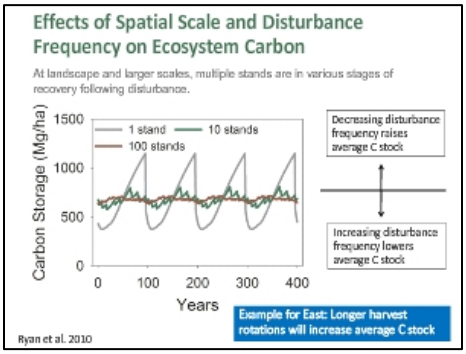
So here's the continuation of this same example. It shows that on the left-hand side, after 160 years the no management scenario has the highest carbon stocks. On the right-hand side, it shows the uptake during the rotation, and in this case the intensive management takes up more carbon than the no management scenario.

Slide 10. Carbon Balance Changes



Making things just a little bit more complicated, we need to expand the accounting system to come a little bit closer to considering all the factors that affect the amount of carbon that enters the atmosphere. So here we're not just looking at carbon in the ecosystem, which are the green bands and the brown soil carbon at the bottom, but really begin to think about the products that are in use, the products that end up in the landfill, the substitution of wood products for products that require more energy, as well as the use of wood for bioenergy. And there's two examples here. The top one shows land that has been afforested, and the bottom shows, similar to the previous example, land that had high carbon stocks and was converted into a more intensive management situation. And you can see that there are a number of different ways of looking at this and making a decision that depend on your time scale. For example, if you have a short time horizon, you might end up selecting intensive management in both cases. If you have a medium time scale, in the top example you might still go for intensive management, but in the bottom example you're in that middle part or the lower part of the curve and you might say, well if I'm thinking of 60 or 80 years, you might say well we better leave this forest alone. So the timing and the accounting elements make a difference in the choice of activities.

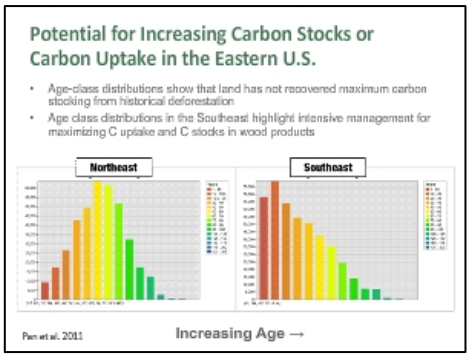
Slide 11. Spatial Scale and Disturbance Frequency



Another important point is the effects of spatial scale and disturbance frequency on ecosystem carbon. We just heard in the previous talk about how disturbance affects carbon. In the East we may think a little bit more about harvest as disturbance rather than fire. Harvest is, in many parts of the East, the main disturbance, and with harvest we have more ability to influence harvesting compared with influencing the occurrence of natural disturbances. This example in the charts shows the comparison of carbon storage over time between a single stand, a few stands, or 100 stands, and as you add more and more stands into the equation such that you're looking at a larger landscape, the curve tends to flatten out because some stands are going to be in an early stage of recovery after disturbance and others are going to be at a mid stage, and others are going to be in a later stage, so this tends to average out over a landscape. If you decrease the disturbance frequency, the average carbon stock goes up. If you increase the disturbance frequency, the average carbon stock goes down. This is something that can be manipulated in eastern forests since they are dominated by harvests. So you may then think of increasing the

rotation length or increasing the time between harvests may be a reasonable strategy to think about, which would then result in an increased average carbon stock on the landscape.

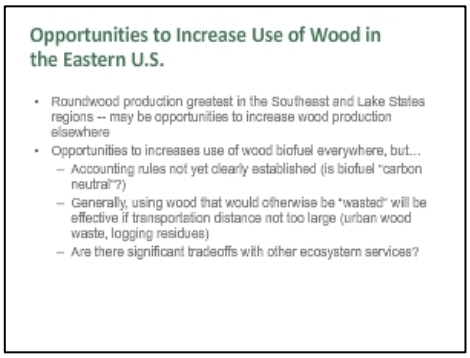
Slide 12. Increase Potential



With regard to the potential for increasing the carbon stocks in the East, one clue to what this potential is, is to look at the age class distributions of forests. In these charts the red and yellows are younger forests, and as you move toward the right, the greens and the blues are the older forest, and this is the area of each age class. So these age classes indicate that land has not yet fully covered the maximum amount of carbon that could possibly be stored there from the historical deforestation that took place through much of the eastern U.S. In other words, the distribution could be shifted to the right so there would be more green or blue colors so more forests would be of an older age.

The Southeast is a little different situation because our forestlands have evolved to be heavily oriented toward timber production, and those objectives tend to be more oriented toward maximizing the carbon uptake, and thus, maximizing the amount of carbon that's put into wood products. It's another reasonable strategy to take, and in that case, having an age class distribution that shifted to the left or to younger forests that take up carbon very rapidly, is probably a reasonable strategy.

Slide 13. Opportunities to Increase Wood Use



The wood products in the eastern United States are a critical factor because they do have quite a lot of harvesting and a lot of wood utilization. Currently round wood production is greatest in the southeast and the Lake States region. There may be other opportunities to add carbon to wood products in the East, areas where the wood is less utilized. And there's opportunities to increase use of wood biofuel everywhere. However, it's a little bit more controversial because the rules are not yet clearly established about how we account for the carbon in biofuels relative to fossil fuels. But generally there is waste wood in places that could be used if the transportation distance is not so long that a lot of fossil fuel is used to move the wood to where it can be burned. And there's some questions about the environmental tradeoffs of using wood for biofuel.

Slide 14. Economic/Social/Political Factors

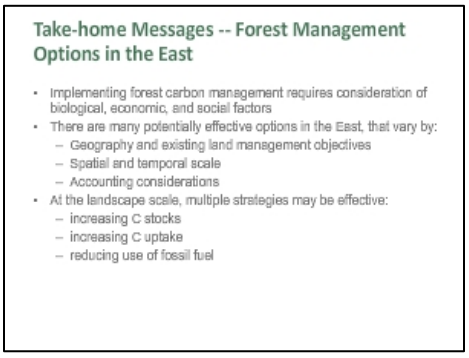
Finally, I'd like to mention a little bit about the economic, social, and political factors that may affect the potential for using forests for mitigation. A high price, for example, of carbon is a strong incentive for landowners. That would increase potential. Same way with incentives or subsidies, they also may increase potential. On the other hand, there are many other factors that are likely to decrease potential. Countries or states may restrict the list of activities that could qualify. There's a confusion of climate change action plans and registries and

so forth that may make it uncertain for people to know which are going to be the most important ones in the future. There's a lot of complexity out there, the terminology is unfamiliar, existing forest regulations by states may preclude or incentivize certain activities. There's a need for efficient monitoring technology. If it costs more to monitor than the carbon is worth then that's a disincentive. And finally, simply the lack of technology transfer of education and of knowledge by forest managers about what the opportunities are can decrease potential.

Slide 15. Strategies for C Sequestration

So what are some suggested strategies for increasing carbon sequestration? Each strategy should be evaluated by looking at many different factors and I've listed six of them here. Effects on storage and emissions, the cost of implementation, the timing of benefits, the capacity to offset CO_2 emissions, the risks and uncertainties, and often very important, the tradeoffs and the co-benefits that may occur. At the landscape scale it's worth considering a combination of both increasing carbon stocks in forests and wood products, increasing carbon uptake and avoiding loss of forest area where those approaches make the most sense. I've mentioned several times full carbon accounting is essential to evaluate the alternatives from the atmospheric perspective. And finally, the best approach is likely to be different for managers with different land conditions and different ownership objectives.

Slide 16. Take Home Messages



So for take home messages, I hope you remember just a couple of things. Implementing forest carbon management requires consideration of biological, economic, and social factors. There are many potentially effective options in the East that vary by geography and management objectives, spatial and temporal scale, and accounting consideration. And finally, at the landscape scale, multiple strategies may be effective. Increasing carbon stocks, increasing carbon uptake, and reducing use of fossil fuel all have a place in a comprehensive strategy.

Slide 17. Thank You

Thanks very much, I appreciate your attention.