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Abstract

Issues in Ecology
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A Synthesis of the Science on Forests and Carbon for U.S. Forests
Michael G. Ryan, Mark E. Harmon, Richard A. Birdsey, Christian P. Giardina, Linda S. Heath, Richard A. Houghton, Robert B. Jackson, Duncan C. McKinley, James F. Morrison, Brian C. Murray, Diane E. Pataki, and Kenneth E. Skog
Report Number 13
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Summary

Forests play an important role in the U.S. and global carbon cycle, and carbon sequestered by U.S. forest growth and harvested wood products currently offsets 12-19% of U.S. fossil fuel emissions. The cycle of forest growth, death, and regeneration and the use of wood removed from the forest complicate efforts to understand and measure forest carbon pools and flows. Our report explains these processes and examines the science behind mechanisms proposed for increasing the amount of carbon stored in forests and using wood to offset fossil fuel use. We also examine the tradeoffs, costs, and benefits associated with each mechanism and explain how forest carbon is measured.
Current forests are recovering from past land use as agriculture, pasture, or

harvest, and because this period of recovery will eventually end, the resulting forest carbon sink will not continue indefinitely. Increased fertilization from atmospheric nitrogen deposition and increased atmospheric carbon dioxide may also be contributing to forest growth. Both the magnitude of this growth and the future of the carbon sink over the next hundred years are uncertain. Several strategies can increase forest carbon storage, prevent its loss, and reduce fossil fuel consumption (listed in order of increasing uncertainty or risk):
-Avoiding deforestation retains forest carbon and has many co-benefits and few risks.
-Afforestation increases forest carbon and has many co-benefits. Afforesting ecosystems that do not naturally support forests can decrease streamflow and biodiversity.
-Decreasing harvest can increase species and structural diversity, with the risk of products being harvested elsewhere and carbon loss in disturbance.
-Increasing the growth rate of existing forests through intensive silviculture can increase both forest carbon storage and wood production, but may reduce stream flow and biodiversity.
-Use of biomass energy from forests can reduce carbon emissions but will require expansion of forest management and will likely reduce carbon stored in forests.
-Using wood products for construction in place of concrete or steel releases less fossil fuel in manufacturing. Expansion of this use mostly lies in the non-residential building sector and expansion may reduce forest carbon stores.
-Urban forestry has a small role in sequestering carbon but may improve energy efficiency of structures.
-Fuel treatments trade current carbon storage for the potential of avoiding larger carbon losses in wildfire. The carbon savings are highly uncertain.
Each strategy has risks, uncertainties, and, importantly, tradeoffs. For example, avoiding deforestation or decreasing harvests in the U.S. may increase wood imports and lower forest carbon elsewhere. Increasing the use of wood or forest biomass energy will likely reduce carbon stores in the forest and require expansion of the area of active forest management. Recognizing these tradeoffs will be vital to any effort to promote forest carbon storage. Climate change may increase disturbance and forest carbon loss, potentially reducing the effectiveness of management intended to increase forest carbon stocks. Finally, most of these strategies currently do not pay enough to make them viable. Forests offer many benefits besides carbon, and these benefits should be considered along with carbon storage potential.

forest dynamic, gap dynamic, succession
forest management
forest use

forest ecology
climate: climate change
ecosystem: mass, water and energy cycling
Notes

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