



Carbon Takes Center Stage at 4th International Fire Congress

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Carbon was one of the dominant themes of the 4th International Fire Ecology and Management Congress held this past December (2009). Out of 293 papers presented at the Congress, 19 (6.5%) dealt with fire and carbon sequestration in some way, and two special sessions were completely dedicated to the topic. That is considerable in such a multi-faceted field as fire research. To further emphasize the rising importance of carbon in fire research, the Association for Fire Ecology issued a position paper during the conference, *The Role of Fire in Managing Long-Term Carbon Stores: Key Challenges*. The AFE lays out a series of concerns regarding the incorporation of an understanding of fire ecology into the rapidly developing carbon policy. Particularly, the AFE emphasizes the complexity of the role of fire in promoting long term carbon storage in fire dependent systems, and the danger of relying on suppression alone to protect carbon stocks from fire. AFE also provides a series of policy recommendations including: exemption of prescribed fire from annual carbon budget and caps, evaluation of how wildfires are considered in national carbon policy and consideration of suppression as a risk-mitigation strategy not a “remedy for curbing carbon emissions.”

Much of the increased interest in carbon is a result of looming policy changes such a potential “cap and trade” program. In addition, President Obama has issued an Executive Order mandating all federal agencies to develop plans that “consider and account for sequestration and emissions of greenhouse gases resulting from Federal land management practices.” Dave Peterson, a researcher with the Pacific Northwest Research Station, believes that the Forest Service will have detailed carbon accounting mandates and methodologies in place within three years.

Even though research into carbon sequestration has increased over the past decade, there are a lot of unknowns in the field: the effects of fire of various scales on above- and below-ground carbon stocks, the long term carbon tradeoffs of different fuels management strategies, and the potential role that climate change can play in driving the relationship between fire, forests, and carbon storage. Researchers are scrambling to fill in the gaps, but the presentations from the conference highlighted the fact that the field has not settled on the right models, assumptions, and approaches for finding the answers for carbon management.

Land managers will soon be faced with the apparent paradox of simultaneously managing forests for both fire management and carbon sequestration. Research presented at the conference showed that

researchers will be working alongside land managers to solve that puzzle. This is likely to be one of the most dynamic and important topics in fire science for the coming decade.

Carbon Sequestration and Fuels Management

The topic that has generated some of the most interest in recent years is the relative impact of different fuel treatment strategies on carbon sequestration potential. A good overview of the current state of the field, and also the research needed to fill in the gaps on fuels treatments and carbon sequestration was provided by Matt Brooks. Brooks pointed out that quantifying the full range of effects of fuels treatments on carbon sequestration potential requires understanding of the relationships between above-ground vegetation, below-ground organic and inorganic soil factors, and fires of different sizes and severities. Brooks feels that more research is needed to inform the carbon policy process and to provide recommendations to land managers attempting to balance new requirements for carbon storage with other objectives.

The Fire and Fire Surrogate study, a multi-site project examining the effectiveness and ecological consequences of mechanical fuel and prescribed fire treatments on a wide range of outcomes, also has been looking at effects of various fuel treatment strategies on carbon sequestration. The FFS study is unique in that the combination of mechanical, Rx fire, and control treatments have been replicated at 12 sites across the US. A group of researchers from the western FFS sites presented results of treatment effects on carbon pools, carbon lost from harvesting and burning associated with treatments, and the potential for carbon loss due to wildfire. They found that the amount of aboveground carbon in live trees was greatest in control plots (no treatments), followed by fire only treatments, and similar in the mechanical and mechanical followed by fire treatments. However, modeling indicated that in control treatments 70% of live tree carbon had a high chance (75%) of being killed in a wildfire, whereas most active treatments had low vulnerability to carbon loss due to wildfire.

Ralph Boerner presented more FFS results, and found that overall the effects of fire surrogates were consistently different from those of Rx fire alone. The studies found that mechanical treatments produced carbon losses in the first post-treatment year, but the losses were partially balanced by substantial carbon uptake in the subsequent two years. Carbon stored in vegetation was significantly impacted by Rx fire, but decreased significantly with mechanical and mechanical + fire treatments. The FFS studies also found that neither dead wood carbon or soil organic carbon was significantly impacted by fire or surrogates, and that the long term impact of fire surrogates on forest floor and soil carbon stocks depended on the amount and quality (carbon:nitrogen ratios) of the residues.

Matt Hurteau has been looking at the impact of alternative treatment strategies in forests with frequent surface fire regimes. Together with Malcolm North, he presented results of a study looking at pre- and post-treatment carbon stocks and emissions for three levels of thinning and two levels of burning in Sierran mixed conifer forests. The study also modeled the impacts of different treatments on long-term carbon stocks under high-severity wildfire conditions. Overall, they found that thinning smaller trees and retaining large-diameter, fire-tolerant pines provides the most favorable outcome for long-term carbon stocks that are resistant to high-severity wildfire.

In contrast, in a modeling study of forest types in the northern Rockies, Elizabeth Reinhardt and Lisa Holsinger found that fuel treatments decreased fire severity and crown fire occurrence, but did not increase post-wildfire carbon stored on site. They found that untreated stands had greater wildfire emissions but stored more carbon post-fire.

In one of the only papers presented in relation to carbon processes in southern forests, Dave Godwin presented preliminary results of a study examining the effects of prescribed fire on soil carbon pools and fluxes. The study is designed to measure soil carbon respiration rates in relation to different prescribed fire burning regimes over a two year period, and data collection has only recently begun, but a number of patterns have become apparent. Godwin found higher respiration rates in long unburned areas than in frequently burned ones. He also found that soil respiration rates vary monthly between late summer and early fall, and a distinct correlation between temperature and soil respiration rates. Data collection will continue over two more years and will include more forest types.

Fire Management and Carbon

One of the key challenges to carbon management is the widespread and rapid changes in fire regimes across the West. Understanding the effects of fire on long-term carbon storage potential is difficult in such a dynamic fire environment. A number of studies were aimed at trying to create baseline sets of results for estimating the effects of variable fire rotations on carbon pools. Crystal Raymond presented results from a study designed to model live biomass carbon accumulation and net primary productivity as a function of stand age in the Western Cascades of Washington. Raymond hopes to be able to combine the age-based patterns of carbon dynamics with landscape age-class distributions to create a method for estimating the potential impact of changes in fire rotations on carbon dynamics.

There is concern that the severe fires that have recently become more common have pushed ecosystems into carbon “tipping points.” In essence this means that fire severity reduces post-fire tree regeneration and the ecosystem changes from high-carbon storage forest to low carbon storage grasslands or other ecosystem types. Erica Smithwick presented results of a study modeling the influence of fire frequency, size, and severity on seedling regeneration and landscape carbon storage in the PNW. The researchers found that increasing fire size and severity will slow tree regeneration rates, but this is only significant for carbon storage potential when the fire return intervals are short. At longer intervals, reduced rates of regeneration did not affect long-term carbon storage potential. The researchers concluded that characteristics influencing ecosystem recovery are site-dependent and cannot be modeled from characteristics of fire regime alone. In other words, more research is needed into recovery processes in order to make accurate predictions about changes in long-term carbon storage with changes in fire regimes.

And, Of Course, There is Climate Change

The effects of warmer weather over the coming decades will be variable in different parts of the country, and there are considerable unknowns in how climate change will play out in different regions. Two studies presented the Fire Congress modeled the impacts of different climate scenarios and fire management approaches on carbon dynamics. Rebecca Kennedy presented results of a study in Olympic NP that found that under a warmer, drier climate, fires were more frequent and severe, and this led to a reduction in long-term carbon storage in older forests. And, a warmer, wetter scenario also led to lower carbon stocks over time as the wetter weather led to a build-up of fine fuels and more frequent fires even with suppression. However, in a study in Glacier NP in the Northern Rockies looking at a range of potential future climate conditions, another group of researchers found that wetter, milder conditions led to greater retention of carbon. Simulations also showed that under many scenarios, ecosystems were able to recover short-term losses to fire and return to pre-fire sequestration rates unless the fire-climate interactions create a “threshold response” such that landscapes are not able to recover existing sequestration rates. This finding echoes that of Smithwick in looking at ecosystem regeneration and “tipping points.”

Final Thoughts

What we learned is that fire and fuel treatments can have positive, negative, or neutral implications for carbon management. We also learned that different models and different assumptions lead to different answers. No surprises there. But, it is apparent that research into carbon sequestration is increasing rapidly and starting to generate a flurry of methodologies and approaches, out of which will likely emerge the types of results and insights that natural resource managers can use.

Advances in Fire Practice is a sub-site of wildfirelessons.net and is focused on bringing efforts and ideas to the forefront that leaders in the fire management, practice, and research communities have identified as innovative and widely applicable. It provides access to critical and proven fire information and resources. Advances in Fire Practice section can be reached directly by going to <http://www.wildfirelessons.net/AFP.aspx> or through the main Wildland Fire Lessons Learned Center website at www.wildfirelessons.net.

The Wildland Fire Lessons Learned Center actively promotes a learning culture for the purpose of enhancing safe and effective work practices in the entire U.S. wildland Fire community. It is located at the National Advanced Fire & Resource Institute in Tucson, Arizona.

