PNW
Pacific Northwest
Research Station

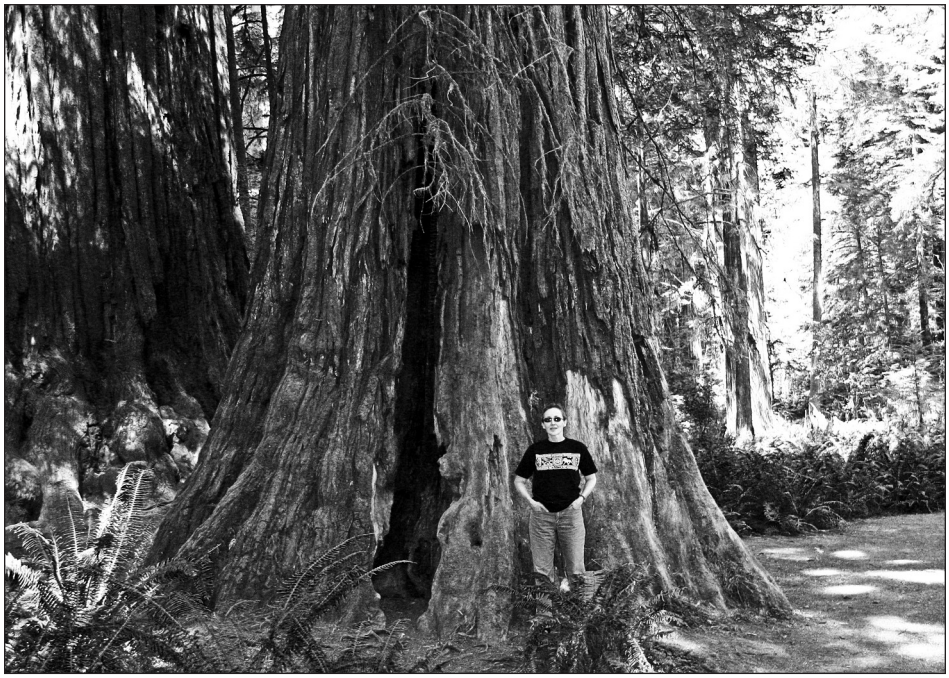
Science
FINDINGS

INSIDE

issue one hundred sixteen / september 2009

"Science affects the way we think together."
Lewis Thomas

WE'RE ALL IN THIS TOGETHER: DECISIONMAKING TO ADDRESS CLIMATE CHANGE IN A COMPLEX WORLD



Ralph Alig

About half of the world's terrestrial carbon is stored in forest ecosystems.

"Trees can reduce the heat of a summer's day, quiet a highway's noise, feed the hungry, provide shelter from the wind and warmth in the winter. You see, the forests are the sanctuaries not only of wildlife, but also of the human spirit. And every tree is a compact between generations."
—President George H.W. Bush, 1989

Concern about climate change has placed forest management in a different light. Because growing trees is currently a technologically feasible way to sequester and store large amounts of carbon, managing forests to increase their capacity to do so may become another significant component of forest management.

Determining the role of public and private forest management in strategies for mitigating and adapting to the impacts of climate change is challenging, both from a technical standpoint and in terms of facilitating participation by willing landowners.

When tallying the global carbon budget, there are three components to consider: storage capacity, emissions, and sequestration—the process through which trees and plants absorb atmospheric carbon dioxide during photosynthesis and store, or sequester, it in their permanent tissues.

IN SUMMARY

Forests significantly influence the global carbon budget: they store massive amounts of carbon in their wood and soil, they sequester atmospheric carbon as they grow, and they emit carbon as a greenhouse gas when harvested or converted to another use. These factors make forest conservation and management important components of most strategies for adapting to and lessening the impacts of climate change. Developing these strategies is complicated by the constant interplay between forest ecosystems and climate, which impacts the costs and effectiveness of mitigation.

Researchers at the PNW Station have developed novel methods for integrating the complex relationships between human decisions, forest ecosystems, and the climate system. Their work shows that there is substantial room for increased carbon storage on public and private forest land. Sequestering large amounts of forest carbon, however, could require significant funding for incentives to induce private owners to conserve forests, which during the 1990s were converted to developed uses at a rate of more than 1 million acres per year. Because climate change is such a far-reaching topic, policy alternatives must be evaluated in terms of land-use changes, forest management strategies, and connections to other sectors of the economy.

Forests and their management contribute to all three components.

About half of the world's terrestrial carbon is stored in forest ecosystems. Without forests, the world would be a much warmer place because much of that carbon would be incorporated into heat-trapping greenhouse gases in the atmosphere. This brings us to emissions. Activities leading to forest loss and degradation worldwide currently account for 20 to 25 percent of human-caused carbon emissions—second only to the combustion of fossil fuels. What's more, forest fires and natural decomposition emit massive amounts of carbon each year. Finally, there is carbon sequestration. Currently, forests sequester carbon at an amount equal to 10 to 15 percent of annual fossil fuel emissions per year.

Keeping tabs on all the ways that forests affect the climate is complicated by all the reciprocal ways that the climate affects forests. Increases in greenhouse gases could result in a warmer climate and perhaps more climate variability. Warmer temperatures, in turn, can increase the productivity of forests in some northern regions—meaning they sequester more carbon dioxide and can slow the rate of warming. Of course, warmer temperatures can also lead to droughts, changes in forest composition and distribution, more wildfires, and more emissions. And round and round we go. It's an accounting nightmare.

KEY FINDINGS

- Public forests in the United States represent about 20 percent of the timberland area and hold 30 percent of the timber volume. Future public land management will have considerable impact on the U.S. forest carbon balance.
- In the 1990s, each day 6,000 acres of open space were converted to developed uses in the United States as more people chose to live at the urban fringe and in scenic, rural areas. As part of that open space loss, the United States converted more than 1 million acres of forest annually to other uses, which has greatly reduced forest-based carbon sequestration benefits.
- If current trends among landowners continue, about 6 percent of existing forests will be lost (on net), mainly to more developed uses, by the year 2062.

Ralph Alig, a research forester with the Pacific Northwest Research Station in Corvallis, Oregon, is unraveling the feedbacks and integrating the human and natural dynamics that influence the forest-climate system. He and his colleagues have developed several techniques to track the dynamics of humans and forests with respect to climate change.

"Policymakers are facing urgent calls to protect the global environment from additional emissions of greenhouse gases leading to more climate change and further environmental harm, while helping maintain or improve standards of living as the world adapts to the unavoidable climate change," says Alig. "We provide decision support for formulating and analyzing integrated policy alternatives."

For scientists to advise decisionmakers, they need to understand the connections between ecology and economics—at local to global scales—and they need to identify the key relationships between human and natural systems. "In this interconnected world, distinctions between disciplines are essentially artificial," he says. "Global climate change elevates the need for research to move toward a holistic perspective in planning and conducting research to answer integrated policy-relevant questions." For example, one such question involves determining the links between carbon management, fire management, and woody bioenergy production because each can have a profound impact on the carbon balance, ecological integrity, and socioeconomic value of the forest.

LANDOWNER DECISIONS AFFECT US ALL

"Millions of private landowners are key players in how the world's land base is currently utilized," says Alig. "Their decisions influence how the land might be used to increase carbon sequestration and help address global climate change either through adaptation or mitigation or both. About two-thirds of carbon stored on U.S. timberland is on private lands, and these private lands offer substantial opportunities for more storage," he explains.

"Whether that potential is realized will depend partially on motivations of landowners and their response to market signals and other incentives." In addition, market forces will affect opportunity costs for landowners as more landowners become involved in carbon-related markets. The sociopolitical influences will also be important as the country looks at alternative ways to address climate change.

Many forest management choices directly impact the amount of stored carbon. Consider the aptly named "pickling rate," which describes the proportion of carbon that is permanently stored as wood products, as opposed to that lost to the atmosphere after harvest. When trees are harvested and converted into large wooden beams in a house, for example, they have a higher pickling rate than do trees that are harvested for paper products. According to Alig, policies or market forces that promote higher pickling rates and management toward longer term forest products can have a significant impact on our carbon balance. Projections indicate that more carbon could be sequestered via that wood-product pickling route than in modifying agricultural soil tillage practices, for example.

It's not just private landowners. "Public forests in the United States represent approximately 20 percent of the timberland area and also hold a large share (30 percent) of the timber volume," says Alig. "With such a large standing timber inventory, these public forest lands have considerable impact on the forest carbon balance."

To help decisionmakers understand the carbon implications of potential changes in public

Purpose of PNW Science Findings

To provide scientific information to people who make and influence decisions about managing land.

PNW Science Findings is published monthly by:

Pacific Northwest Research Station
USDA Forest Service
P.O. Box 3890
Portland, Oregon 97208

Send new subscriptions and change of address information to:

pnw_pnwpubs@fs.fed.us

Rhonda Mazza, editor; rmazza@fs.fed.us
Keith Routman, layout; kroutman@fs.fed.us

USDA United States Department of Agriculture
Forest Service

Science Findings is online at:
http://www.fs.fed.us/pnw/publications/scifi.shtml

forest land management, Alig and several colleagues recently analyzed several potential forest management scenarios. They found that eliminating harvests on public lands in the United States would result in an annual increase of 17 to 29 million metric tons of carbon storage per year, equivalent to the carbon dioxide emitted by about 4 to 7 million cars per year. The additional carbon storage due to not harvesting represents as much as a 43-percent increase over current carbon sequestration levels on public timberlands and would offset up to 1.5 percent of total U.S. greenhouse gas emissions. Nearly 70 percent of the public land analyzed in these scenarios includes forests where fire risk, insect outbreaks, and disease prevention are key management concerns. Thinning and controlled burns, activities that do emit carbon, are two common practices to address these issues, illustrating the nuanced understanding needed for effective carbon management.

Eini Lowell

Carbon sequestered by the tree remains stored in long-lasting wood products for the life of the product.

In contrast, moving to a more intense harvesting policy, similar to that which prevailed in the 1980s, may result in annual losses of carbon stored in forest ecosystems of 27 to 35 million metric tons of carbon per year. These losses would represent a 50- to 80-percent decline in anticipated forest carbon sequestration relative to that associated with the existing timber harvest policies.

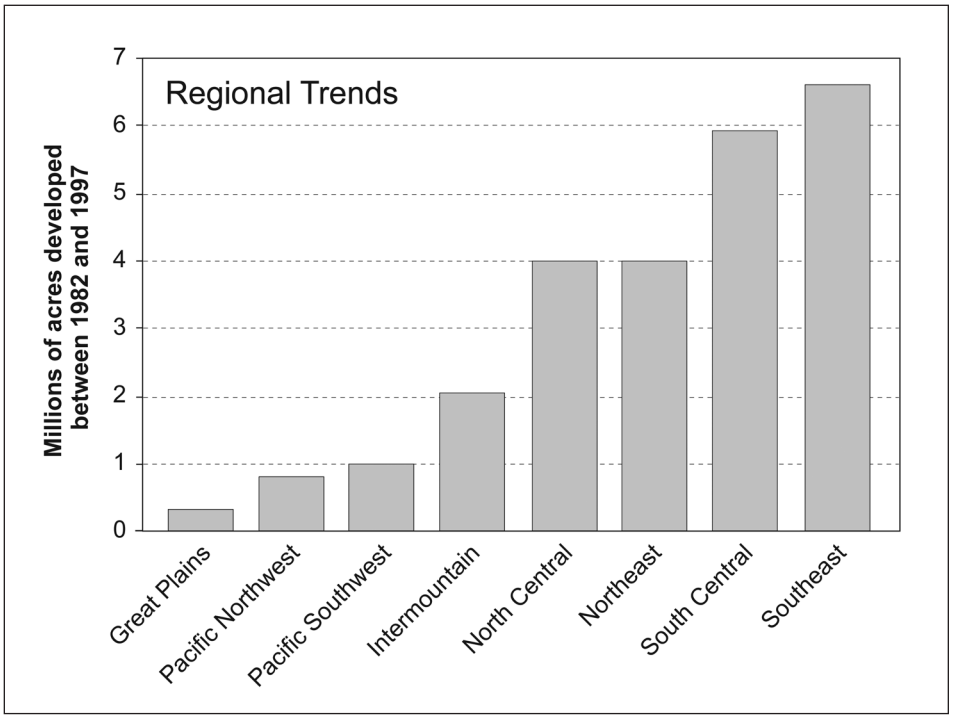
As of now, the role of public forest as a carbon sink is somewhat of an abstraction compared to the jobs and revenue created by timber sales. "If carbon sequestration were valued in the marketplace as part of a greenhouse gas offset program, the economic value of sequestered carbon on public lands could be substantial relative to timber harvest revenues under some future scenarios," says Alig.

KEEPING FORESTS IN TREES

Deciding to keep their land forested—as opposed to converting it to a more developed use—is the single most important decision that forest owners confront with regard to carbon storage and global climate change.

"In the 1990s, each day we were losing 6,000 acres of open space in the United States as more people chose to live at the urban fringe and in scenic, rural areas," says Alig. Nearly half of this loss came from forests, which has greatly reduced the amount of forest carbon storage and sequestration. Generally speaking, increases in population and personal income are the key determinants of deforestation in the United States. No surprise, then, that urbanization is considered the biggest threat facing our forests.

"Adding another 125 million people in the United States over the next half century may lead to a net reduction in the area of private timberland available for carbon sequestration," he says. "The amount of developed area, which would hold less carbon, is projected to increase from almost 100 million acres in 1997 in the United States to 180 million acres by 2025."



The conversion of forests to home lots and other developed uses has a significant impact on the climate system. In recent decades, human population growth and deforestation in the South has outpaced other parts of the country; this trend is expected to continue into the future.

"Overall, if we assume that landowners will behave as they have in the past under a "business as usual" scenario, and we project our findings out to the year 2062, we expect a net loss of about 6 percent of the existing forests," says Alig. "To avoid this level of deforestation could require significant amounts of funding for incentives to induce private owners to conserve forests, including use of conservation easements as through the Forest Service's Forest Legacy program, or an updated mixture of incentives and regulatory measures." Land values for developed uses can be many times those of the land in forest use, so it is not likely that some forested acres

WRITER'S PROFILE

Jonathan Thompson is a forest ecologist and science writer based in Petersham, Massachusetts.

can be maintained solely by using financial incentives.

Interestingly, during the past few decades, while many forests were lost to urbanization, many other new forests have emerged. Abandoned agricultural lands have naturally become forested, and in some cases, been actively converted to pine plantations. This process, referred to as afforestation, has largely offset the total forested acres lost over the past two decades. However, over the longer historical period from 1963 to 1997 for which statistics are available, there was a net loss of 15 million acres of forest area in the United States. A trend toward afforestation is certainly good news from a carbon point of view, but it is important to realize that an acre of new forest stores and sequesters less carbon than an acre of older, established forest.

FORESTS AND ENERGY

The world's forests are also increasingly coupled to the choices we make about energy. For example, for the past several years, as countries seek to reduce their use and reliance on fossil fuels, the demand for corn-based biofuel has increased substantially. This has had some surprising unintended impacts on forest conservation.

"Government subsidies for agricultural production of corn-based ethanol are prompting many landowners to convert their conservation lands into agricultural commodity production," explains Alig. "Environmental and hunting groups are concerned that years of progress in land conservation could soon be lost. However, other interest groups—such as snack food, ethanol, and livestock groups—say that bigger agricultural harvests are more important."

"This illustrates the socioeconomic tension that policymakers face. Some constituents want the government to ease restrictions on the conserved land, and release land from the Conservation Reserve Program so that it can be used to grow corn and other commodity crops. A host of possible impacts arise, including impacts on food and fiber prices, wildlife habitat, water quality, and many others involving forest and agricultural ecosystems. Our research helps to point out the implications and tradeoffs inherent in such land-use decisionmaking." Alig's team is also analyzing the competitiveness of forest-based bioenergy, such as use of logging and mill residues, under a number of scenarios about future fossil fuel prices.

Ralph Alig

Land-use competition among forestry, agriculture, and development influences the amount of terrestrial carbon storage, and can be notably influenced by policy.

Charlie Rahn

Increased demand for corn-based biofuel has prompted some landowners to bring land that had returned to trees back to agricultural use.

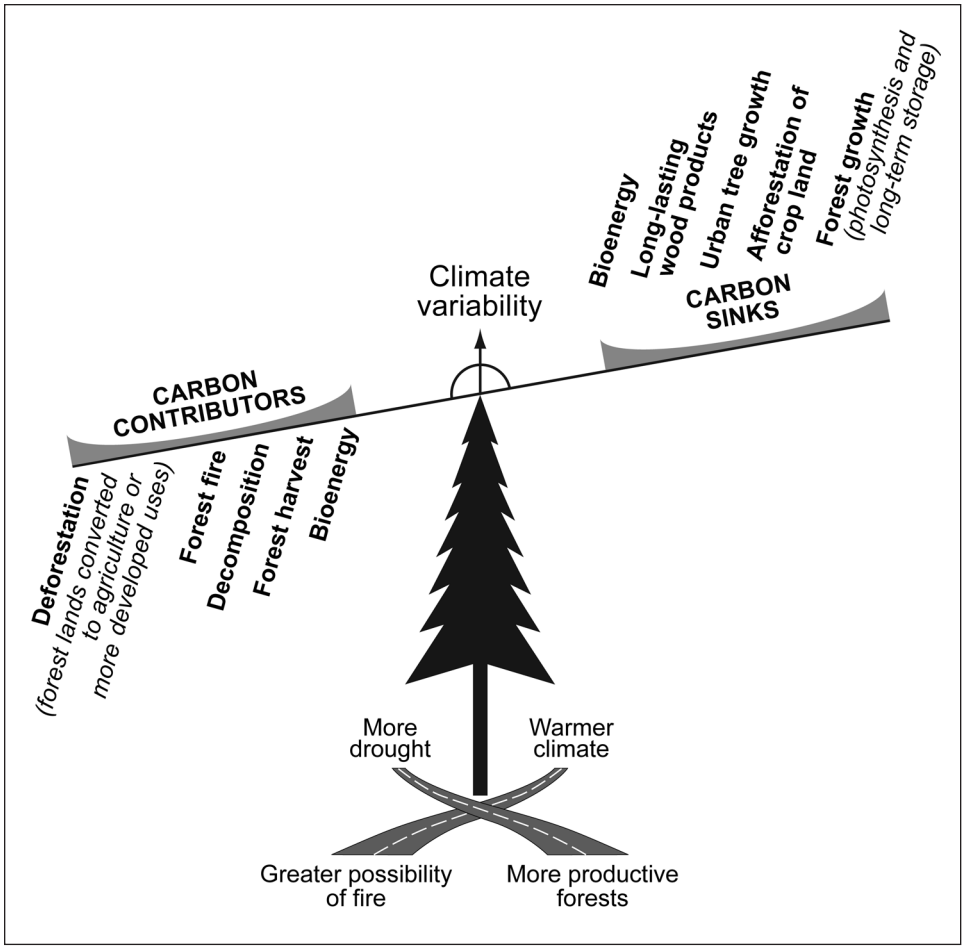
INTEGRATIVE THINKING

Novel analytical techniques are needed to track the interrelationships between forests, people, and the climate. Alig and his colleagues have been developing and refining an integrated modeling system—called the Forest and Agricultural Sector Optimization Model (FASOM) with Greenhouse Gases (GHG)—that allows researchers to explore the implications of legislative proposals to address climate change and how forest-related activities may fit into a portfolio of actions by society to mitigate climate change.

"To our knowledge, the comprehensive nature of the modeling system that includes land-use change, forest and agricultural markets, and extensive greenhouse gas accounting is unique in the world," says Alig. The approach has been used for more than 15 years by the Forest Service and the Environmental Protection Agency for climate change analyses. FASOM-GHG was also a part of the projections made by the Intergovernmental Panel on Climate Change, for which Alig and many members of the modeling team were recognized with the 2007 Nobel Peace Prize, which they shared with former Vice President Al Gore.

FASOM-GHG allows decisionmakers to take an integrated approach to addressing policy-relevant questions and helps to avoid piecemeal analyses that can ignore interactions with other ownerships, other parts of the economy, and other parts of the country and world. The model has been used to look at effects of climate change on forest growth and timber markets, implications of forest adaptation, and mitigation strategies involving forests and wood products.

"For example, in the early 1990s when the Northwest Forest Plan reduced timber harvest levels in the Pacific Northwest, there



Carbon moves among many pools and requires holistic approaches to address climate change. Forests are a key factor in the Earth's carbon budget. But the movement of carbon between the atmosphere and terrestrial storage is influenced and in turn influences the interplay between human activities and natural processes that affect forests, making it challenging to develop policies aimed at shifting the carbon tally.

LAND MANAGEMENT IMPLICATIONS

- Some forestry-based actions involve avoiding actions such as deforestation, whereas others involve active measures to promote more forest cover and additional capture of carbon in wood products offering long-term storage of carbon.
- Eliminating timber harvest on U.S. public lands would result in an annual increase of 17 to 29 million metric tons of carbon storage per year, equivalent to the carbon dioxide emitted by about 4 to 7 million cars per year. In contrast, moving to a more intense harvesting policy, similar to that which prevailed in the 1980s, may result in annual losses of carbon stored in forest ecosystems of 27 to 35 million metric tons of carbon per year.
- Land management related to carbon budgets will require policymakers and land managers to consider forest ecological processes and the myriad benefits and services that forests provide society.
- Conversion of forest land to other land uses deforested more than 1 million acres annually in the United States in the 1990s. Avoiding such deforestation could require, among other things, significant amounts of funding for incentives to induce private owners to conserve forests, including use of conservation easements, and the updating through time of institutional tools such as Oregon's land-use law to deal with a growing population and changing economic conditions.

was a ripple effect that shifted a substantial amount of harvest to the Southeast," says Alig. "At the time, there wasn't much consideration given to how policy decisions in the Northwest might affect other parts of the economy and other parts of the world. We are now trying to broaden analyses to capture these types of dynamics."

Some of the more recent applications of the FASOM-GHG model have been for examining programs designed to meet the requirements of the Energy Independence and Security Act of 2007.

"Because climate change is such a far-reaching topic, opportunities are most usefully formulated in an integrated fashion, so that findings from research regarding land-use changes, forest management, adaptation and mitigation alternatives in the forest sector and costs, and connections to other sectors of the economy, can be used to formulate more holistic policy alternatives," says Alig.

"What we are doing to the forests of the world is but a mirror reflection of what we are doing to ourselves and to one another."

—Gandhi

FOR FURTHER READING

Alig, R.J.; Adams, D.; McCarl, B. 2002. *Projecting impacts of global climate change on the U.S. forest and agriculture sectors and carbon budgets.* Forest Ecology and Management. 169: 3–14.

Alig, R.J. 2003. *U.S. landowner behavior, land use and land cover changes, and climate change mitigation*. Silva Fennica. 37(4): 511–527.

Alig, R.; Adams, D.; Joyce, L.; Sohngen, B. 2004. *Climate change impacts and adaptation in forestry: responses by trees and markets*. Choices. Fall: 7–11.

Depro, B.; Murray, B.; Alig, R.; Shanks, A. 2008. *Public land, timber harvests, and climate mitigation: quantifying carbon sequestration potential on U.S. public timberlands*. Forest Ecology and Management. 255(3-4): 1122–1134.

Pataki, D.E.; Alig, R.J.; Fung, A.S. [et al.]. 2006. *Urban ecosystems and the North American carbon cycle*. Global Change Biology. 12: 2092–2101.

Science
FINDINGS

U.S. Department of Agriculture
Pacific Northwest Research Station
333 SW First Avenue
P.O. Box 3890
Portland, OR 97208-3890

Official Business
Penalty for Private Use, $300

PRSRT STD
US POSTAGE
PAID
PORTLAND OR
PERMIT N0 G-40

SCIENTIST PROFILE

RALPH ALIG is team leader of the Land Use and Land Cover Dynamics team within the Human and Natural Resources Interactions Program of the PNW Research Station. He received a doctorate in land use economics from Oregon State University, where his research centered on economic and demographic factors in land use changes involving forestry. For more than 30 years, he has continued that research, and has developed land-use and land cover models that have been applied in policy analyses involving timber supply, wildlife habitat, global change, and conservation programs. He is the USDA Forest Service's national coordinator for projections of land-use changes for Resource Planning Act assessments and also has helped develop a national model of land allocation for the forestry and agriculture sectors.

Alig can be reached at:
USDA Forest Service/Pacific Northwest Research Station
Forestry Sciences Laboratory
3200 SW Jefferson Way
Corvallis, OR 97331-4401
Phone: (541) 750-7267
E-mail: ralig@fs.fed.us

COOPERATORS

Andrew Plantinga, Department of Agriculture and Resource Economics, Oregon State University

Brian Murray, Nicholas Institute for Environmental Policy Solutions, Duke University

Bruce McCarl, Texas A&M University

Darius Adams and Greg Latta, College of Forestry, Oregon State University

Adam Daigneault, U.S. Environmental Protection Agency, Climate Economics Branch, Washington, DC