Carbon as One of Many Management Objectives

Preparers

Maria Janowiak, Northern Institute of Applied Climate Science, US Forest Service, Houghton, MI.
Chris Swanston, Northern Institute of Applied Climate Science, US Forest Service, Houghton, MI.
Todd Ontl, Northern Institute of Applied Climate Science, US Forest Service, Houghton, MI.

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Management objectives dictate the decisions land managers make. These objectives vary widely based on the landowner as well as the conditions of the ecosystem in question, and objectives may include any number of desired ecosystem benefits: water protection, wood production, wildlife, specific recreational opportunities, aesthetics, privacy, and more. Greenhouse gas mitigation is thus part of a wider array of management aims for forests and grasslands. Managers may choose to incorporate greenhouse gas mitigation as a management objective for a number of reasons, including increasing forest productivity or deriving benefits from participating in carbon markets. However, focusing solely on carbon could lead to non-optimal management decisions, and, in some situations, managing for carbon benefits may be at odds with other goals.

The tradeoffs inherent in balancing multiple management goals necessitate the recognition that it may not be possible to meet all goals, including those for carbon, in a single stand or at a single point in time (15). Consideration of the effects of management actions on carbon require thinking broadly across large spatial scales and long timeframes to determine the true effects on atmospheric greenhouse gases (4). The following topics represent some examples of tradeoffs between carbon and other management goals or intentions; it is not meant to be an exhaustive list, but rather to illustrate some of the considerations that factor into carbon as one of many management objectives.

Wildlife and Carbon

The effects of wildlife management activities on carbon vary widely depending on the ecosystem and habitat characteristics of the location in question. For many habitats, management can provide carbon as a co-benefit in addition the many other forest uses and values, but in some cases people may decide to maintain lower carbon stocks as a side effect of pursuing other values, such as wildlife habitat. For example, forest restoration activities for the endangered red-cockaded woodpecker in the Southeast United States use thinning and prescribed burning to emulate frequent fire and maintain longleaf pine at low densities, which results in lower carbon densities (16). In the Cascade Mountains of Oregon, management activities to increase forest carbon storage are

expected to benefit some wildlife species, such as the northern spotted owl and olive-sided flycatcher (17). Management to maintain high forest carbon levels, however, may not be as conducive with providing habitat for other species more dependent on early seral or less dense conditions like the pileated woodpecker and western bluebird.

Water and Carbon

The provisioning of water is another ecosystem service that, like carbon sequestration, is highly valued within forests and grasslands. Many organizations have land management objectives to protect water quality and maintain water quantity, including the timing and location of delivery (18). Because water is an integral part of ecosystems, land management activities can affect, both positively and negatively, the hydrologic cycle; likewise, changes in the hydrologic cycle—such as those that are occurring as a result of climate change—will invariably affect ecosystem functions including carbon sequestration (18, 19). For example, an analysis of multiple studies of afforestation activities showed substantial reductions in stream flow that lasted multiple decades due to increased water demands from plantation trees (20). At the same time, afforestation practices can improve water quality by reducing erosion, mitigating peak flows, and increasing filtration and groundwater recharge, in addition to providing other important ecosystem benefits (20). In natural (nonplantation) forests, there are many areas in which management can increase both carbon and water benefits. Harvesting woody residue as a source of renewable energy may provide greenhouse gas mitigation benefits by replacing fossil fuel emissions, but these activities may reduce the ability of the forest regulate water quality and quantity or store carbon (21). Lower-intensity silvicultural practices may allow for wood harvest while also supporting water- and carbon-related ecosystem services (21, 22).

Risk Reduction

Observation indicates that risks to ecosystems and their associated human communities from undesired wildfire, insect and disease outbreaks, and invasive species (23, 24) are increasing, and that these can lead to carbon reductions (25). Management actions can often focus on reducing such risks and creating more resilient and adapted systems. Management activities to reduce risk can affect the carbon cycle in numerous, often complex ways. For example, forest management is increasingly used to reduce risk of undesired wildfire by reducing fuel loads, while also meeting management objectives related to restoration of fire-adapted communities (26-28). There is some evidence, described above, to suggest that fuel reduction treatments, which reduce forest carbon in the short term, may have long-term carbon benefits by increasing the growth of the residual stand and reducing risk of catastrophic fire (5, 29, 30). Fuel reduction treatments may have the most substantial carbon benefit when harvest removals are relatively light, near-term fire occurrence is high, the treatments are effective, and thinnings provide wood for energy or products for long-term substitution (6).

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Recommended Reading

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Tools

COLE (Carbon OnLine Estimator)

COLE is a versatile and appropriate tool to use for a wide range of carbon estimation needs. COLE draws from Forest Inventory and Analysis (FIA) data to provide basic carbon inventory and growth-and-yield estimates for a particular forest, region, or state.

ecoSmart Landscapes

This tool can help members of the public, cities and other organizations estimate the carbon and energy impacts of trees. The online tools provide quantitative data on carbon dioxide sequestration and building heating/cooling energy savings afforded by individual trees. Results

can be used to estimate the greenhouse gas benefits of existing trees, to forecast future benefits, and to facilitate planning and management of carbon offset projects.

First Order Fire Effects Model (FOFEM)

FOFEM is a model that predicts first-order fire effects including tree mortality, fuel consumption, emissions (smoke) production, and soil heating caused by prescribed burning or wildfire.

Forest Inventory Data Online (FIDO) and EVALIDator

FIDO and EVALIDator applications both draw from US Forest Service FIA (Forest Inventory and Analysis) data to produce estimates with associated sampling errors for user selected forest attributes. Carbon estimates can be produced for several carbon pools, including total forest carbon, above and belowground carbon in live trees, standing dead trees, and live seedlings shrubs and bushes; litter; soil; and stumps, roots and woody debris.

Forest Planner

The Forest Planner enables landowners to visualize alternative forest management scenarios for their properties. It compares user selected areas to forest stands from a national database to estimate management outcomes including timber stocking and yields, harvest costs and revenues, carbon storage, and fire and pest hazard ratings. The tool does NOT account for the effects of projected climate change on future timber and carbon estimates.

Forest Vegetation Simulator (FVS)

Natural resource managers are increasingly interested in the effects of planned management activities on carbon stocks. The Forest Vegetation Simulator (FVS) is a family of forest growth simulation models that allow a user to explore how silvicultural treatments may affect growth and yield (and, therefore, carbon stocks). "Suppose" is the name for the graphical user interface for FVS.

Fuel and Fire Tools (FFT)

Fuel and Fire Tools (FFT) is a software application that uses fuels data classified as fuelbeds to let users perform a variety of calculations related to fire behavior and emissions. These include predicting surface and crown fire behavior, fuel consumption, pollutant emissions (including carbon emissions), and heat release. The FFT integrates several tools that were previously stand-alone into a single user interface (including the FCCS).

Global Carbon Atlas

The Global Carbon Atlas gives audiences a number of ways to visualize carbon dioxide emissions and flux data, and to compare between countries and regions over time (1960 – 2012). Its products are grouped into three main categories that are intended for users with

varied technical backgrounds. All products are based on current datasets and models contributed by scientists and research institutions (see Contributors).

i-Tree

i-Tree consists of several different applications focused on quantifying the benefits of local trees for neighborhoods and communities. Each application has a unique focus, however several calculate the carbon sequestration and/or energy savings benefits of urban trees, including i-Tree Eco, i-Tree Streets, i-Tree Vue, and i-Tree Design (beta).

NASA - CASA Global CQUEST - Carbon Query and Evaluation Support Tools

This application from NASA provides datasets and a viewer for geographic data that support large-scale carbon inventory. The datasets combine NASA remote sensing technology, ecosystem process modeling, and field-based measurements to characterize impacts on the carbon cycle.

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