Carbon Cycle Science

Quantifying the carbon cycle and potential for carbon sequestration on the Tongass National Forest

Issue

Carbon cycle science is important to research and land management because carbon dioxide accumulation in the atmosphere is linked tightly to climate change. The Tongass National Forest, a carbon-rich temperate rainforest, contains 7% of total U.S. forest carbon storage, making it significant in regional and global carbon cycles. Carbon dioxide incorporated into the forest is lost as the greenhouse gases CO_2 and methane, and in organic forms discharged from rivers. A fraction of the cycling carbon is retained as long-term soil carbon storage leading to the immense accumulation. However, controls on carbon sequestration, and the actual amount sequestered in the Tongass are unknown so it is impossible to predict the impact of a warming climate on the net carbon balance.

Background

The Tongass includes the largest intact area of the coastal temperate rainforest (CTR) biome remaining. Because of abundant rainfall and cool temperatures, coastal rainforests sequester large amounts of carbon, which may help to offset global carbon emissions. Carbon transfers to marine ecosystems may subsidize production of important marine species. However, the magnitude of carbon fluxes in both terrestrial and aquatic systems and their sensitivity to climate change is poorly quantified. The Pacific Northwest Research Station (PNW) is collaborating with the Tongass to determine the potential for forested and wetland ecosystems to sequester carbon and to determine the potential for managed young growth stand to increase carbon sequestration. This initiative will address the emerging mandate to determine how forest carbon sequestration can help offset increases in atmospheric carbon dioxide.

Current Situation

Interest in the storage and cycling of carbon in coastal temperate forests has increased with recognition that the vast carbon store within them may not be stable under a warming climate. The CTR extends from the Gulf of Alaska to northern California and is an area of rapid biogeochemical exchange among terrestrial, marine and freshwater ecosystems. The cool, wet conditions promote the development of coniferous forests and soils that accumulate organic matter. Wetlands and poorly drained soils dominate the landscape, where wetlands alone comprise 21% of the watershed land area. Climate warming will have potentially profound

impacts on soil processes, forest structure, stream hydrology, and the large and valuable salmon fishery. A collaborative carbon cycle research project is led by the PNW, the University of Alaska Southeast, the University of Alaska Fairbanks, with assistance from the Tongass. This project has measured carbon fluxes in several key areas including: dissolved organic carbon export from forested wetlands, bogs and uplands; regional watershed dissolved organic carbon concentrations in over 60 watersheds; soil respiration measurements across vegetation types; and storm fluxes of dissolved organic carbon in tributary streams.

Summary

Carbon sequestration has become a high priority for forest managers as a mitigation measure for increased atmospheric carbon dioxide. However, there are many uncertainties in forest management and soil carbon cycling that make estimating carbon sources and sinks difficult. An integrated terrestrial and aquatic research program is addressing the major fluxes of carbon in both these ecosystems in an attempt to reduce the uncertainty in quantifying the carbon cycle in coastal temperate rainforest ecosystems. This research coupled with adaptive management applications will provide information on the magnitude of the carbon sink or source on the Tongass. This information can then be applied to regional and national carbon sequestration goals.

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