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CLIMATE CHANGE ON FEDERAL FORESTS

HEARING

BEFORE THE

SUBCOMMITTEE ON PUBLIC LANDS AND FORESTS

OF THE

COMMITTEE ON
ENERGY AND NATURAL RESOURCES
UNITED STATES SENATE

ONE HUNDRED ELEVENTH CONGRESS

FIRST SESSION

TO

RECEIVE TESTIMONY ON MANAGING FEDERAL FORESTS IN RESPONSE TO CLIMATE CHANGE, INCLUDING FOR NATURAL RESOURCE ADAPTATION AND CARBON SEQUESTRATION

NOVEMBER 18, 2009



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CLIMATE CHANGE ON FEDERAL FORESTS

WEDNESDAY, NOVEMBER 18, 2009

U.S. SENATE,
SUBCOMMITTEE ON PUBLIC LANDS AND FORESTS,
COMMITTEE ON ENERGY AND NATURAL RESOURCES,
Washington, DC.

The subcommittee met, pursuant to notice, at 2:35 p.m. in room SD–366, Dirksen Senate Office Building, Hon. Ron Wyden presiding.

OPENING STATEMENT OF HON. RON WYDEN, U.S. SENATOR FROM OREGON

Senator WYDEN. The subcommittee will come to order.

Good afternoon to all, and welcome. The purpose of today's hearing in the Subcommittee on Public Lands and Forests is to explore how the relevant Federal agencies are managing Federal forests in response to climate change, including for natural resource adaptation and carbon sequestration.

I know in my home State, we understand how important it is to manage forests with an eye to the future, to preparing for both the stresses that climate change will place on our forests, and for the opportunities they have to be part of the climate solution. These are certainly among the top concerns facing the Department of Agriculture and the Interior Department, and we look forward to hearing from them today.

The country's forests already provide a wide array of benefits—clean water and air, fish and wildlife habitat, timber and recreation. But, perhaps most timely is their potential to contribute to tackling the issue of climate change.

In particular, I see two significant opportunities for the Federal forests. First, they could provide renewable energy, biomass energy from the millions and millions of acres of land that are dangerously overstocked and ready to explode into the next inferno; and second, they can sequester carbon to help battle climate change. In my view, it is time to manage the nation's forests, to address climate change, and unlock their potential.

Substituting renewable biomass from forests for fossil fuels will help reduce the emissions of greenhouse gases that fossil fuels would have created. In addition, thinning Federal forests and restoring their health will also help protect them from insects, disease, and unnatural forest fires which release still more carbon into the atmosphere. Healthy forests lock up carbon dioxides through sequestration and provide an opportunity to create carbon offsets. These offsets can be used to help minimize the cost of car-

bon reduction in other parts of the economy, and finally, provide a way to truly account for this economic benefit that Federal forests provide to our environment.

There is no doubt that climate change is having a significant impact on Federal forests. In recent years, forests have suffered from wildfires and bark beetle outbreaks that not only clearly prove that climate is, in fact, changing, but also that our forests are surprisingly sensitive to that change. These findings will require forest management actions that help make them more resilient to the impact of climate change.

In my part of the country, particularly in our dry forests, this means that forest restoration and thinning activities are urgently needed to save the very forests that have the potential to be part of the climate change solution.

I am very much aware that these issues are not without controversy and uncertainty, and I know the nation's land managers are faced with a daunting challenge, and know that they are dedicated to building a healthier future for our forests. So, they're going to face some important questions in the days ahead. How can be forests be managed so that they can withstand the ongoing and expected impact of a warming climate? What are the best tools for making sure that fish and wildlife adapt to a changing climate? What is the best way to manage forests for carbon sequestration while working to reduce emissions? These are difficult questions to answer given the daunting complexities and uncertainties that are involved, but I have faith that our witnesses are up to this challenge.

In a few minutes, we are going to hear from Dr. Kit Batten, a science advisor of the Department of the Interior, and Tom Tidwell, the chief of the Forest Service at the Department of Agriculture. We welcome both of you this afternoon and are anxious to hear your testimony.

I'm going to recognize the ranking minority of the subcommittee for any statement, and Senator Johnson, as well.

I want to tell my colleagues that this will be perhaps a hectic afternoon. I may have to step out and take several calls in connection with some of the discussions going forward with respect to healthcare. Both of my colleagues, I know, have a great interest in this, as well, so my hope is, is that we will be able to work together and keep this going. At the very worst, we would have to take a short recess, but I hope that that won't be the case.

So, I'd like to recognize Senator Barrasso, the ranking member of the subcommittee, for his statement. Senator Johnson and I have been involved in these issues together since our days in the other body, and he's got a great interest in this, as well. So, let's begin with Senator Barrasso's opening statement.

[The prepared statement of Senator Bingaman follows:]

PREPARED STATEMENT OF HON. JEFF BINGAMAN, U.S. SENATOR FROM NEW MEXICO

Mr. Chairman, thank you for holding this hearing, which addresses an important topic—how to manage national forests in response to climate change. There is no doubt that our Federal lands play a unique and essential role in our response to climate change, and that role demands unique responsibilities of our land managers and special considerations for policy-makers.

The science is clear that climate change already is having significant impacts on our forests, and land managers across the county are faced with the difficult challenge of managing them in light of these impacts.

To help address these problems, I recently introduced legislation to facilitate natural resource adaptation across the Federal land management agencies, States, and tribes.

I believe that coordination and communication among the various land managers will be vital to ensuring that our forests and other public lands become more resilient to climate change.

In my opinion, it is clear that land managers will need to use a variety of tools to successfully manage our forests in light of a warming climate. Adaptation and carbon sequestration are two of those tools.

Our Federal land managers already consider the protection of stored carbon and the sequestration of additional carbon as an important part of their mission-and I think that is appropriate. But I am very skeptical about managing-much less marketing-Federal lands with a singular objective of sequestering carbon.

STATEMENT OF HON. JOHN BARRASSO, U.S. SENATOR FROM WYOMING

Senator BARRASSO. Thank you very much, Mr. Chairman. I want to thank you for scheduling this hearing today.

Forest adaptation and climate change, as well as carbon sequestration, are extremely important issues, especially given the increasing risk of catastrophic wildfires and the continent-wide incidences of bark beetles that are killing our forests.

Mr. Chairman, while we like to focus on all of the good things that are happening in our forests—and there is a lot—we cannot ignore some of the not-so-good things that are happening, such as forest fires or the 300,000 acres of forest killed by insect and disease in the Intermountain West. Research has shown that, as carbon dioxide levels increase in the atmospheres, plants actually grow better. They become more efficient carbon sinks, and they provide the soil and moisture conditions which benefit the trees. Research also tells us that about half the carbon dioxide sequestered by a tree is stored in its wood and in its needles, and the other half is stored in the soil that the tree grows in. When trees are harvested and converted into lumber for housing, then carbon within them is sequestered for decades, if not centuries. The soil-bound carbon dioxide is slowly released over time.

When a tree dies in the forest, the tree almost immediately begins to decompose and release carbon right at that point. Perhaps even more devastating is when those stands of dead trees burn. Most of the carbon stored within the soil is volatized and released into the atmosphere.

Now, I know we're going to hear, a little bit later, mention from Ms. Oneil in her testimony, but it bears repeating, that between 2002 and 2006 wildfires in the United States emitted the equivalent of between 4 to 6 percent of all manmade emissions of carbon dioxide for the country for those same years. Wildfires in California from 2001 to 2007 released 277 million tons of carbon dioxide from both the fire and the decay of dead trees. This is the equivalent of the emissions from half of the registered automobiles in California for an entire 7 years.

So, we all know the importance, and we all love our public lands. We all want them to maintain a resiliency that allows them to respond to changing environmental conditions. Forests are not as fragile as we humans sometimes believe them to be. They have sur-

vived dramatic climatic changes in the past, and they will continue to do so in the future. They have survived dramatic events like volcanoes, floods, and fires; they also likely will adapt to a changing climate, if and when that occurs.

The real question is how best to manage the lands to produce the resource values that we need and that we desire while adapting to changes in our forests and in our climate. Mr. Chairman, I think it's important that any carbon sequestration plan for our Federal forests consider the following:

How much carbon is released as a result of fires, insect, and disease, and ultimately, the decomposition of dead trees? What is the total energy cradle-to-grave carbon cost of the various management plans in each forest type?

Allowing forests to grow for 300 hundred years may be a great idea on the west side of Oregon, but, as Senator Udall and I are experiencing, we can't expect lodgepole pines to survive 150 years in the Intermountain West. Logging some or all of this material might be wise, in terms of carbon and the future. Is there a management strategy to remove material that might burn or rot, and turn that material into products that will store carbon while improving the health of the forest?

Finally, how do we account for those fire and insect events that occur in the wilderness and other protected areas?

So, we have to be able to answer questions like these as we look at ways to reduce our carbon footprint.

Mr. Chairman, thanks for the time of the committee, and I look forward to hearing from our witnesses.

Senator WYDEN. Thank you, Senator Barrasso.

Senator Johnson.

STATEMENT OF HON. TIM JOHNSON, U.S. SENATOR FROM SOUTH DAKOTA

Senator JOHNSON. I am pleased that as the committee continues to examine a range of climate change issues, that the Public Lands and Forest Subcommittee is examining the effects of changes in our climate and public forestlands.

The clear evidence suggests that the worldwide accelerated release of greenhouse gas emissions is resulting in observable changes to regional climates. For the forestlands in the West, including my State, the Black Hills, these changes in climate could produce dramatic effects on forest health. Even modest changes in temperatures that result in milder winters and hotter and drier summers can create the conditions for insect epidemics, leaving in their wake millions of dead standing trees and increasing the risk of catastrophic wildfires.

In the Black Hills and in large areas covering Wyoming and Colorado, hundreds of thousands of acres of lodgepole and ponderosa pine are infected by a mountain pine beetle epidemic. Although these epidemics historically come and go, the severity and depth of the current infestation is causing uncertainty and concern that permanent changes in temperature and moisture will further strain the forest health of the Intermountain West.

In the near term, public land managers must develop strategies for combating insect infestations and forest land thinning projects

to reduce the threat of catastrophic wildfire. While these acute issues must be tackled immediately, I hope that today's hearing produces a better understanding of how our public forestlands can be managed in a manner that adapts to climate changes while meeting the important regional and national purposes. Specifically, I am looking for insights and answers to how individual forest management plans incorporate climate change impacts into strategies for effective forest health stewardship, timber sale management, as well as recreation and public enjoyment.

Again, thank you, Chairman Wyden and Ranking Member Barrasso, for holding this important hearing, and I look forward to hearing from the panel.

Senator WYDEN. Thank you, Senator Johnson. We look forward very much to working with you. I remember our efforts and discussions on timber payments and the counties, and it will be great to team up with you.

We're also very glad to have Senator Risch on this subcommittee, as well. He has a great interest in these issues and, I think, is going to be a very good partner in these efforts, on the basis of our discussions.

So, Senator Risch, welcome, and any statement you'd like to make.

STATEMENT OF HON. JIM RISCH, U.S. SENATOR FROM IDAHO

Senator RISCH. Thank you so much, Senator Wyden, for holding this important hearing.

This is a subject that's particularly important to Idaho and to the Intermountain West. As you travel across the State of Idaho today, the landscape that's been described, particularly in the lodgepole pine habitats, is very troubling.

When I was in forestry school, I visited a number of these places, and it's saddening—it's very saddening to go back, at the present time, and see what's happened to the condition of those. A lot of them are just waiting for a match to strike, and it's going to be very catastrophic, particularly in the central parts of Idaho, where we have large stands of lodgepole pine, similar to the stands that are in the Yellowstone Park. A fire there will be just as catastrophic as it was in the Yellowstone ecosystem.

We all know that we're going through these cycles of drying conditions and wet conditions. Last year in Idaho, we had a particularly wet winter, followed by a wet spring, and things were actually pretty good in the ecosystem. But, for some years prior to that, we had drought conditions, and those drought conditions, of course, weaken the tree. The tree is not able to pitch out the attacks from the pine beetles. As a result of that, your get massive stands of these standing matches, if you would, ready to burn.

So, it's important that we have this hearing, and I'm very interested to hear what the witnesses have to say. With that, Congress hopefully will be able to create some unique ways of addressing the situation.

Thank you, again, Mr. Chairman.

Senator WYDEN. Thank you, Senator Risch.

All right, let's welcome Ms. Kit Batten and Mr. Tom Tidwell. We will make your prepared statements part of their record—part of

the record in its entirety. I know there is always almost a compulsion to kind of read statements, and if you could take a few minutes and summarize your principal views, we'll make your prepared statements a part of the record in their entirety.

Dr. Batten, welcome.

STATEMENT OF KIT BATTEN, PH.D., SCIENCE ADVISOR, OFFICE OF THE DEPUTY SECRETARY, DEPARTMENT OF THE INTERIOR

Ms. BATTEN. Thank you so much, Mr. Chairman, members of the subcommittee. Thank you for the opportunity to appear before you today to discuss the impacts of climate change on the ecosystems managed at the Department of the Interior, including forests and woodlands. I am Dr. Kit Batten, science advisor to the Deputy Secretary of the Interior.

My written testimony today highlights the impacts of climate change on these lands, and describes how sustainable public land management can help forests and other ecosystems adapt to and mitigate climate change. I would like to summarize the main points for you, and I ask that my complete statement, as you just said, be entered into the record.

Senator WYDEN. It will be done, without——

Ms. BATTEN. Thank——

Senator WYDEN [continuing]. Objection.

Ms. BATTEN [continuing]. You. Thank you.

In the Department of the Interior, the U.S. Fish and Wildlife Service, the National Park Service, the Bureau of Land Management, the Bureau of Indian Affairs all oversee the management of forestland in the refuges, parks, public, and tribal lands under their jurisdictions.

A recent report by the U.S. Climate Change Science Program and the Subcommittee on Global Change Research predicts that forestlands will respond in different ways to changes in temperature, precipitation, and other factors related to climate change. With warmer temperatures, tree species may respond by migrating both northward and to higher altitudes. Thus, species with restricted ranges may be most vulnerable, while species with broader climate tolerances may be able to adapt more easily. Species composition of forests may also change dramatically. Climate change may favor drought-resistant species, such as juniper is some areas, which are expected to migrate into higher-elevation forests, and could compete with other forest types for moisture.

Southwest woodlands are at a high risk of conversion to desert shrub and grassland. Wildlife and plant communities may migrate as temperature, habitat, and water resources change. Climate change may result in an increased establishment of invasive species, such as tamarisk, that not only pose a risk of displacing desirable native plant species, but can also consume water in already dry areas, leading to increased competition for this important resource.

Finally, forest seed production could be impacted due to its cyclical nature and response to temperature and precipitation. Seedling establishment, survival, growth, and vigor are all critically depend-

ent on available soil moisture, and would be reduced during periods of increased drought.

Insects, pathogens, invasive species, drought, and increased wildfire activity are all risks for forests and woodlands as a result of climate change. In fact, the Department's land and wildlife managers are already confronting many of these impacts.

In the interior forests of the Rocky Mountain States, a combination of warmer winters over the past decade, drought stress, and a prevalence of overmature, overstocked, even-aged, single-species forests have created a perfect condition for proliferation of bark beetles and increased vulnerability for fire.

Approximately 800,000 acres of BLM-managed forestlands in Colorado, Wyoming, Montana, and Idaho are suffering from mountain pine beetle attack, and are at risk of widespread mortality. Similar effects are seen in Rocky Mountain, Yellowstone, and other western national parks.

Pinyon pine forests have experienced widespread both mortality in Colorado, Utah, New Mexico, and Arizona.

Climate change adaptation strategies can enhance the ability of our ecosystems, such as forests and woodlands, to adapt to or withstand current and projected climate change impacts. Departmental bureaus are working with each other and our external partners to adapt our forest and woodland management programs to anticipate and adapt to the effects of climate change and mitigate the potential impacts across our lands.

Key strategies in the Department include reducing stressors, encouraging diversity, such as through fire management and control of invasive plants, forests pests, and pathogens. To assure that our adaptation strategies are grounded in sound science, Secretary Salazar has created a new climate change strategy for the Department of the Interior through Secretarial Order Number 3289, which he signed on September 14 of this year, and it's entitled, "Addressing the Impacts of Climate Change on America's Water, Land, and Other Natural and Cultural Resources." This order establishes a new departmentwide strategy to address climate change, with an emphasis on climate change science, adaptation, and mitigation, and it recognizes the value of relying on partnerships with other agencies, States, and adjacent landowners, to respond to climate change.

Forestlands also play an important role in climate change mitigation by sequestering carbon dioxide from the atmosphere through photosynthesis and storing this carbon in tree—in the trees biomass, soils, and wood products. The use of biomass, such as waste material from timber harvests, as a substitute for fossil fuels, which emit more greenhouse gas emissions for generating power, is expected to increase as bioenergy facilities come online.

The Department is actively engaged with partners who are interested in acquisition and restoration projects resulting in carbon sequestration. For example, more than 22 million trees and 40,000 acres of restored habitat have been added to the national wildlife refuge system, and such partnerships have resulted in the restoration of more than 80,000 acres of native habitats, benefiting fish, wildlife, and migratory bird populations in bottomland hardwood forests in the Southeast.

In the Sacramento Delta of California, the USGS and its partners are developing a process to farm carbon by restoring wetland vegetation and rehydrating and restoring organic peat soils. This not only sequesters carbon, but provides wildlife habitat, and actually increases the soil elevation in restored areas, decreasing the stress across delta levees. I actually have a short factsheet on that, that I'd also like to submit for the record.

Senator WYDEN. Without objection, it's ordered.

Ms. BATTEN. Thank you.

The Fish and Wildlife Service is also exploring new habitat restoration techniques that could enhance carbon sequestration in the Florida Everglades and across the expansive coast and wetlands of the Carolinas.

Finally, the Department, through the U.S. Geological Survey, is developing a methodology to measure and assess biological carbon sequestration and greenhouse gas fluxes, and will use this methodology to conduct a national assessment of ecosystem carbon storage and greenhouse gas fluxes. This methodology will be released in 2010.

Restoring the health and maintaining the resiliency of our nation's public lands, including forests and woodlands, is crucial to ameliorating and adapting to the effects of climate change. Much has been learned as this effort has evolved. Most importantly, the Department has recognized that landscape-scale problems require landscape-scale responses. The impacts of climate change do not distinguish between lands managed by different Federal agencies.

The development of successful science-based adaptation and mitigation strategies is critical to the health of these resources and to the human communities and fish and wildlife that are dependent on them.

Again, thank you for the opportunity to testify today. I am happy to answer any questions that you may have.

[The prepared statement of Ms. Batten follows:]

PREPARED STATEMENT OF KIT BATTEN, SCIENCE ADVISOR, OFFICE OF THE DEPUTY SECRETARY, DEPARTMENT OF THE INTERIOR

INTRODUCTION

Mr. Chairman and Members of the Subcommittee, thank you for the opportunity to appear before you today to discuss the impacts of climate change on the ecosystems managed by the Department of the Interior, including forests and woodlands, wetlands, and many others. I am Dr. Kit Batten, Science Advisor to the Deputy Secretary of the Interior. My testimony today highlights the impacts of climate change on these lands and describes how sustainable public land management can help forests and other ecosystems adapt to and mitigate climate change.

The Department manages over 500 million acres of land—one-fifth of the nation's land mass—and these lands include many types of ecosystems, from coastal estuaries to riparian corridors along our nation's rivers to prairie wetlands to alpine forests. The U.S. Fish and Wildlife Service, the National Park Service, the Bureau of Land Management, and the Bureau of Indian Affairs all oversee the management of forest land in the refuges, parks, public and tribal lands under their jurisdictions. Forests and other lands and waters managed by the Department's bureaus provide critical ecosystem services, such as wildlife habitat for a variety of species, clean air and water, biodiversity, pollinator services, cultural heritage resources, recreational opportunities, forest products, and mineral and energy resources.

POTENTIAL CLIMATE CHANGE IMPACTS TO FORESTS

Perhaps no resource management issue is as complex and challenging as climate change. Climate change affects biota, water, ecosystems, cultures, and economies.

The Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) notes that climate change is expected to affect precipitation patterns, vegetation types and distribution, wildlife habitat and behavior, wildfire frequency and risk, sea levels, and the spread of pests and diseases. These, in turn, will affect a broad range of human activities.

With specific regard to forest and woodland plant species, a recent report by the U. S. Climate Change Science Program and the Subcommittee on Global Change Research predicts that these lands will respond in different ways to changes in temperature, precipitation, and other factors related to climate change.[1] With warmer temperatures, tree species may respond by migrating both northward and to higher altitudes. Species with restricted ranges may be most vulnerable, while species with broader climate tolerances may be able to adapt more easily. Alpine forests are at risk of loss because there will be no place for them to migrate. However, forests in the Pacific Northwest, west of the Cascades, may benefit by increased growth if both temperature and precipitation increase as forecasted in some climate change models. Interior Northwest forests may suffer as warmer winters decrease the retention of snowpack.

Species composition of forests also may change dramatically. Climate change may favor drought-resistant species such as juniper in some areas. Juniper woodlands are expected to migrate into higher elevation forests and could compete with other forest types for moisture.

In addition, changes in biodiversity are possible with changes in species mix and habitat. Southwest woodlands are at high risk of conversion to desert shrub and grassland. Wildlife and plant communities may migrate as temperature, habitat, and water resources change. Climate change may result in increased establishment of invasive species such as tamarisk that not only pose a risk of displacing native plant species but can also consume water in already dry areas, leading to increased competition for this limited resource.

Finally, forest seed production could be impacted due to its cyclical nature and response to temperature and precipitation. Seedling establishment, survival, growth, and vigor are all critically dependent on available soil moisture, and would be reduced during periods of increased drought. Insects, pathogens, invasive species, drought, and increased wildfire activity are all risks for forests and woodlands as a result of climate change.

CURRENT LANDSCAPE CHANGES

In fact, the Department's land and wildlife managers are already confronting the impacts of climate change on the lands they manage. Reduced snowpack combined with earlier melting and runoff—particularly in the Northwest and Mountain-West—is leading to decreased recharge of groundwater systems, increasing stress on public water systems and altering river flows, temperature, depth, and other characteristics of spawning environments for fish.[2] Our Arctic parks, refuges, and public lands are seeing some of the earliest impacts of climate change—for example, melting sea ice threatens marine mammals as well as coastal communities, and contributes to a warming feedback loop—melting ice reduces albedo, which only leads to greater melting of sea ice. Thawing permafrost not only destabilizes buildings, roads, and facilities and disrupts the structural basis of large regions of interior lands, but also leads to even greater amounts of greenhouse gas emissions into the atmosphere, such as carbon dioxide and methane, which only reinforce the warming cycle.

Vegetation in some places has converted to more drought-hardy species[3] and, in some instances, species numbers have been reduced or lost.[4] Our scientists are also noting changes in abundance and distribution of species, including changes in migration patterns; the expansion of pests and invasive species; increased vulnerability to wildfire and erosion; and overall changes in carrying capacity and the ability of

[1] Climate Change Science Program, The effects of climate change on agriculture, land resources, water resources, and biodiversity in the United States, Backlund, et al. (2008).

[2] Stonestrom, D.A. and J.R. Harrill, Ground-water recharge in the arid and semiarid southwestern United States-climatic and geologic framework. U.S. Geological Survey Professional Paper, 1703-A: 27 (2007); IPCC Fourth Assessment Working Group II: Impacts, Adaptation and Vulnerability (2007); Barnett, T. P., and D. W. Pierce (2008), When will Lake Mead go dry?, Water Resour. Res., 44, (2008).

[3] Backlund, Peter, et.al. (2008).

[4] IPCC Fourth Assessment WG II (2007).

ecosystems to support different species populations.[5] Many of the iconic wildlife species that the Department manages from the Arctic to the Everglades will see their habitat and ranges affected by global climate change.

In the interior forests of the Rocky Mountain States, a combination of warmer winters over the past decade, drought stress, and a prevalence of over-mature, overstocked, even-aged single species forests have created perfect conditions for a proliferation of bark beetles. The stressed condition of the forests makes them more susceptible to fatal insect attack.[6] Approximately 800,000 acres of BLM-managed forestlands in Colorado, Wyoming, Montana, and Idaho are suffering from mountain pine beetle attack and are at risk of widespread mortality. The effects of bark beetle infestation can also be seen in forests in Rocky Mountain, Yellowstone, and other western national parks. Similarly, pinyon pine forests have experienced widespread mortality from bark beetle attack in Colorado, Utah, New Mexico, and Arizona. As noted in the previous paragraph, forestlands suffering from these stresses—especially in combination with drought—are also more susceptible to wildfire, increasing the threat of catastrophic fire in the wildland-urban interface areas across the West.

ADAPTATION AND MITIGATION STRATEGIES

Climate change adaptation strategies can enhance the ability of ecosystems, such as forests and woodlands, to withstand, or adapt to, current and projected climate change impacts. For example, a healthy forest—a species-diverse, multi-aged forest, with proper stocking densities—is resilient in response to environmental stresses, better able to resist insect attacks and diseases, and less vulnerable to catastrophic wildfire. Restoring forest health on our public lands through active management is one way to promote adaptation to climate change.

The Department of the Interior is on the front lines of protecting our country's water, land, marine, fish, wildlife, tribal, and cultural heritage resources from the effects of climate change we are witnessing—from the Arctic to the Everglades. The realities of climate change will require the Department to change how we manage the resources we oversee. To assure that our climate change adaptation strategies are grounded in sound science, Secretary Salazar has created a new climate change strategy for the Department through Secretarial Order #3289 (September 14, 2009): "Addressing the Impacts of Climate Change on America's Water, Land and Other Natural and Cultural Resources." This Order establishes a new Department-wide strategy to address climate change, with an emphasis on climate change science, adaptation, and mitigation.

This Order also recognizes that the Department must rely on important partnerships to respond to climate change, including the White House Council on Environmental Quality, the White House Office of Energy and Climate Change, the White House Office of Science and Technology Policy, the National Science and Technology Council, the U.S. Global Change Research Program, the Department of Agriculture, the Department of Commerce, the Department of Defense, the Environmental Protection Agency, the National Aeronautics and Space Administration, Tribal governments, State and local governments, universities, non-governmental organizations, and private landowners.

Specifically, the Order establishes the following:

- DOI Climate Change Response Council: Composed of the Secretary (Chair), Deputy Secretary (Vice-Chair), Counselor to the Secretary (Vice-Chair), Assistant Secretaries, Bureau Directors and the Solicitor, the Council will help coordinate activities within and among the Department's agencies and bureaus to develop and implement an integrated strategy for responding to climate change impacts involving the resources managed by the Department.
- Regional Climate Change Response Centers: Eight Regional Climate Change Response Centers will deliver climate change impact science, modeling, and forecasting to DOI natural and cultural resource managers within a region; synthesize, integrate, and communicate climate change impact data gathered by the Department and external partners; develop management-relevant adapta-

[5] IPCC Fourth Assessment WG II (2007); Parmesan (2006) Ecological and Evolutionary Responses to Recent Climate Change, Annu. Rev. Ecolo. Evol. Syst. 37: 637-69.

[6] Bentz, B., J. Logan, J. MacMahon, C. Allen, et al. 2009. Bark beetle outbreaks in Western North America: Causes and consequences. Chicago, IL: University of Utah Press. 42 pp. Also Logan J.A.; Powell J.A. 2001. Ghost Forests, Global Warming, and the Mountain Pine Beetle (Coleoptera: Scolytidea). American Entomologist. 160-172; Kurz, W.A. et al. Mountain Pine Beetle and Forest Carbon Feedback to Climate Change; Campbell, Elizabeth M. 2007. Climate change, mountain pine beetle, and the decline of whitebark pine, a keystone species of high-elevation ecosystems in British Columbia, Canada. Ecological Society of America meeting, August 2007, San Jose, CA.

tion tools that the Department of the Interior's resource managers and its partners can use when managing resources in the face of a changing climate; and help to educate the public about climate change impacts within the region.

- Landscape Conservation Cooperatives: Interior bureaus and agencies, guided by the Climate Response Council, are working to stimulate the development of a network of collaborative "Landscape Conservation Cooperatives." These cooperatives will work interactively with the relevant DOI Regional Climate Change Response Centers and help coordinate landscape-scale adaptation efforts with federal, Tribal, state, and local governments, and private landowner partners.
- DOI Carbon Storage Project: DOI is working to develop measurement and verification methodologies and carry out assessments of carbon storage in geologic formations (geological carbon sequestration) and in plants and soils (biological sequestration) in a manner consistent with the Department's responsibility to provide comprehensive, long-term stewardship of its land, water, marine, fish and wildlife, and cultural heritage resources.
- DOI Carbon Footprint Project: DOI is developing a unified greenhouse gas emission reduction program, including setting a baseline and reduction goal for the Department's greenhouse gas emissions and energy use.

As an example of what this will look like on the ground, the BLM is conducting a series of eco-regional assessments to improve our understanding of the existing condition of BLM-managed landscapes, identify potential impacts from climate change, and develop and implement strategies and conduct on-the-ground restoration projects on the public lands to help native plant (including forest) and animal communities adapt to climate change. These assessments will work with and contribute data to the Regional Climate Change Response Centers and be used in conjunction with climate change models to aid BLM and other managers within Landscape Conservation Cooperatives in developing regional adaptation strategies that promote sustainable land stewardship across the landscape.

Strategies to protect forest ecosystems managed by DOI focus primarily on increasing the resilience and the natural capacity of these forests to adapt to new conditions. Key strategies are to reduce stressors and encourage diversity, such as through fire management and control of invasive plants, forest pests, and pathogens. Successful adaptation efforts must involve cooperation and collaboration with adjacent lands and partners.

The same sustainable management activities used on our public lands to restore forest health and help forests adapt to climate change impacts can also contribute to minimizing GHG emissions. Forestlands play an important role in climate change mitigation by sequestering carbon dioxide from the atmosphere through photosynthesis and then storing this carbon in tree biomass, soils, and wood products. Forests can also provide biomass for energy production, which can supplant the use of fossil fuels that emit greater amounts of GHG. The use of biomass (e.g., waste material from timber harvest) as a substitute for fossil fuels for generating power is expected to increase as bioenergy facilities come on-line.

BIOLOGICAL CARBON SEQUESTRATION

Forests, range lands, wetlands, and other landscapes play a vital role in the carbon cycle. These natural systems take in and store carbon dioxide in plants and soils. Secretarial Order 3289 established the DOI Carbon Storage Project through which the Department is developing methodologies for both geological and biological carbon storage, and is working with states, Tribes, localities, private landowners, and other stakeholders to execute on-the-ground restoration projects that sequester carbon, consistent with our existing stewardship responsibilities.

The Department is actively engaged with partners, including the Trust for Public Land and the Conservation Fund; energy and other industrial companies, and the Carbon Fund, who are interested in acquisition and restoration projects resulting in carbon sequestration. Our partners secure lands and sponsor habitat restoration through carbon sequestration value in the form of credits, as calculated through methods developed by Environmental Synergy, Inc. and the Conservation Fund. These partnerships have so far added 40,000 acres of restored habitat to the National Wildlife Refuge System and restored more than 80,000 acres of native habitats benefiting, fish, wildlife, and migratory bird populations in bottomland hardwood forests. More than 22 million trees have been planted through this partnership.

In the Sacramento Delta of California, USGS and partners are developing a process to "farm carbon" by restoring wetland vegetation and re-hydrating and restoring organic peat soils. Carbon farming works through the sequestration of carbon in native plants such as tules and cattails, which in turn decompose very slowly and cre-

ate new peat soil. This effort is not only sequestering carbon, but is also providing wildlife habitat and increasing the elevation of the soil surface in restored areas, decreasing the stress across Delta levees. Additional scientific work is necessary to learn how to maximize growth rates and minimize decomposition rates, verify greenhouse gas benefits over several years, and minimize any potential adverse environmental impacts, such as methane and nitrous oxide emissions.

In addition, the Fish and Wildlife Service is exploring new habitat restoration techniques that could encourage carbon sequestration in the Florida Everglades and across the expansive pocosin wetlands of the Carolinas. A project at Pocosin Lakes National Wildlife refuge involves verifying carbon sequestration benefits of the pocosin hydrology restoration work that began in the 1900s.

In accordance with responsibilities mandated in the Energy Independence and Security Act of 2007, the Department (through the U.S. Geological Survey) is developing a methodology to measure and assess biological carbon sequestration and greenhouse gas fluxes, and will use this methodology to conduct a national assessment of ecosystem carbon storage and greenhouse gas fluxes. This methodology will be released in 2010.

Scientists, using geospatial data, remote sensing applications, and ecosystem modeling, have developed research and working models to describe storage and fluxes of carbon in relationship to climate change and land use for large-scale landscapes. These efforts will be expanded into a national framework that is adaptive, incorporating new information about carbon cycling and sequestration as it becomes available. Best management practices for carbon sequestration in saline and freshwater wetlands, soil and sediments, permafrost areas, hardwood and coniferous forests, grasslands and rangelands are needed for use by public, Tribal, and private land managers.

OPPORTUNITIES & CHALLENGES

The Department is working to increase its ability to monitor, assess, forecast, and respond to landscape changes over time, implementing programs to address climate change on a broad scale. Restoring the health and maintaining the resiliency of our nation's public lands (including forest and woodland ecosystems) is crucial to ameliorating and adapting to the effects of climate change. Much has been learned as this effort has evolved. Most importantly, the Department has recognized that landscape-scale problems require landscape-scale responses. The impacts of climate change do not distinguish between lands managed by different federal agencies.

The various bureaus at the Department of the Interior are working with each other and external partners to adapt our forest and woodland management programs to anticipate and adapt to the effects of climate change and mitigate the potential impacts across all lands. As mentioned earlier, coordination is one of the keys to our success. Secretarial Order #3289 establishes a new Departmental strategy to promote Department-wide coordination as well as coordination with outside partners on climate change science and resource management strategies for understanding and responding to climate change impacts.

CONCLUSION

Climate change is impacting all of our ecosystems, including our forests and woodlands. The development of successful science-based adaptation and mitigation strategies is critical to the health of these resources and the human communities, and fish and wildlife that are dependent on them.

Again, thank you for the opportunity to testify today. I am happy to answer any questions that you might have.

Senator WYDEN. Doctor, thank you. Very helpful.

Mr. Tidwell, welcome.

STATEMENT OF TOM TIDWELL, CHIEF, FOREST SERVICE, DEPARTMENT OF AGRICULTURE

Mr. TIDWELL. Thank you. Mr. Chairman, members of the subcommittee, I want to thank you for inviting me here today to discuss how we need to be managing the national forests and grasslands in response to climate change.

Mr. Chairman, I want to thank you for your opening remarks. I appreciate your understanding of these issues, and I can tell you that I share those concerns.

You know, climate change is altering our landscapes, altering the national forests and the grasslands. That change will likely accelerate in the future.

Climate change will also have a variety of effects across different parts of the country. But, what will—what's probably more problematic is that the level of disturbances—these level of disturbances are going to increase, and their frequency will increase. When I talk about "disturbances," I'm talking about wildfire, about floods, insect and disease outbreaks. Our response to these changes is going to be increase our—increase our focus on restoration.

The goal of the Forest Service is to restore the forest and grassland health so that we have healthy, functioning ecosystems, so they can withstand the stressors from climate change and they can continue to deliver all of the ecosystem services, all of the benefits that we need and want from our national forests, but especially water. With the increase in disturbances, watershed management is going to only increase in its importance, and it's essential that, as we go about designing our restoration work, that we focus on the benefits to watershed health.

Now, we cannot do this alone. You know, these changes are occurring on a landscape scale, and we must work together with our partners across all jurisdictions to restore healthy, functioning ecosystems. We need to work on all the landscapes that we share.

Secretary Vilsack has helped in this regard by giving us direction that we need to take a more all-lands approach. Now, this will require additional collaboration, but it's essential that we work with our Federal—the other Federal agencies, the States, the local communities, tribal, and private landowners to be able to take on the restoration that needs to occur at a landscape level.

Last year, the Forest Service developed a strategic framework for responding to climate change to help us set priorities. This framework has seven goals: science and management, adaptation, mitigation, policy, sustainable operations, education, and alliances. Now, these goals will not be realized immediately, but we already have made a good start.

Now, before I close, I'd want to just say a few words about science, adaptation, and mitigation. Forest Service researchers have been in the forefront of climate change science. Our challenge now is to transfer that knowledge to the land managers so we can make a difference on the ground. We now have developed tools that actually help our land managers and help the public to understand the carbon consequences of various project designs.

On the national forest system, we're now designing projects to help us—systems adapt to climate change. Our restoration efforts can make these systems more resilient, more resistant to the climate changes that we are seeing. For example, with an overgrown stand of ponderosa pine, we can make it more resistant to climate-induced drought and wildfire. We can also introduce more diversity into the species mix, for that will help these systems adapt. We also need to look at expanding restoration of wetlands, of flood

plains, to reduce the effects of floods, but also to prolong seasonal water flows. Now, mitigation is another part of that strategy.

Now, carbon likely will not be the primary management objective for the national forests, but it will be one of the ecosystem services, one of the benefits that we will manage for and we will factor into our decisions, and we can tailor our restoration treatments to increase carbon storage over the long term.

Now, net carbon uptake by our terrestrial systems in the United States, coupled with wood products and landfills, currently offsets about 12 percent of our nation's greenhouse gas emissions. Now, our goal is to hold that steady, and hopefully be able to increase that.

Now, whether we're talking about the life cycle or the effects of climate, we need to understand that, even with the level of science that we have today, there is much that we need to learn. Now, we're going to be—it's going to be necessary for us to be flexible and adaptive in our management. You know, the value and the importance of the national forests are just going to increase, and especially provide us the opportunities to help address the effects of climate change.

This concludes my opening remarks. Thank you again for the opportunity, and I look forward to answering your questions.

[The prepared statement of Mr. Tidwell follows:]

PREPARED STATEMENT OF TOM TIDWELL, CHIEF, FOREST SERVICE, DEPARTMENT OF AGRICULTURE

Mr. Chairman and members of the Subcommittee, thank you for inviting me today to discuss the important role National Forests and Grasslands play in addressing climate change. As you may know observations show that climate change is already altering our Nation's forests in significant ways and those alterations are very likely to accelerate in the future, in some cases dramatically[1]. These alterations present significant challenges to sustainable management of these forests. Decisions being made today by policymakers and resource managers will have implications through the next century.

Secretary Vilsack is asking the Forest Service and our sister agency, the Natural Resources Conservation Service (NRCS), to adopt an "all-lands approach" in our restoration efforts. Our approach takes actions across large landscapes so that our actions will make a substantive difference. It also, will include close collaboration on our part with Federal, State, local, tribal, and private landowners, land managers, and other stakeholders.

CLIMATE CHANGE—MANAGING UNCERTAINTY

In the uncertain environment of climate change, risk management will become critical. This is managing ecosystems for resiliency to prepare for uncertain future outcomes. I have spoken many times in the past about our desire to restore the health of the nation's forests. When we use the term restoration, we do not mean returning a stand or forest to a previous condition but rather bringing back some of its previously lost ecosystem functions or returning its ability to withstand otherwise mild disturbance events. Our approach is to make forests and grasslands more resilient to disturbances under a range of future conditions.

To help the land management professionals deal with this uncertain environment, the Forest Service developed a Strategic Framework for Responding to Climate Change to guide our actions in addressing climate change. The Framework envisions a future where ecosystem services are sustained and forests and grasslands are adapting successfully to a changing climate and our management actions are

[1] CCSP. May 2008. Synthesis and Assessment Product 4.3 (SAP 4.3): The Effects of Climate Change on Agriculture, Land Resources, Water Resources, and Biodiversity in the United States, P. Backlund, A. Janetos, and D. Schimel, lead authors. A report by the U.S. Climate Change Science Program (CCSP). Abstract.

contributing to mitigating impacts of climate change. The Strategic Framework identifies seven key goals:

- Science—Advance our understanding of climate change and its impacts and develop effective ways to improve science delivery to managers.
- Adaptation—Enhance the capacity of forests and grasslands to adjust to the impacts of climate change.
- Mitigation—Promote the management of forests and grasslands to reduce the build-up of heat-trapping gases in the atmosphere.
- Policy—Integrate climate change considerations as appropriate into Forest Service policies, program guidance, and communications.
- Sustainable Operations—Reduce the environmental footprint of our operations and facilities.
- Education—Advance awareness and understanding of climate change implications among Forest Service employees and the public.
- Alliances—Establish, enhance, and retain strong alliances and partnerships.

These goals have helped us organize our thinking about climate. Forest Service goal implementation teams are recommending key actions that the Agency can take for the short-term and to position itself for the long-term. I recognize these goals will not be realized immediately, but we have already done much. The Science, Adaptation, and Mitigation goals are most germane to today's topic, so I will focus my testimony there.

CURRENT STATE OF SCIENCE

Having science that advances our understanding of the environmental, economic, and social implications of how climate change affects forests and grasslands in the future is essential for managers and policy officials to make informed decisions. The Forest Service already has wide breadth of experience with managing and responding to weather extremes and natural catastrophes. The scientific community has generated an even greater abundance of knowledge and produced an extensive literature on the subject. These two bodies of knowledge, that of managers' and of scientists', is being transformed into best management practices, land management tools, and information. In addition, we are communicating through various means to citizens the effect of climate change and its impacts on ecosystems so they will be better prepared to participate in decisions and actions affecting their National Forests and Grasslands.

The Science & Management goal will be forwarded by Forest Service Research & Development. As you may be aware, the Forest Service has amassed over two decades of focused climate change research, three decades of air pollution research, and a century of experience in scientific assessments and research that provides a firm scientific foundation for addressing the challenges of managing these ecosystems relative to climate change.

I need to stress again, however, that we are a long way from knowing all we need to know about the impacts of climate change on forests and grasslands. In some areas of study we have significant science gaps that need to be addressed. Climate models lack the ability to provide projections at the detailed scale that is more useful to land managers and local and regional planners. To address this gap, our scientists are working with the Department of Commerce's National Oceanic and Atmospheric Administration and USGS to improve these models. Our scientists are also looking for better ways of forecasting how terrestrial ecosystems will change in response to a changing climate and how the changes will affect animals and plants that depend on these ecosystems. The Strategic Framework recognizes these gaps and I want to assure you that the Forest Service is working with USDA and other Federal agencies and partners to address these and other issues.

ADAPTATION AND CARBON SEQUESTRATION

I want to now switch my attention to how we are beginning to adapt our National Forests and Grasslands to a changing climate. During my many years with the Forest Service, I have come to realize that effectively accomplishing our mission will require us as land managers to anticipate and adapt to the profound environmental stresses of climate change. These systems must be capable of delivering the ecosystem goods and services that this country needs, such as pure, clean water; habitat for wildlife and fish; opportunities for outdoor recreation; wood products; and energy. These systems can create local economic opportunities to support local communities. I want to assure you that we at the Forest Service are committed to success in this enterprise.

Many of the same management techniques used to restore forest health can be used to help forests adapt to climate change impacts. Forest Service land management professionals know they will need to be vigilant, strategic and flexible in using new information to accommodate changing conditions because the scope of climate change and its impacts on ecosystems are difficult to predict. In addition, our management decision processes will need to include ways of dealing with risks and uncertainties introduced or made worse by climate change. In some cases, failing to take management actions will result in significant disruptions to ecosystems, so we must maintain as many options as possible, both now and in the future, for handling unexpected events and conditions.[2]

In addition, we are designing a better science-based adaptive management approach to, promote learning through doing, monitoring, and modifying. This approach involves actively making decisions and monitoring the results of those decisions to improve our understanding about the complex systems we manage. Some management actions may need to be expanded, such as reforestation with a more diverse species mix that may be better adapted to future climate projections.

Our land managers are also learning from their close working relations with our scientists. The West Wide Climate Initiative (WWCI), a partnership among scientists and managers at the three western Forest Service Research Stations and National Forests, is developing decision-support tools to help managers address climate change and adaptation in national forests and national park units representing major regions of the West. These case studies are on the Olympic National Forest and Olympic National Park, the Tahoe National Forest, the Inyo National Forest and Devils Postpile National Monument, and Shoshone National Forest. With these pilot projects the Forest Service is analyzing projections of future vegetation and developing specific adaptation strategies to promote resilience of national forest resources to climate change.

Another management responsibility is mitigating the effects of climate change. As we all know, to significantly reduce our greenhouse gas emissions, the United States will need to implement a variety of mitigation strategies. These strategies include storing more carbon in forests and wood products implementing greenhouse gas capture and storage from point sources, and reducing fossil fuel use through multiple options. For instance, biomass from restoration and hazardous fuels reduction projects can be used for energy production.

However, the issue is complex and requires both science and thoughtful land management policy. However, the potential of some of our forests to store additional carbon may be limited because of management designation, accessibility, and/or stand characteristics. In many areas our forests contain overly-dense stands that are under stress and have become more susceptible to wildfire, insects, and disease[3]. Management actions, designed to restore these forests and grasslands and protect communities, such as thinning or allowing fire to resume its natural role as a cleansing and regenerative force, can improve the ability of these ecosystems to adapt to the continually increasing stress of changing climate and may have the increased benefit of sequestering more carbon over the long-run through increased net growth.[4]

While healthy functioning forests may serve as a means to sequester carbon, under current practices, many of our western forests are at risk of turning from a carbon sink to a carbon source. Projections indicate that while these forests continue

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[2] CCSP. 2008: *Preliminary review of adaptation options for climate-sensitive ecosystems and resources*. A Report by the U.S. Climate Change Science Program and the Subcommittee on Global Change Research. [Julius, S.H., J.M. West (eds.), J.S. Baron, L.A. Joyce, P. Kareiva, B.D. Keller, M.A. Palmer, C.H. Peterson, and J.M. Scott (Authors)]. U.S. Environmental Protection Agency, Washington, DC, USA, 873 pp. http://www.climatescience.gov/Library/sap/sap4-4/final-report/#finalreport

Scott, D. and C. Lemieux. 2005. Climate change and protected area policy and planning in Canada. The Forestry Chronicle 81(5):696-703.

[3] Fettig, Christopher J.; Klepzig, Kier D.; Billings, Ronald F.; Munson, A. Steven; Nebeker, T. Evan; Negron, Jose F.; Nowak, John T. 2007. The effectiveness of vegetation management practices for prevention and control of bark beetle infestations in coniferous forests of the western and southern United States. Forest Ecology and Management, Vol. 238: 24-53.

Graham, Russell T.; McCaffrey, Sarah; Jain, Theresa B. 2004. Science basis for changing forest structure to modify wildfire behavior and severity. Gen. Tech. Rep. RMRS-GTR-120. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 43 p.

[4] CCSP. May 2008. Synthesis and Assessment Product 4.3 (SAP 4.3): The Effects of Climate Change on Agriculture, Land Resources, Water Resources, and Biodiversity in the United States, P. Backlund, A. Janetos, and D. Schimel, lead authors. A report by the U.S. Climate Change Science Program (CCSP).

to sequester more carbon in the short-term, in 30 to 50 years[5], disturbances such as fire and insects and disease could dramatically change the role of forests, thereby emitting more carbon than currently sequestering. Monitoring both climate change effects and the outcomes of management actions are key to adapting to a changing climate.

WORKING WITH PRIVATE LANDOWNERS

Although there is much we can do to sequester carbon on federal lands, it is also crucial for us to recognize the role that private forest land in the United States can and must play in the Nation's mitigation options for greenhouse gas emissions. People are often surprised to learn that the majority of forest land in the United States—about 56%—is owned privately[6]. An important contribution we can make to increase carbon sequestration in and decrease emissions from U.S. forests is by working with the owners of these 423 million privately-owned forested acres.

Privately-owned forests can be converted into subdivisions, other developed uses, or agriculture—all land uses that sequester substantially less carbon per acre than forest trees and soil[7]. Even though the private forest landowners of the United States are making significant contributions to cleaner air, cleaner water, and carbon sequestration simply by maintaining their land in a forested state, they often make decisions to convert their forest land.

Forest Stewardship, Forest Legacy, and the Community Forest and Open Space Program are voluntary landowner assistance programs that recognize how important it is that private forestland stays forested and continues to provide these benefits. Landowners across the U.S. can receive assistance with forest management and a written forest plan through the Forest Stewardship Program. Today, about 22 million acres of private forest lands are already managed under a current forest stewardship plan and there continues to be enormous demand for the program. The Forest Legacy Program recognizes the public benefits provided by private lands; conservation easements on vulnerable forest lands guarantee that they will not be subdivided or developed, and that they will be able to store carbon in their trees and soils. To date, the Forest Legacy program has protected over 1.8 million acres of vulnerable private forest lands from development.

CONCLUSION

Secretary Vilsack is asking the Forest Service and our sister agency, the Natural Resources Conservation Service (NRCS), to adopt an all-lands approach working with willing land owners across boundaries when addressing restoration. The Forest Service's Strategic Framework provides a guide to addressing climate change and the challenges at spatial and temporal scales unimaginable in the past. Coming to grips with climate change will require landscape-scale conservation, working together across borders and boundaries, and focusing on a common restoration vision for the greater good. The future of America's lands and waters, and the future of generations who will rely on them, depend on nothing less.

Thank you for the opportunity to discuss these issues with the Subcommittee. I would be happy to answer any questions you may have.

Senator WYDEN. Thank you both very much. I've got some questions for you, and I know colleagues do, as well.

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[5] Westerling, A. L., H. G. Hidalgo, D.R. Cayan, D. R., and T.W. Swetnam, 2006,. "Warming and earlier spring increase western US forest wildfire activity", Science 313(5789): 940-943.

Haynes, R.W., et al. 2007. The 2005 RPA timber assessment update. Gen. Tech. Rep. PNW-GTR-699. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 212p.

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Smith, J.E.; L.S. Heath, 2004. Carbon stocks and projections on public forestlands in the United States, 1952-2040. Environmental Management 33(4): 433-442.

U.S. Environmental Protection Agency. 2009. Inventory or U.S. Greenhouse Gas Emissions and Sinks: 1990-2007. EPA 430-R-09-004.

[6] USDA. May, 2008. Forest Ownership Patterns and Family Forest Highlights from the National Woodland Owner Survey. U.S. Forest Service. Northern Research Station. NRS-INF-06-08.

[7] Joyce, Linda A.; Birdsey, Richard 2000. The impact of climate change on America's forests. Gen. Tech. Rep. RMRS-GTR-59. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 133 p.. http://www.treesearch.fs.fed.us/pubs/4567

You all, of course, have been intimately involved in these issues, and you represent our government in two agencies that are central to this debate about climate change. I think this is the first time, in this Congress, we've looked at Federal lands as it relates to the whole debate about climate change. Let me see if I can ask some questions to get your position on the record on some of the key questions.

First, we'll just go to you, Dr. Batten and Mr. Tidwell. What is your position on including Federal lands in a cap-and-trade offset program?

Ms. BATTEN. We think that—the Department of the Interior thinks that there are tremendous opportunities for the incorporation of offsets into a cap-and-trade program; and, in fact, just as you just said earlier, Mr. Chairman, that they can be cost-reducing measures that can be incorporated into a cap-and-trade program. We're willing to work with you and provide as much information as we can, in terms of the amount of carbon that our ecosystems currently store and can store with best management practices, and we—as this—as legislation is being developed here in the Senate, that includes offsets. We're happy to provide as much information as we can during that process.

Senator WYDEN. I may have a second round, again, because—the fact that today is so busy—to talk about the some of the science and policy questions in that, but I'm glad to hear that you all would favor Federal lands being part of a cap-and-trade offset program.

Mr. Tidwell, your position on that?

Mr. TIDWELL. This is a very important topic that we need to spend, you know, time carefully considering. No doubt, this is one way to bring considerable investment, you know, to the nation's forests. There is also, you know, some concerns and some questions. You know, and some of those are, like, with the Federal Government setting up the rules and the regulations, should we also, you know participate? There is the question about accountability. There's also questions about, you know, how would public lands—how would that affect the market for private lands? Then, there's also the—you know, the question—and I pointed it out earlier—about how essential it is that—you know, carbon will be just one of the benefits that we manage for.

I think these are, you know, some of the questions that we need to address. We look forward to working with the Senate, you know, to find our way through this. It has tremendous potential. There's no question—there's just no question that, in—you know, investing in the resiliency of our national forests and grasslands are going to have positive-benefit effects. Carbon is part of that overall benefit.

Senator WYDEN. So, you're not quite where Dr. Batten is today; you didn't answer "yes," but you did say you thought that there was considerable potential. Is that the word you used?

Mr. TIDWELL. Yes.

Senator WYDEN. OK. Chief, one other question for you, and then we'll have one other for you, Dr. Batten. You all have done a fair amount of work with ecosystem services and carbon sequestration. My understanding is that the Department has established an office

for ecosystem services marketing to explore opportunities, to advance payments, to look at a variety of issues. Can you tell me the current thinking you have with respect to ecosystem service markets for Federal land and how carbon sequestration could be factored into that? I mean, what we'd really like to know is whether it could be a source of revenue for the Federal Government.

Mr. TIDWELL. That's one of the things that this new agency that we've set up is working on, to help address those questions. One of the things that that staff is working on is to develop methods for quantification of greenhouse gas emissions and offsets. They're also looking at ecosystem services around water quality, around biodiversity, and it's also with wetlands.

One of the advantages of this group, it's going to help the USDA to have a very—take a consistent approach to answering these questions, because this agency will be looking across all of USDA, but it's essential that we—I feel great that we have this staff that's in place now. Sally Collins, who used to be our associate chief that I worked with for years, I'm very confident to have her leadership in this arena on this agency to help us find these answers, to help us kind of work our way through this.

Senator WYDEN. I'll have some additional questions. I think we will have to have a second round, at least, to get at a couple of other matters.

But, let me recognize ranking minority member, Senator Barrasso.

Senator BARRASSO. Thank you, Mr. Chairman.

Dr. Batten, if I could—as you know, I've been concerned about Secretarial Order Number 3289. It relates to climate change. Secretary Salazar wrote a reply to me and to the Western Caucus on October 30. The Senate and House Western Caucus, you know, represents just about every Western State. In our letter to the secretary, we expressed concerns, because this Order 3289 will inject climate change into all Department of the Interior decisions and activities—it actually said "activities." So, it could potentially put into question past and future management agreements related to oil and gas development, renewable energy, recreational use of the land, grazing, hunting on public and private property, and wildlife protection. I mean, it is a broad, broad area that the Department covers. We expressed some concerns that the order was signed by the Secretary before Congress, which was currently considering different climate change legislation before Congress could pass any kind of a bill. So, the Secretary responded that his order relies on existing legal authority to implement these activities.

So, the question is, Just because the Secretary has the legal authority to do something, does—you know, does it mean he has to do that, he should do it? Or should the Department be taking its direction on something as big as injecting climate change, quote, "into all land management decisions" from the people who are elected to represent folks around the country?

Ms. BATTEN. Thank you for the question. If I may just very quickly clarify a statement that I made earlier, the administration has no official position on the use of public lands in the offset program; however, we stand ready to provide as much knowledge that we have, in terms of the science that's available and best manage-

ment practices. We stand ready to work with you in the development of this legislation.

To answer your question, sir, I understand the concerns that you just presented, and I want to comment on a number of them.

Secretary Salazar is faced, as the Secretary of the Department of the Interior, with managing 20 percent of our nation's terrestrial lands, 35,000 miles of coastline, 1.7 billion acres of the Outer Continental Shelf, and millions of acres of national monuments, parks, and refuges. So, as a result, all of those land management decisions, resource management decisions—we need to be considering climate change as the driving force in making decisions about how best to protect those resources and those lands for our communities and for fish and wildlife, and in order to continue to be able to provide the water, land, marine, cultural, and fish and wildlife and other resources that we have been tasked to oversee thus far.

So, in so doing, recognizing that climate change is such a challenge for all managers, both public and private across the United States at this time, we are including the consideration of climate change in making decisions about how to manage our resources, moving forward.

In terms of existing agreements that we have, we look forward to continuing our relationships with our Federal partners, our State and local partners, and additional private land partners, in terms of making—forging agreements, making sure that we're taking in the inputs, in terms of designing strategies that—for adaptive management of our landscapes. But, this is not a change from the past; this is a continuation of the type of interactions that we've had in the past with the American citizens and other Federal and State agencies.

Senator BARRASSO. When you said that this climate change will be "the driving force"—I mean, people are concerned about agreements that are already in place and what, retroactively, is going to happen.

Ms. BATTEN. Climate change is certainly a driving force, in terms of land and natural resource management. So, is land-use change and other forces. As we move forward, with the continued balanced energy strategy that the Secretary is committed to, in terms of oil, coal, and gas development, as well as renewable energy development, we will consider climate change as we're developing these resources and providing transmission to connect these resources to the populations that need them, and doing so in an environmentally sustainable way.

Senator BARRASSO. So, what's going to be the impact on agreements that have already been——

Ms. BATTEN. There is nothing in this secretarial order that addresses any existing agreements. This is about unifying all of the bureaus' work on climate change science, on adaptation strategies and mitigation strategies, so that we can design a unified way to move forward in order to best protect and continue to provide the services that our bureau and our Department is committed to do.

Senator BARRASSO. OK.

Mr. Chairman, perhaps in a second round I'll have a few more questions.

Senator WYDEN. Thank you. Very good.

Senator Johnson.

Senator JOHNSON. Chief Tidwell, if climate change means a warmer, drier climate with a higher risk of catastrophic forest fires and pine beetle epidemics, what specific management strategy is the Forest Service considering to increase the resiliency of the national forests to catastrophic disturbances?

Mr. TIDWELL. Thank you, Senator.

Yes, our information, our science, indicates that, with these warmer and drier seasons that we're having, we're seeing a direct effect on fire, and that we are experiencing, you know, larger fires, more intense fires than we have in the past.

Some of the things that we are looking at doing, and have been doing, is to recognize that. Where we can, to get in and do some strategic thinning to reduce the stand density is one way to help mitigate some of the effects of these large fires. It's essential, you know, to be able to place these treatments on the landscape where they'll be effective. We primarily look at around our communities and key watersheds, but there's also opportunities to look at places where we can break up the fuel loading across watersheds.

That's probably one of our best opportunities that we have to get in and do some thinning. Then, often follow that with prescribed burning to just reduce the overall fuel loading so that when we do get the fires, we don't see probably as large as fires, and we definitely will not see the level of intensity.

Then, the other benefit is that, when wildfires do burn into these treated areas, the fire behavior lessens, and our suppression actions are much more effective to be able to get in and to control those fires.

Senator JOHNSON. Would you discuss the value of diversity of age classes; for example, having representative proportions of all age classes, not just old or mature trees, especially in forests like the Black Hills National Forest, where we've seen examples of catastrophic fires and beetle epidemics? Would you agree that forest diversity is a key component of forest management, similar to planning a stock portfolio?

Mr. TIDWELL. Yes. You know, species diversity and also age diversity are two other things that we want to look at to increase that, especially in the—you know, some of the areas in the Intermountain West with lodgepole pine, where we have the hundreds of thousands of acres of, basically, even-aged pine. One of the things we want to work with in the future is to be able to break that up so we have more age diversity, and then, where we have the opportunity, to also increase the species diversity so that when we do get these large-scale events, we won't have that continuous fuel loading across, you know, the hundreds of thousands of acres that we do have in some places now.

Senator JOHNSON. How do you envision individual forest plans developing specific strategies and approaches in response to climate change? How would you account for differences between Black Hills ponderosa pine forests, New England maple forests, and West Coast Douglas-fir forests? What is your timeline to incorporate climate change into the forest plans?

Mr. TIDWELL. We've issued direction to our forests and grasslands, that they need to factor in, you know, the current science

that we have about climate change into their plans and also into their project designs. Where we have the opportunity to be doing forest plan revisions, we'll be able to factor that in—you know, into that plan.

But, even today, that—when we're designing projects, it's essential that our managers are factoring in the latest science, and also the changing climate that we're seeing. For instance, in the Pacific Northwest, on the Olympic National Forest, folks have been noticing how we're getting much more winter runoff, in that our infrastructure, when it comes to culverts and bridges, is no longer large enough to be able to handle those winter flows. We recognize that, and are in—and need to get in there and restore some of those drainages. But, one of the things is to increase the culvert size. So, just to be able to deal with these winter stream flows that are different than what we've seen in the past.

You know, in other areas that—we have to look at to really factor in how—what—a change in climate, and to make sure that we're not creating some expectations that are not available anymore, you know, with our ecosystems and with the changing climate. One of the things we have to factor in, Do we need to, you know, consider different species from what we've—maybe have considered in the past? We need to look at our thinning standards, that there may be some places we actually need to be thinning to at a much higher level to make sure that we can maintain the vigor and the resiliency in the stands. But, each of these situations are going to be unique. As I mentioned in my opening remarks, you know, climate change is going to have a variety of effects across the country. Depending where you're at and the type of ecosystems you're dealing with, we'll have to factor in that science to help us, you know, make the right decisions, not only with the plans, but with our project design.

Senator JOHNSON. My time is expired.

Senator BARRASSO [presiding]. Thank you.

Senator Wyden had to step out for a few moments, and asked that I call on Senator Risch.

Senator RISCH. Tom, you used a statistic, right at the end of your talk, or your statement, and it went over the top of my head. What—the offset statistic that you used—what was that?

Mr. TIDWELL. That with the terrestrial ecosystems, plus the wood products and landfills, that together they intake 12 percent of the greenhouse gas emissions in this country each year.

Senator RISCH. Now, is that Forest Service property, or is that all property, or—what is that?

Mr. TIDWELL. That's all.

Senator RISCH. All property. What—any idea what percentage the Federal share would be of that?

Mr. TIDWELL. You know, Senator, I don't have that figure today. I can get back to you with that.

Senator RISCH. Where did this figure come from? Who came up with this?

Mr. TIDWELL. You know, I don't have the source in my testimony, but I can get that source to you.

Senator RISCH. I assume it's one you deem accurate, or you wouldn't——

Mr. TIDWELL. Yes.

Senator RISCH [continuing]. Quoting it. OK.

This is a question for both of you. You know, when I took silviculture, years ago, we gave lipservice only to the carbon containment of forests. Now, we look at it differently today, obviously, because there's obviously more benefit there than what was recognized years ago. But, the thing that strikes me is that a forest will sequester carbon for 100 years and then—over recent years in Idaho, we've had catastrophic fires, and they're all released at one time. How does that work? What is the balance of that? Can you help enlighten me on that, this taking of it in and then releasing it all? Obviously, if a forest goes through a natural cycle without burning, it'll tie the carbon up for some time. That is, it turns into soil and it—at least for quite a period of time, it'll be held. But, if it burns, obviously letting it all out at once seems to me something that is substantially—that is very detrimental, and you question whether or not there's really an offset there, as far as sequestering over a period of time and releasing it all at once.

Have there been studies done on this or—help enlighten me on that. Tom, do you want to go first?

Mr. TIDWELL. Yes, Senator. You know, the carbon cycle is complex. You know, the things that you raised, the questions that you raised, are the things that we have to factor, you know, into our decisions. There's no question about the amount of carbon that's released with catastrophic wildfires. There's been numerous studies on that to be able to, you know, measure that.

You know, at the same time that—you know, trees store a lot of carbon, and generally, you know, larger trees, you know, store more carbon. They don't—their sequestration rates drop, but the large trees—you know, generally, they store more carbon.

So, it's part of looking at the cycle, but then also looking at what's sustainable. So, you know, our efforts are going to be focused on what we can do to, you know, increase the resiliency of our forest stands, and so that there is potentially less, you know, catastrophic fire, and, when we do have large fires, maybe able to reduce some of the intensity. We'll be able to do that, you know, through thinning and also, you know, through prescribed fire at different times of the year, when we could have a less intense burn occur.

But, a lot of this—our actions are going to be driven by just the need to sustain these forests, for all the benefits. Carbon is just one of those.

Senator RISCH. Thank you.

Doctor.

Ms. BATTEN. I think this is an excellent question. I think that one of the things we need to do is stop thinking about forests as a static system. Unfortunately, a lot of our forestry management in the past has led to this place of being where we are right now with being at risk for catastrophic wildfires in a way that, if we had allowed the natural cycle of some fire in some of these fire-generated systems, or fire—systems that are healthy when they have occasional fires go through them with much less intensity than these catastrophic wildfires—it's not an either/or situation; it's not as if you plant a forest or a forest naturally grows, and then there's car-

bon sequestered, and then it all goes away in a catastrophic wildfire. It doesn't need to be that way. It can be managed, as I'm sure my colleague here is working to do, in the Forest—the Forest Service manage. If you manage these forests in a way that allows for some fire—controlled burns, et cetera—it doesn't need to have this dramatic release of all the carbon, because, you're right, that's one of the main concerns with out-of-control wildfires.

Senator RISCH. Thank you.

Senator BARRASSO. Mr. Chairman, Senator Wyden had to step out. I don't know if you'd like to go into a series of questions and——

The CHAIRMAN. If you had questions, go ahead.

Senator BARRASSO. We've completed the first round, and then——

The CHAIRMAN. OK.

Senator BARRASSO [continuing]. We were going to go into a second round after——

The CHAIRMAN. I apologize to the witnesses for not being here to hear their testimony, but I just wanted to be here for a little bit of the hearing, at least, to indicate my recognition about the seriousness of this issue. I know we've all seen it in our States out west, and I certainly have seen it in New Mexico.

We recently put a bill in to facilitate the natural resource adaptation across the Federal land management agencies and States and tribes so that there would be better coordination and communication among the various land managers as to the policies that are being followed to deal with the problem. I think—I assume that's been a subject of some of the discussion here. If it hasn't been, I hope we can get more attention to that.

I think that there's a lot we need to know about the science, as well, about—in trying to adapt to the changes that we're seeing. I think what I'll do is just hold off, maybe ask a question or two of the next panel.

Senator WYDEN [presiding]. All right. Apologies again. It's almost like healthcare has sucked all the oxygen out of the room.

Senator BARRASSO. Then there won't be a fire.

Senator WYDEN. Yes. Senator Barrasso reminds us, "Then there won't be a fire."

[Laughter.]

Senator RISCH. Oh, there's going to be fire, all right, Mr. Chairman.

[Laughter.]

Senator WYDEN. This topic has never been for the fainthearted, there is no question about that.

Let's move to a couple of other areas, particularly biomass. Let me start with you, Dr. Batten.

This is an area where, you know, we, in rural Oregon, have been very exasperated about Federal policy, because we just think that there are millions and millions of acres essentially untreated. We could get merchantable timber to the mills, opportunity to have a very promising source of green energy, and there's great frustration about Federal policy. Of course, biomass has the potential to provide a low-carbon, you know, alternative to fossil fuels, and, as I say, a vehicle for treating millions and millions of acres of

forestland that need restoration and thinning. But, the fact is, you know, Federal law still puts up barriers to receiving full renewable fuels credit for biomass. In fact, there are a host of barriers with respect to using biomass on Federal lands. I'm very much committed to fixing this. I think, for purposes of starting, you know, questions here, what are your agencies doing now to further biomass development?

Start with you, Dr. Batten.

Ms. BATTEN. Secretary Salazar, as you know, is committed to a balanced energy strategy, and that includes looking into opportunities for biomass, whether it's biomass cofiring or use of biomass for renewable fuel generation. I—we are, in our assessment of carbon fluxes and looking at how carbon is stored across the United States, and in public lands in particular, we're looking at the carbon balance across the board and looking at both inputs and outputs, in terms of how we could be using biomass, moving forward. So, I would like to offer our assistance, as a department, both in terms of the science that we're doing on the carbon cycle and in terms of best management practices that could lead to the sustainable harvest of biomass and its use for renewable energy purposes.

Senator WYDEN. What would you cite today as the most significant thing the agency is going to promote biomass development?

Ms. BATTEN. The—we are working on—in our service contracts, in enhancing the availability of biomass, where it's ecologically appropriate.

Senator WYDEN. OK.

Mr. Tidwell, same question. Two questions to you. What's your agency doing now to further biomass while we wait for some legislation to change the barriers? Tell me, if you would, what you consider the most significant action that the agency is taking to promote biomass development.

Mr. TIDWELL. We have been promoting utilization of biomass as part of our restoration work. I like to look at it that, when we're doing this restoration work, often there's material that's smaller than sawlog, it's a lot of residual material that needs to be removed when we're doing our restoration work. Currently we have the options, in a lot of places in the country, to, one, pay somebody to pile it and then burn it, or to find a way that it's economically feasible for someone to haul it, you know, to a facility so they can make use of it. So, we've been encouraging that utilization in some places where, in the past, when we had more favorable markets, we would require the removal of that material instead of burning it. But, in the current markets, there's less of an opportunity to, you know, be able to do that.

So, we've been encouraging that. We also have been up utilizing our biomass grant program to help, you know, develop additional infrastructure. Often these have been relatively small facilities, but we've been very successful in schools and in a couple of small hospitals and other administrative facilities and that—you know, as the technology increases with these facilities, folks are seeing more and more use of that type of a facility to make use of that material.

Your last question was——

Senator WYDEN. What do you consider the most significant action you've taken to date to promote biomass development?

Mr. TIDWELL. Yes, I would think with—working with our grants to develop additional infrastructure so that there's use of this; also, the work that our forest products lab has been doing to, you know, help look into other—new technologies that make the use of this material more efficient. Those are probably the two things that I would say are probably the most significant right now.

Senator WYDEN. I'll hold the record open. Could the two of you get to us, say, within the next 2 weeks, a list—a specific list of what your two agencies are doing to promote biomass development?

Ms. Batten, that acceptable?

Ms. BATTEN. Absolutely.

Senator WYDEN. Mr. Tidwell.

Mr. TIDWELL. Yes.

Ms. BATTEN. May I offer two more——

Senator WYDEN. Sure.

Ms. BATTEN [continuing]. Bits of information that the BLM has been working on, and offer my colleagues from BLM for some additional detail, if you're interested?

BLM, in 2009, offered 100,000 tons of biomass for cogeneration. In 2010, plus under—using the ARRA funds, this will include over 250,000 tons of biomass offered for these purposes. So, we will include those two projects in the list that we submit to you.

Senator WYDEN. Good, thank you.

Senator Barrasso.

Senator BARRASSO. Thank you, Mr. Chairman

Mr. Tidwell, thank you for being here and sharing your thoughts.

I wanted to visit a little bit about—well, the President recently signed the executive order that all management will be undertaken with climate change in mind. I'm just curious if you could spend a little bit of time giving the committee a couple of examples of maybe some of the specific changes that your agency is going to be making to respond to that executive order.

Mr. TIDWELL. Thank you for the question.

You know, I mentioned one, our strategic framework that we put out last year to help us set our priorities. I also will be sending out direction to our regions and research stations to have the regions and the stations work together to develop an action plan around that strategic framework, to actually lay out specific actions that those regions are going to be implementing, you know, through planning or through, you know, project design. You know, we have, you know, projects throughout the country in places where we are already addressing, you know, some of the changes. You know, one of them is there in the greater Yellowstone area. We're very concerned about what's happening to white bark pine, and the infestation of the pine beetles in that white bark pine is something that we haven't had to deal with in the past. It—in the past, where the white bark pine is, it's usually high enough and cold enough that we haven't had to deal with that. So, we're spending a—you know, some time to look into that and have our researchers to actually help us to develop some different options about how to—what should we do with that. You know, is there an opportunity to get in there and do some thinning, and should we do some additional planting? Or just what do we need to do? So, that's one example.

Senator BARRASSO. Dr. Batten, along the same lines—it's interesting, because you're the science advisor to the Deputy Secretary, and, you know, my background in orthopedics, it's always a matter of what's sound science, what's junk science. I know you have to face that, as well, as you're dealing with the climate change. Along the lines of what Mr. Tidwell was talking about, you know, how to handle the situation with the trees and the forests.

You know, all forest science that I'm aware of would recommend that the lodgepole pines should have been harvested over the last 50 years to avoid some of the situations that we're in now, that we are—that our forests are suffering. So, how do you—tell me a little bit about sound science, junk science, and how you make some decisions, because there have been some concerns from the Department, before you arrived, that—where perhaps it was junk science instead of sound science.

Ms. BATTEN. As an ecologist—that's my background—I stand, in my role at the Department of the Interior, to make sure that sound science is supporting policymaking at the Department. This follows both the Secretary—Secretary Salazar's and President Obama's commitment to science-based policymaking. A number of our bureaus conduct peer-reviewed, excellent science that is contributing to our policymaking all along. In fact, the new secretarial order that we discussed earlier is designed to ensure that the best available science is being translated into adaptive management strategies for our land and natural resource managers so that they can be responding and then monitoring the effect of their actions over time to truly adaptively manage. All of this grounded in sound science.

Senator BARRASSO. So, if you look at forest science and lodgepole pines that we should have been harvesting over the last 50 years to avoid the current situation, so that would have required some significant timber harvesting, which Federal land management agencies have resisted over the last several decades. So, you know, given that science, but seeing no action from the Department of the Interior's standpoint, you know, what do we advocate now?

Ms. BATTEN. Science is an evolving field. As scientists, we learn more as we continue to explore how natural systems interrelate to one another in the field of ecology. What we do is, we use the best available information that we have at the time to make decisions. As we learn more about the vulnerability of single-stand forests and older forests and their susceptibility to infestation, wildfires, then we need to react as we learn more about that and incorporate that information into these management strategies.

So, science is—again, it's not a static field, it's an evolving field, over time. We're always learning more things. That's what so exciting about science. That's why it's so important to incorporate this type of evolving knowledge, over time, into policymaking.

Senator BARRASSO. So, what does the science tell you now to do with those forests?

Ms. BATTEN. With those forests? As Mr. Tidwell is talking about earlier, we are in the midst of planning for the fire season upcoming, and we're doing that in cooperation with the Forest Service and with USDA. We recognize the severe consequences that may arise as a result of the dry and dead timber that we are currently

having in our forests. So, again, it's an evolving process. We're looking at thinning, we're looking at a number of different alternatives to address this issue.

Senator BARRASSO. One final question, Mr. Chairman, if I could; it's a yes-or-no answer.

Can you assure me, based on what you earlier said about climate change as the driving force—can you assure me that no existing land management agreement for energy development, recreational use—talking about existing land management agreement—will be changed because of the Secretary's climate-change order, which you say makes climate change the driving force in land management decisions?

Ms. BATTEN. There is nothing in the secretarial order that discusses anything to do with altering any existing agreements or arrangements between the Department of the Interior and any of our partners as a result of the secretarial order.

Senator BARRASSO. So, the answer is "yes," there is nothing——

Ms. BATTEN. There is nothing——

Senator BARRASSO. You can assure me.

Ms. BATTEN [continuing]. In that secretarial——

Senator BARRASSO. You can assure me.

Ms. BATTEN [continuing]. Order that says anything about these existing agreements.

Senator BARRASSO. Thank you.

Thank you, Mr. Chairman.

Senator WYDEN. Thank you, Senator Barrasso.

Senator Bingaman.

The CHAIRMAN. I did think of a question I wanted to ask Chief Tidwell.

The Congress passed, and the President signed, the Landscape—the Forest Landscape Restoration Act earlier this year. How do you see that Act and that authority as relating to your planning to deal with this climate change problem? Is it providing tools to you that you didn't otherwise have? Or how do you see that?

Mr. TIDWELL. Senator, thank you for the question. Also, thank you for the work to get that legislation passed, because we do feel that it'll be very beneficial. There's a couple of key parts of it.

One of them is the requirement for collaboration so that we bring people together and reach agreement about the kind of restoration that needs to occur, and also the size.

One of our challenges is that—as I had mentioned earlier in my remarks, is that these issues, the change that we're seeing, it's across large landscapes and that we have to find ways so we can look at our restoration across larger landscapes. So, that legislation and that authority now will give us the opportunity to really look at much larger landscapes, bring people together, reach agreement on the level of restoration, the type of restoration that occurs. It's been my experience that, when we take that task, we're able to build that support, and we're able to implement the projects.

The CHAIRMAN. Thank you very much.

Senator WYDEN. Senator Risch.

Senator RISCH. Briefly. Tom, I hadn't heard that, about the pine beetles in the white bark pine. Is that only at the lower part of its range, or does it go all the way through?

Mr. TIDWELL. It's—at least out there in Wyoming and Montana, really around the greater Yellowstone area is where we were seeing the effects. We were seeing it, you know, to the very top of the range. You know, that's definitely unique for us. It's one of the things we just haven't had to really worry about in the past, about that level of infestation. We're also seeing a very high level of mortality in the white bark pine.

Senator RISCH. They're a delicate species.

Mr. TIDWELL. I'm not sure it had to evolve, you know, dealing with mountain pine beetle.

Senator RISCH. Thank you very much.

Thank you, Mr. Chairman.

Senator WYDEN. I thank my colleague.

We've got a couple of things you're going to make available to us for the record, particularly your contributions in biomass. We're going to be talking about this subject often, because certainly the—the question of climate change, forestry, and biomass, this is right at the intersection of policy for this country that can help us create more good-paying jobs, green good-paying, you know, jobs, and help us to deal with this pressing question of climate change. We're committed to getting this right. We're going to be talking to both of your agencies often.

Is there anything either of you would like to add before we excuse you?

[No response.]

Senator WYDEN. You're not required to add.

Mr. TIDWELL. Just, once again, I want to thank you, not only for taking the time for today's hearing, but also your interest in this issue, and really appreciate that and appreciate your leadership. Thank you.

Senator WYDEN. Dr. Batten

Ms. BATTEN. I also want to thank you for this opportunity. It's been a real pleasure talking about these very important issues with the subcommittee.

I just wanted to also say that I really appreciate the links that you're making between mitigation, taking greenhouse gases out of the atmosphere, adaptation, helping our natural systems adapt to the impacts of climate change, and job creation, all in one fell swoop. We can do all of this at once, and it really is key to the success of our new economy and moving forward and combating climate change.

Senator WYDEN. For the part of the world that Senator Risch and I represent, I can tell you, citizens are counting on getting it done with that kind of focus. So, we'll be working with you often. We'll excuse you, at this time.

Our next panel, Beverly Law, Ph.D., from Oregon State; Elaine Oneil, Ph.D., from the University of Washington; Chris Wood, with Trout Unlimited. If you all will come forward.

Welcome, to all of you. We're going to make your prepared statements a part of the record; if you could summarize your principal views, that would be good.

Why don't we begin with you, Dr. Law.

STATEMENT OF BEVERLY LAW, PROFESSOR, GLOBAL CHANGE FOREST SCIENCE, OREGON STATE UNIVERSITY, AND AMERIFLUX NETWORK SCIENCE CHAIR, CORVALLIS, OR

Ms. LAW. OK. Chairman Wyden——

Senator WYDEN. From Oregon State.

Ms. LAW. From Oregon State University, yes.

Chairman Wyden and members of the subcommittee, thank you for inviting me here today. I'll focus my talk on forest carbon sequestration and adaption to climate.

So, first some basics on what we consider to be carbon sequestration. Forests take up carbon dioxide by photosynthesis, and then carbon goes into soils in the vegetation, and both are considered carbon sequestration. But, carbon is also released from forests by natural processes, restoration and slow decomposition so that, on balance, a forest may be a source or a sink or neutral to the atmosphere, depending on climate, land-use change, and things like wildfire.

So, when an old forest is harvested, much of the carbon that it contains is released back to the atmosphere as carbon dioxide, and it takes, on average, about 15 years for a forest to become a net-zero emitter of carbon dioxide. So, I'm talking about the land base and how the land base acts.

Now, in terms of carbon storage, in Oregon and California it takes about 180 years to over 600 years to attain the same biomass carbon that was on an old forest before it was cut, so it's a long time to get to that level of carbon storage.

Many of the mature and old forests are on Federal lands, and carbon stores are usually higher on public lands, primarily because of the younger forests on private lands. To manage Federal lands in the public interest of sequestration, we should strive to preserve the mature and old forests to avoid losses of carbon due to harvest. To avoid losses of carbon on public lands due to fire, fuel reductions may be necessary in dry regions, where an uncharacteristic amount of fuels have built up. In moist forests, however, like in the Northwest or the West, the Cascades, fires were historically infrequent, and they may be best used for the high sequestration capacity.

Most of the live and deadwood is not consumed in wildfires, contrary to common belief, in high-severity fires. We've done measurements before and after fires to determine that. Most of the live and deadwood—I was going to say, fuel reduction can be effective in reducing fire severity, however it comes at the cost of reducing carbon sequestration. So, they're tradeoffs.

Balancing a demand for maximizing carbon storage with a desire to reduce fire severity will require treatments to be applied strategically rather than indiscriminately across landscapes.

Now, the IPCC climate projection for North American shows increased precipitation at high latitudes, like up in Alaska, and a sharp decrease across the Southwest. Drought-affected areas will likely increase in extent. There's also likely to be an increased risk of extinction if warming continues at the rate that it continuing.

Changes in seed and in plants include rain shifts in latitude and elevation and threatened systems include those with barriers to migration, like mountaintops, simply going right off the top of the mountains.

To facilitate forest response to climate change, measures can be taken to conserve species and genetic diversity and ensure forest landscape connectivity for migration of plants and animals to a climate where they can survive and thrive.

Federal lands are uniquely valuable for providing the connectivity and refugia, and they can work with neighbors to expand these areas. New policies are needed for Federal forests to focus on ecological function; conserving old forests and old trees, where they exist; and possibly even expand preserve areas.

To inform policy decisions, ecosystem function should be assessed at long-term observationsites to quantify baseline conditions and track changes in response to climate. The Forest Inventory Program, FIA, could be modified to address carbon sequestration. The AmeriFlux Network has 30 sites on Federal lands, and they are—can be used to inform—to provide information on responses to both climate and disturbance; that's what they're designed to do. The two can provide programs—can be combined with a decision support system to produce assessments for policy decisions and strategic management actions.

So, in summary, forests can play a limited yet important role in carbon sequestration for mitigating climate change. In evaluating carbon policies, it's important to fully account for the carbon involved, including the carbon transport. To manage Federal lands in response to climate change for carbon sequestration and adaptation, we can increase or maintain carbon sequestration by replanting forests and avoiding forest carbon losses. We can facilitate response to climate change by sustaining genetic and species diversity through forest preservation and enhancing landscape connectivity for dispersal of plant and animal species. Then, Federal lands are uniquely valuable for sequestration and facilitating adaptation to climate. The overarching goal should be to sustain forest ecosystem function, and we need adaptive management.

[The prepared statement of Ms. Law follows:]

PREPARED STATEMENT OF BEVERLY LAW, PROFESSOR, GLOBAL CHANGE FOREST SCIENCE, OREGON STATE UNIVERSITY AND AMERIFLUX NETWORK SCIENCE CHAIR, CORVALLIS, OR

Mr. Chairman and members of the Committee, thank you for inviting me today to discuss managing federal forests in response to climate change for natural resource adaptation and carbon sequestration. I am a Professor of Global Change Forest Science at Oregon State University, and Science Chair of the AmeriFlux network of observation sites that study the effects of climate and disturbance on ecosystems across the U.S. I am also a co-author of the *U.S. Climate Change Research Program's Synthesis and Assessment Product 2.2*, which addressed the "North American Carbon Budget and Implications for the Global Carbon Cycle." I will focus my remarks on current knowledge on forest carbon sequestration and adaptation.

CARBON SEQUESTRATION

Forests take up carbon dioxide by photosynthesis and store it in biomass and soils, which are both forms of carbon sequestration. Some of the carbon rapidly returns to the atmosphere from respiration by live plants and soil microbes or more slowly through the decomposition of dead material. Fire and harvesting activities also result in carbon emissions to the atmosphere. On balance, forests may be a positive, negative, or neutral contributor of carbon to the atmosphere, depending on variation in climate, land use, wildfires, and harvest activities.

When a mature forest is harvested, much of the carbon that it contains is released back to the atmosphere as carbon dioxide. The disturbance involved in harvesting a forest creates conditions that speed up decomposition; it takes, on average 15

years for a new forest to become a zero net emitter of carbon dioxide (Luyssaert et al. 2008). Harvesting wood increases carbon stores in wood products, but it also decreases live and dead stores in the forest. Thus, it is important to consider changes in all carbon stores (Law et al. 2004).

Today, carbon is accumulating in U.S. forests, offsetting about 16% of the nation's fossil fuel emissions (CCSP 2007). Without forests, atmospheric CO_2 levels would be rising even faster. Over this century, net carbon uptake by terrestrial ecosystems at the global scale is likely to peak before mid-century and then weaken or even reverse, thus amplifying losses associated with predicted climate change (IPCC 2007b). Part of the reason is increasing loss of soil carbon with increasing temperature and disturbances. Disturbances that release even a small percentage of the soil carbon content could have a large effect on atmospheric CO_2 levels, particularly if the soils contain high concentrations of organic matter, like those in high latitude ecosystems (Schuur et al. 2009).

To manage federal lands in the public interest of carbon sequestration, we should strive to preserve mature and old forests to avoid losses of carbon associated with harvest. Many of the mature and old forests are on public lands, so they are uniquely positioned to act as carbon reserves. For example, in the Pacific Northwest, biomass carbon is usually higher on public lands, primarily because of the younger forests on private lands (Hudiburg et al. 2009). Activities that can contribute to increasing carbon sequestration include: planting forests in areas previously harvested (reforestation), and on lands suitable for growing forests (afforestation). Such forests can be expected to accumulate carbon for many decades.

CARBON SEQUESTRATION VS THINNING TO REDUCE FIRE POTENTIAL

Variation in climate, and surface fuel supply and continuity are factors that contribute to increased fire potential. Recent studies (Campbell et al. 2007&2009, Hudiburg et al. 2009, Donato et al. 2009, Mitchell et al. 2009) suggest that efforts to reduce fuels in many types of forests will be counterproductive to sequestering carbon to help offset climate change. Fuel reductions may be necessary in dry regions where uncharacteristic amounts of fuel have accumulated. In moist forests, however, fires were historically infrequent. Findings:

- Most of the forest biomass (live and dead wood) is not consumed by wildfires, even in high severity fires
- Some fuel reduction techniques, especially those that remove half or more of the larger trees, could lead to an increase in fire severity because of additions of logging debris
- Fuel reduction can be effective in reducing fire severity, however, fuel reduction results in decreased long-term carbon storage

Balancing a public interest in maximizing landscape carbon storage with a desire to reduce wildfire severity will likely require thinning treatments to be applied strategically rather than indiscriminately treating all forest stands across the landscape.

One suggested method of compensating for losses in carbon storage due to thinning to reduce fire hazard is to use carbon harvested in fuel reduction treatments as biofuels. Timing is an important factor to consider, for example, how long it took to grow the trees, how quickly the biomass will be used, and how long it will take to replace the removed carbon. Other considerations are fuel efficiency and carbon cost of removal, so there needs to be full carbon accounting. A recent study indicated that using the thinned trees for biofuels will not be an effective strategy over the next 100 years (Mitchell et al. 2009), and 50-100 years is probably the relevant timeframe of forest carbon policy. The analysis on forests with high biomass production and storage capacity showed it would take ~170 years for biomass production to offset carbon emitted from fossil fuels, and over 300 years for ethanol production. This assumed all of the possible energy in these fuels would be utilized, which isn't likely to be the case.

CLIMATE CHANGE PROJECTIONS AND ADAPTATION

The IPCC (Field et al. 2007) climate projection for North America is characterized by a variety of different patterns of precipitation, with increasing precipitation at high latitudes and a sharp decrease in precipitation across the Southwest. Drought-affected areas will likely increase in extent. Warming in western mountains of the U.S. is projected to cause decreased snowpack, more winter flooding and reduced summer flows.

The IPCC (2007b) also states that (1) about 20-30% of known plant and animal species are likely to be at increased risk of extinction if increases in global average

temperature exceed 1.5-2.5°C; (2) types of changes seen in plants include range shifts (latitude, elevation) and changes in growing season length, and threatened systems include those with physical barriers to migration (e.g. montane ecosystems); (3) non-climate stresses can increase vulnerability to climate change by reducing resilience and adaptive capacity; and (4) unmitigated climate change would, in the long term, be likely to exceed the capacity of natural and managed systems to adapt (IPCC 2007c).

To facilitate forest response to climate change, measures can be taken to conserve plant and animal species and genetic diversity, and ensure forest landscape connectivity for migration of species to climate in which they can survive and thrive (e.g. corridors, roadless areas). Genetic diversity allows selection for traits that may be more suited to a new climate. There will be winners and losers in a new climate, and species diversity improves the odds of formation of sustainable ecosystems. Federal lands have many of the mature and old forests that can serve as sources of genetic and species diversity needed for dispersal.

In semi-arid to arid regions like the Southwest U.S., prolonged drought pushes species to the limits of survival, and this is often followed by mortality from insects and diseases. If climate becomes more severe in these regions, the idea of sustaining a particular plant association in a particular location could be futile because a tipping point may be reached where climate is outside the historical range for survival of some species within a forest type. If prolonged drought impacts dry forests, thinning may be effective to alleviate drought stress in the remaining trees, but if there is no water available within the rooting depth, mortality will occur even if the forests are thinned (independent of density). Thinning could be counterproductive to adaptation goals if removed trees or seedlings damaged from harvest activities are those best suited to survive and thrive in a new climate.

NEW POLICIES

New policies are needed for federal forests to focus on sustaining ecological function. Policies should accommodate the variation that exists in forest ecosystems in terms of their diversity and disturbance histories. For example, in the Pacific Northwest, there are distinct differences between moist forests and dry forests that require different policies and adaptation approaches (Johnson & Franklin 2009). The moist forests have evolved with very infrequent high severity disturbance regimes (e.g. wind, fire) where mosaics of stand replacement have occurred. Old-growth moist forests have had little human impact and management treatments are generally not needed to maintain them in the foreseeable future. Younger forests that exist in this moist region could be manipulated to increase ecological diversity. The dry forests have evolved with more frequent low and mixed severity wildfire as the primary disturbance regime, and the structure and function of old forests has been altered by ingrowth of less drought-and fire tolerant species.

Historically, these forests had relatively low densities and with scattered older trees of highly drought-and fire-resistant species. In dry forests, focus should be on sustaining the old trees, modifying fuel loads, and reducing trees that crowd the older trees and make them susceptible to mortality from fire, insects and disease. Such careful applications are needed to maintain ecological function of forests.

Long-term observation networks and a decision support framework will be required to assess the vulnerability of forests to climate change, and to refine management of forests for carbon sequestration. Critical elements of decision support for regional to local actions include integrated long-term observations, an accessible data and information system populated in a timely manner, forest process studies to improve regional prediction, and regional climate modeling appropriate for societal decisions. This would allow management for goals of carbon sequestration and ensuring species and genetic diversity for a future climate. The existing Forest Service Forest Inventory & Analysis program (FIA) has observation sites where measurements could be modified for producing carbon budgets of soil and vegetation and for detecting shifts in productivity and species. The AmeriFlux network that examines responses to climate and disturbance has ~30 sites on federal lands and can be used to detect vulnerabilities and improve model predictions of forest response. For example, over 10-15 years, sites in the network have seen increases in growing season length and the effects on the carbon balance of the ecosystems. The two observation systems can be combined with a decision support system that is needed to produce assessments for aiding policy and management decisions.

CONCERNS ABOUT CARBON POLICY

It is important for carbon credits to prove a concept called additionality, whereby additional carbon is stored due to new actions, going beyond business-as-usual. The

concept of 'additionality' addresses the question of whether the project would have happened anyway, even in the absence of revenue from carbon credits. In the case of federal lands, it seems it would be difficult to be considered for additionality because they are mandated to be managed for the public interest of carbon sequestration (the project would have happened anyway). Federal lands should be managed for the public interest of carbon sequestration, not revenue from carbon credits. If federal lands are managed for revenue from carbon credits, it will likely impact ecosystem functioning and other ecosystem services.

A potential unintended consequence of carbon policy would be a reduction in carbon sequestration prior to implementation of the policy so that revenue could be obtained for new actions to increase carbon storage.

If credit is given for choosing not to cut existing forests, monitoring and audits of carbon sequestration will be necessary to determine status of carbon uptake, insurance will be necessary to protect past carbon sequestration from destruction by fire or windstorms, and penalty payments will be necessary if the forest is eventually cut. Such efforts will be costly to administer, diminishing the value of the rather modest carbon credits expected from forestry (Schlesinger 2006).

The IPCC (2007) suggests net carbon uptake by the land is going to decrease in the future. The risk with ecosystem impacts and feedbacks to climate is that once climate reaches a certain point, the problem will become more difficult to address because of less capacity of forests to store carbon. Forests have an important but limited potential to offset climate change. The critical issue is that we need to slow GHG emissions growth rapidly to quickly enter into a period of decreased emissions.

SUMMARY

As climate change accelerates, the capacity of forests to store carbon will decline, and unmitigated climate change could exceed the capacity of natural and managed systems to adapt. Forests can play an important but limited role in carbon sequestration for mitigating climate change. In evaluating carbon sequestration policy and management options, it is important to fully account for the carbon involved. To manage federal forests in response to climate change for carbon sequestration and adaptation, we can (1) increase or maintain carbon sequestration by avoiding forest removal, replanting forests, and restoring ecosystem function; and (2) facilitate response to climate change by sustaining genetic and species diversity through forest preservation (e.g. for seed sources), enhancing landscape connectivity for migration/dispersal of plant and animal species, and by aiding dispersal to favorable climates. To avoid carbon losses due to drought or fire, it may be necessary to thin some dry forests that have accumulated uncharacteristic amounts of fuels. Thinning could be counterproductive to adaptation goals if removed trees are those best suited to survive and thrive in a new climate. Federal lands have an important role to play in both carbon sequestration and ecosystem adaptation to climate change. The overarching goal should be to sustain forest ecosystem function.

To inform policy decisions, ecosystem function should be assessed at long-term observation sites to quantify baseline conditions in ecosystem function and carbon sequestration, and to track changes in response to climate. The existing FIA and AmeriFlux observation sites on federal lands could serve this need. Critical elements of decision support for regional to local actions include integrated long-term observations, an accessible data and information system, process studies to improve regional prediction, regional climate modeling, and integration of research to produce assessments for aiding policy and management decisions.

Senator WYDEN. Dr. Law, thank you. Oregon State is renowned for its forestry school, and you have accounted well for them today. I knew it was—there was a reason why we campaigned to have you make the long trek back. I was especially glad that you also brought into your comments the focus on the older forests, because that's an important part of this debate, and we're going to make sure that's not going to get short shrift, either. So, thank you very much for a very good presentation.

Dr. Oneil, also from the Pacific Northwest, we thank you for making the trip, as well. Welcome, and please proceed with your remarks.

STATEMENT OF ELAINE ONEIL, PH.D., M.S., BSF, RPF, RESEARCH SCIENTIST, SCHOOL OF FORESTRY, COLLEGE OF FOREST RESOURCES, UNIVERSITY OF WASHINGTON AND EXECUTIVE DIRECTOR OF CORRIM (CONSORTIUM FOR RESEARCH ON RENEWABLE INDUSTRIAL MATERIALS), SEATTLE, WA

Ms. ONEIL. Thank you, Senator Wyden. Thank you for inviting me to provide my testimony.

Let's start by looking at some climate change impacts that are now occurring on our national forests. They've all been discussed here today.

I provided some corroborating documents, and in them are 11 pictures in this folder that highlight two specific impacts on national forests that I want to talk about. We're talking about areas in the Intermountain region from eastern Washington to the Black Hills, from the Canadian border to New Mexico.

Across the land—the West, what we're seeing is landscapes with almost complete tree mortality, whether from mountain pine beetle or from stand-replacing fires. That means fires where old trees—or mostly all trees are killed.

Now, under climate change scenarios, these impacts are expected to only get worse; in some cases, a doubling of the area burn per year, and in some regions the loss of the entire mature pine forest.

So, what does this means in terms of climate change adaptation and carbon storage? Obviously when trees are dead, they're no longer sequestering carbon. They're releasing it; some slowly, through decay, or rapidly, through wildfire.

Under normal circumstances, the forest would regenerate, the carbon would be taken up again, and the carbon neutrality of the forest would be assured. Currently, we're seeing something quite different in western forests. In the Fremont-Winema in Oregon, there's a 300,000–acre dead zone that used to have lodgepole pine on it, and which is now slowly releasing carbon. What's happening in that forest is that, even though lodgepole typically regenerates after there's some sort of a disturbance, they're not getting the regeneration there, usually because they're having—they have difficulty regenerating in that forest anyhow, because of the extreme climatic conditions. Similarly, in some areas of Washington State, we're expected to lose one or two pine species, with no equivalent species to take their place, because of ongoing changes to summer drought.

Once these forests die and dry out, they become especially good candidates for uncontrollable fire and its attendant greenhouse gas emissions. On page 6 of the document, it shows that a NOAA satellite image of the 2006 tripod complex fire on the Okanogan-Wenatchee National Forest in Washington. That forest used to contain 100 permanent sample plots within the fire perimeter. In the years prior to that—I had done some analysis—60 out of 100 of those plots had severe mountain pine beetle infestations in the prior 4 years. That exacerbated the ability to control the fire, and it also led to some of the more damaging impacts in that particular region.

You know, definitely because we had that big fire, we managed to control—or, slow down the bark beetle epidemic; we knocked out

a lot of the bugs. But, the carbon emissions profile from that one fire was estimated to be equivalent to a million sport utility vehicles running on Washington's roads for a single year.

Senator WYDEN. What? Say that again? One million sport utility vehicles?

Ms. ONEIL. Running on Washington's roads for a year. That one fire. That's the estimate. Now, that doesn't say that every single tree was completed toasted.

Senator WYDEN. Right.

Ms. ONEIL. That's just looking at about 15 percent of the aboveground biomass being lost. It did not account for any losses in soil carbon.

So, we can have—in situations like this, where you have a pretty severe wildfire, you can have difficulty—the same difficulty with regeneration that they're seeing on their Fremont-Winema. Work done in California has found that upward of 85 percent of the area does not regenerate after these catastrophic wildfires. As the pictures show for the—Arizona's Rodeo-Chediski, in areas of complete mortality the soil was essentially cooked, and there's no seed source left. So, the question that we have to look at is—we once had forest there; we don't have them now—Will they be able to regenerate? Will we have this carbon-neutral situation, where we have extreme wildfire?

So, those are the impacts. What can we do about it? Building resilience into these forests by thinning them to some—down to some level where the trees can look after themselves is important. We need to get realistic about increasing forest resilience through targeted treatments that are driven by underlying ecological carrying capacity, not by a premandated, negotiated definition of tree size or density or spacing. The top-down will not work in a situation where we have this much complexity across our landscape.

If we thin, we can reduce fire impacts. If you look at slides 11 and 12, you'll see the contrast between the fire impacts from the Rodeo-Chediski on national forests versus adjacent tribal lands. That will increase tree vigor, it'll improve forest health. You're still going to maintain some carbon storage on these remaining trees, and maintaining a seed source, as well.

We can't just thin the forests and leave the material there; we have to find a way to remove it, because if you just cut it and leave it, you're not actually reducing fire risk, you're increasing it. You, in some instances, can make insect outbreaks worse. In order to remove it, we need to make it financially viable to address these biomass removals.

Now, policies to address carbon storage would ideally include some local collaborative efforts, decisionmaking, and augmenting it by applying the kinds of research that we've done and that have been done in multiple ecosystems on climate change, on carbon storage, and on best options for biomass recovery and uses, and using lifecycle inventories to actually measure real inputs and outputs from the system that are based on known uses, processes, and recovery potentials. What that means is that you have to tie the kinds of removal and the kind of biomass use to the available feedstock, and that's something that we're looking at now in some of our research.

I think anything less than this is going to result in—more in ongoing massive carbon debt. In these particular forests, as they die, they decay, they burn, and release carbon at a rate that probably exceeds current uptake in these lands, if it has not already done so.

Each forest has a unique carrying capacity. With 50 years of fire suppression, coupled with hotter and drier summers, warmer winters, the hallmarks, really, of predicted future change—I think we're already seeing it—we are at a threshold where carrying capacity is exceeded, the results of these massive bark beetle outbreaks and the attendant fire. We really already have the tools. We don't have to invent additional tools to—for biomass removal, considering that current harvest removal is also—or biomass—and we have plenty of rules to address those removals.

We seem to be caught up with arguing about definitions of biomass and old growth, while the old forests around us are killed, while these forests around us are killed by bark beetles, and then they burn, adding additional carbon to our atmosphere.

I'll just give you a few numbers here, in the time remaining. In 2007, there was 6.8 million acres of mortality in the entire U.S. Sixty-one percent of that was from mountain pine beetle, so that's 4.1 million acres. Those are Federal statistics from the U.S. Forest Service. They also say that there's a total of 22 million acres at risk to bark beetle mortality, but in a single year, we lost 20 percent of it. That's a lot of carbon sequestration potential loss. That's a lot of potential carbon emissions.

In addition, there are about 28 million acres that could use some help in reducing fire risk. Those—there may be some overlap between the 22 and the 28 million; those were two different studies. So, you see that, in effect, what we have here is a situation where we're at a tipping point, and we can address the situation through some fairly aggressive management that looks at site-specific outcomes, or we can address it—we can address it at some—with some dedicated resources to look at these problems in a site-specific way, or we can continue to do research on how we could look at storage in a different way.

I talked way faster than I thought I would, so I could ad lib here or I could open it up for questions.

[The prepared statement of Ms. Oneil follows:]

PREPARED STATEMENT OF ELAINE ONEIL PH.D., M.S., BSF, RPF, RESEARCH SCIENTIST, SCHOOL OF FORESTRY, COLLEGE OF FOREST RESOURCES, UNIVERSITY OF WASHINGTON AND EXECUTIVE DIRECTOR OF CORRIM (CONSORTIUM FOR RESEARCH ON RENEWABLE INDUSTRIAL MATERIALS), SEATTLE, WA

I am a research scientist at the University of Washington with a specialization in forest health and climate change. I am also the Executive Director of CORRIM, the Consortium for Research on Renewable Industrial Materials. CORRIM is a consortium that was created in 1996 between fifteen universities to conduct research on the environmental performance of every stage of forest products manufacture from cradle (planting the tree seed) to grave (landfill of solid wood products at the end of their first use). The research conducted by CORRIM uses life cycle inventory (LCI) and life cycle analysis (LCA) techniques which take into consideration the energy balance and carbon emissions inherent in the growth, procurement, manufacture, and eventual use of wood products.

Effective policy for integrating forest ecology, climate, forest management options, and the potential use of products derived from management must account for interactions both inside and outside the forest boundaries. My goal is to provide you with

an understanding of how these interactions can be used to develop optimal strategies for natural resource adaptation and carbon sequestration on national forest lands in the face of climate change. My particular emphasis will be on the forests of the western USA.

The factors central to determining optimal carbon management under climate change are:

1. Each forest site has a carrying capacity which dictates the maximum amount of fiber, wood, or carbon that can be stored in that forest. Carrying capacity is determined by site quality, climate, and to a lesser degree the current species mix.

2. Once forests reach their site's carrying capacity there is enormous stress on the living trees which manifests itself in insect outbreaks and disease, culminating in the death of some or all of the trees on site. The mountain pine beetle (MPB) epidemic in western North America epitomizes how existing stressors (forests at or above site carrying capacity) interact with subtle shifts in climate to create unprecedented mortality on our National Forest Lands. The spruce bark beetle epidemic in Alaska is another example of the same impact in a different ecosystem. Climate change is impacting our western forests now. It is not a future possibility or probability.

3. Wildfire ignition is random, but the consequences of wildfires are driven by climate, and prevailing weather and forest conditions. Forests that have reached maximum carrying capacity, and which contain large amounts of dead trees, produce conditions for wildfires that are uncontrollable, with devastating consequences to the forest, the adjacent communities, and the budgets of land management agencies.

4. Wildfires generate enormous releases of carbon dioxide and other greenhouse gases. From 2002-2006 wildfires across the entire US, including Alaska, released the equivalent of 4-6% of the US anthropogenic emissions for that same period. The average yearly emissions from the California wildfires alone were equivalent to the emissions of 7 million cars/year for each year from 2001-2007. Extreme fire conditions can render sites infertile or incapable of regenerating future forests, which effectively leads to deforestation.

5. If we apply the precautionary principle, the most risk adverse option we have at the present time is to thin forests that are at risk to reduce wildfire impacts, reduce insect mortality, and build health and resilience against extreme climate conditions that these forests are expected to face in the near future. The cut material can be used as biofuel feedstocks to support energy independence goals and meet renewable fuel and electricity standards. Even greater carbon benefits are possible if the cut wood is used in green building construction. Using life cycle analysis we can identify optimal carbon sequestration and storage options that include forests as part of the broader matrix of national carbon accounts; failure to account for the carbon interactions beyond the forest can lead to counterproductive policies.

6. Grassroots initiatives aimed at addressing forest health, wildfires, insect outbreaks, and sustainability on federal lands have begun. The goals of removing excess fuels and dead trees for use in bioenergy projects, while generating economically viable and sustainable jobs in rural communities and maintaining sustainable ecosystems are laudable. Policies are needed that integrate the knowledge and trust built by local initiatives, support national renewable energy goals, and recognize the inherent ecological carrying capacity of the land and how it might alter under changing climatic conditions.

Each forest site has a carrying capacity which dictates the maximum amount of fiber, wood, or carbon that can be stored in the forest. Carrying capacity is determined by site quality, climate, and to a lesser degree the current species mix.

Tree growth, competition, and death are governed by known "laws" that have withstood the rigors of scientific investigation for the past 66 years. For example, we have the -3/2 power law (Reineke 1933) which identifies how trees compete, when competition will begin, and when mortality will occur as trees grow, age, and fill the site. Using that law we can characterize each forest site's carrying capacity, or maximum site occupancy, which is largely a function of soil quality and climate in addition to some interaction with species physiology. Once forests mature, without major disturbances like wind, fire, or insect outbreaks, they fully occupy the site and competition between trees begins. As the forest gets older, eventually growth and mortality reach equilibrium as the trees respond to the resource limits inherent in their site. In effect when a forest stand is mature, it occupies the site at or near maximum carrying capacity. Carrying capacity has historically been measured in tree volume which can easily be converted to biomass and to carbon equivalents.

Thus we can estimate the carbon carrying capacity of any forest by understanding the limits of any particular regions soils and climate.

Once forests reach their site's carrying capacity there is enormous stress on the living trees which manifests itself in insect outbreaks and disease, culminating in the death of some or all of the trees on site. The mountain pine beetle (MPB) epidemic in western North America epitomizes how existing stressors (forests at or above site carrying capacity) interact with subtle shifts in climate to create unprecedented mortality on our National Forest Lands. The spruce bark beetle epidemic in Alaska is another example of the same impact in a different ecosystem. Climate change is impacting our western forests now. It is not a future possibility or probability.

So what happens when forests are old, the site is fully occupied—at or near carrying capacity—and the climate changes? When we get less precipitation, the soils dry out sooner. These dry soils combined with the hotter and drier summers we have experienced for most of the past nine years in the Inland West have effectively reduced carrying capacity. This generates enormous stress on the trees and you get a pulse of mortality. The mortality agent that is causing the greatest impact is the mountain pine beetle (MPB)—a native insect that kills all pine species found in the western US. The MPB prefers to attack old and stressed trees, and our National Forests are full of old trees. When summers are sufficiently hot and dry enough for these old trees to become stressed, it is a precursor to a population build-up of MPB which eventually manifests as an epidemic outbreak. Since 2000, we have experienced a massive West-wide epidemic that has affected a large percentage of the native pines in Washington, Oregon, Idaho, Montana, Wyoming, Colorado, Utah, New Mexico, Arizona, and California and as far east as South Dakota. A relative of the mountain pine beetle, the spruce beetle, has wrought similar impacts on spruce forests in Alaska. There are pictures in your packet that show the extent of mortality from MPB epidemics across several states where the dead and dying trees are releasing rather than sequestering carbon. Recent research has identified the tipping point that lead to these mountain pine beetle and spruce beetle outbreaks as a shift in climate (Carroll et al 2003, Oneil 2006, Berg et al 2006) but that shift in climate acts in concert with current stand conditions to create the outbreaks that are devastating our forests at the present time. In short, climate change impacts in our western forests are a very serious current reality not a future probability.

In the mid-1990's I was a field forester dealing with MPB and spruce bark beetle (SBB) outbreaks on a regular basis. We did not know it was a climate impact until much later when research scientists, including myself, began to analyze the data and realize that the predictors for these huge mortality events were not necessarily found in the beetle/tree dynamics as had been studied for the prior 30 years, but in the climate. Only in hindsight were we able to see how subtle shifts in average temperature and precipitation masked critical thresholds in winter temperatures in northern latitudes, and extreme summer moisture deficits in more southerly latitudes that tipped the balance in favor of the insect over the trees that were its host. Crossing those threshold values for temperature has led to massive MPB outbreaks in the Inland West at a scale unprecedented in our experience.

Wildfire ignition is random, but the consequences of wildfires are driven by climate, and prevailing weather and forest conditions. Forests that have reached maximum carrying capacity, and which contain large amounts of dead trees, produce conditions for wildfires that are uncontrollable, with devastating consequences to the forest, the adjacent communities, and the budgets of land management agencies.

One consequence of large mortality events associated with MPB outbreaks are devastating and unnatural wildfires that are next to impossible to control. While lightening ignites wildfires more or less randomly, the likelihood of those ignitions producing large uncontrollable fires that kill most or all trees in their path is highly correlated with the underlying forest condition. High levels of prior mortality from MPB were found to increase the likelihood of stand replacing fires during the 1988 Yellowstone wildfire event (Lynch et al. 2006); a result that is also supported by anecdotal evidence from the 2006 Tripod Complex fire that burned over 350,000 acres of National Forests in Washington State's East Cascades within a fire perimeter of approximately 400,000 acres. The fire perimeter for the Tripod Complex had approximately 100 forest inventory and analysis (FIA) plots that comprise the national forest census of which 70% had substantial MPB impact in the prior 5 years (Oneil unpublished data). This fire was estimated to emit 2.1 million tons of carbon dioxide into the atmosphere or the equivalent to the emissions of 1 million Sport Utility Vehicles (SUV's) for 1 year (Mason 2006).

High levels of insect attack are not the only precursor to the largely uncontrollable wildfire events of recent years. Dense forests with multi-layered canopies, large amounts of dead wood, and thick understory vegetation make fire control dif-

ficult or impossible under all but the most benign weather conditions. The federal forests of the Inland West are dominated by forests with extensive mortality from MPB and SBB and/or have these dense forest canopies as a result of 50 years of fire suppression making them highly susceptible to uncontrollable wildfires.

Wildfires generate enormous releases of carbon dioxide and other greenhouse gases. From 2002-2006 wildfires across the entire US, including Alaska, released the equivalent of 4-6% of the US anthropogenic emissions for that same period. The average yearly emissions from the California wildfires alone were equivalent to the emissions of 7 million cars/year for each year from 2001-2007. Extreme fire conditions can render sites infertile or incapable of regenerating future forests, which effectively leads to deforestation.

The carbon released to the atmosphere from increasingly large, uncontrollable wildfire events exceeds our efforts to mitigate emissions. Widenmeyer and Neff (2007) found that the average CO_2 emissions from wildfire from 2002-2006 were 213 Tg/yr for the lower 48 states with an additional 80 Tg CO_2/yr emitted from Alaska's wildfires which is the equivalent to 4-6% of anthropogenic emissions for those years. In Alaska there are double the CO_2 emissions from wildfires than there are from human fossil fuel emissions; in Idaho the CO_2 emissions from wildfires are 93% of those from fossil fuels; and in Montana wildfire emissions are 43% of the emissions from human fossil fuel use based on 2002-2006 fire occurrence.

Analysis of California wildfires from 2001-2007 calculates that 277 million tons of CO_2 were released by fires and the ultimate decay of the dead trees (Bonnicksen 2009). This is equivalent to the emissions from 7 million cars each year over those 7 years or about half of the registered cars in the state. The figures highlight how the cost of wildfires are much more than just the direct cost of fighting fires, the impacts on communities, human health, and loss of infrastructure. There is an immediate CO_2 emissions cost to wildfire with subsequent CO_2 emissions from decay that are larger than the fire emissions. Of the 882,759 acres of land where all trees were killed during the California wildfires, an estimate of 86% of the land affected (762,000 acres) will not be reforested with any substantial tree cover within the next century because of regeneration failures (Bonnicksen 2009). This means that the CO_2 emissions from fires are compounded by the loss of CO_2 sequestration capacity from regenerating forests. The burnt forests are not being replanted and there is little chance for re-establishment of sufficient future forests to offset these emissions without substantial investment in replanting, stand tending, and management. In short, wildfire in these harsh dry environments is creating deforestation just when we most need that tree growth to offset carbon emissions from other sources. As with the MPB climate thresholds that have only been identified within the past decade, there may well be a threshold value that we have not identified yet wherein large areas of current forest become shrub land with much diminished capacity for carbon sequestration because of regeneration difficulties.

As a consequence of successful fire prevention for the 50 years prior to 2000, national census data (FIA) indicate that at present we are storing about double the carbon per acre on federal lands than on actively managed private forests in the Inland West (Oneil et al in review). But we are also burning more acres of federal land than non-federal land. For example 89% of the acres burned in Washington State since 1995 have been on federal lands which make up 53% of total forested acreage. These comparisons are for eastern Washington where over 90% of our wildfires occur.

We know that growing trees is the best carbon mitigation tool we have to transfer atmospheric carbon into sequestered carbon that reduces greenhouse gas concentrations. Trees are the most efficient plants for carbon capture with low demand for water and nutrients relative to the carbon uptake they perform. They also actively sequester enormous amounts of carbon relative to other kinds of crops because of the large amount of above ground biomass. Pacala et al. (2001) estimated that 20-40% of all terrestrial carbon sequestration in the United States occurred in western forests. Because of the significant role of trees in forest carbon sequestration, broad scale tree mortality can turn the forest from a net carbon sink to a net carbon source. Increases in wildfire frequency and intensity that release stored forest carbon could result in western forests becoming a source of carbon rather than a sink (Westerling et al. 2006). In British Columbia, Canada, which is experiencing perhaps the largest mortality event from MPB in all of western North America, the forests are now net carbon sources because of the level of mortality (Kurz et al. 2008). While we think the western US forests are still acting as net carbon sinks, the cumulative impacts of MPB outbreaks and wildfires on the carbon budget are substantial and growing every single year.

If we apply the precautionary principle, the most risk adverse option we have at the present time is to thin at risk forests to reduce wildfire impacts, reduce insect

mortality, and build health and resilience against extreme climate conditions that these forests are expected to face in the near future. The cut material can be used as biofuel feedstocks to support energy independence goals and meet renewable fuel and electricity standards. Even greater carbon benefits are possible if the cut wood is used in green building construction. Using life cycle analysis we can identify optimal carbon sequestration and storage options that include forests as part of the broader matrix of national carbon accounts; failure to account for the carbon interactions beyond the forest can lead to counterproductive policies.

Fire impacts can be substantially reduced by thinning treatments that restore densities more like those observed before fire suppression was introduced. Multiple studies have shown that thinning reduces fire severity, sufficient for firefighters to gain control and maintain forest structure, tree seed source, and other values (e.g. Agee and Skinner 2005, Moghaddas 2006, Skinner et al. 2004). After the 2002 fire year, which in hindsight was relatively mild, Dr. Jerry Franklin (ecologist) and Dr. Jim Agee (fire scientist) from the University of Washington offered their perspective on the need for a rationale national forest policy that incorporated ecology, fire science, known benefits of treatment and social benefits. Their perspective is that "Letting nature take its course in the current landscape is certain to result in losses of native biodiversity and ecosystem functions and other social benefits. . ." (Franklin and Agee 2003).

Coupled with the impacts of current wildfire extent and severity is the very real risk of dramatically increased wildfire extent in the near future as a result of further summer warming and drought. Climate impact studies across the west have identified that future climate will likely double wildfire extent in most areas (McKenzie et al 2004, Littell et al 2009) with some areas experiencing a tripling of the current acres burned which will interact with current forest conditions to increase CO_2 emissions from wildfire in the near future. The projected climate impacts, including hotter drier summers, earlier snowmelt with subsequent reduced summer moisture (Westerling et al. 2006), and increasing summer moisture deficits which portend substantial changes in regeneration success at the current forest margins (Littell et al 2009).

Managing federal forests to address the need for increased carbon sequestration and storage, reduced carbon emissions, and adaptation requires an integrated approach that considers the inherent carrying capacity of the land, the fire regime for a specific region and forest type, and societal benefits at local, regional, and national scales. Reducing forest carbon inventories to bring them in line with new estimates of carrying capacity is necessary to increase resilience in the surviving trees, and reduce risks of further mortality from the MPB and other insects. If designed with multiple goals in mind, thinning treatments can also provide better options for wildfire control, restore forest structure, maintain critical habitat, and adjust for the overstocking that has occurred because of 50 years of fire suppression. Optimal thinning strategies will vary by region, forest type, and fire and insect risk. In ecology, one size does not fit all: the kinds of treatments needed in the dry interior west to address climate change and carbon storage are quite different than what is needed at high elevations or in coastal forests. Using local expertise coupled with grass roots input from concerned citizens can ensure that the activities are sustainable over the long term. The result can be at least a triple win scenario with improved habitat, reduced carbon emissions and avoided future wildfire fighting costs.

Paying for these management interventions to reduce fire severity and risk, and to reduce forest densities so as to reduce stress on remaining trees, is a challenge during our current budgetary crisis. There is a huge opportunity to use the material that must be removed from Inland West federal forests to allow them to adapt to climate change. That excess material is a carbon dense renewable feedstock that can be used for meeting energy independence goals under EISA (2007), the renewable fuels standard (RFS) and/or the renewable electricity standard (RES).

Thinning forests can offset carbon emissions from fossil sources if used for energy production either by producing liquid transportation fuels or electricity generation. Based on life cycle analysis conducted to ISO 14044 standards, CORRIM has found that an even better choice from a carbon perspective is to produce products that store carbon and substitute for fossil energy intensive products made of steel or concrete (Perez-Garcia 2005, Milota et al 2005). For example, a ton of wood in engineered wood floor joists displaces 7 tonnes of CO_2 emissions when substituted for a steel floor joist. This is approximately 7 times more beneficial from a carbon accounting perspective than burning the wood for energy. CORRIM is currently conducting additional life cycle analysis of woody biomass for an array of bio-fuels, processing technologies, and material inputs to determine the optimal uses of these renewable fuel feedstocks from a carbon perspective.

As climate change and carbon sequestration are global issues, accounting for only the carbon interactions in the forest without consideration for the wildfire impacts, the ultimate use of potential forest products that can be removed to reduce fire and insect impacts, and current and future societal needs for energy and building products is like a bank measuring only debits without consideration for credits. Losing the carbon that trees sequester to insect epidemics and wildfire under the guise of naturalness or the precautionary principle, not only emits carbon, particulates, and other greenhouse gases to the atmosphere, it is a lost opportunity to store that forest carbon in buildings where the risks of wildfires are largely absent. It is also occurring at a time and on a scale where the increasing rate of CO_2 emissions portends a threshold, or tipping point, that may exacerbate current disturbance trends and subsequent opportunities for management, sequestration, and fire control. In essence, forest thinning operations that reduce fire severity and risk are the most risk adverse option we have at our disposal at this time.

Grassroots initiatives aimed at addressing forest health, wildfire, insect outbreaks, and sustainability on federal lands have begun. The goals of removing excess fuels and dead trees for use in bioenergy projects while generating economically viable and sustainable jobs in rural communities and maintaining sustainable ecosystems are laudable. Policies are needed that integrate the knowledge and trust built by local initiatives, support national renewable energy goals, and recognize the inherent ecological carrying capacity of the land and how it might alter under changing climatic conditions.

As a forester, there is nothing worse than losing your stands to insect attack or fire and in the process losing all the values cherished by your local rural community. If the nearby federal forests, under the guise of naturalness, are not managed, except to suppress fires when they threaten structures, private and other public landowners have no control in preventing the insect invasions and wildfires that start on federal lands but then spread to nearby private and state lands with equally costly and devastating impacts. The degree of interest in the topic of federal land management to reduce these impacts and risks along with the potential to provide resources for bioenergy initiatives is substantial. Recently a large constituency spent three days discussing the issues around biomass utilization in their communities and their region at the Plum Creek Conference on Forests and Energy at the University of Montana. As a speaker at that conference I was thrilled to see the level of interest, integrity, care, and sincere appreciation for the complexity of the task ahead. No one wants to see another 'timber war' or extractive industry with little thought to long term sustainability of the federal lands in their region. But neither do they want to see their backyard go up in flames as the forests around them succumb to MPB and then burn as they were during the conference in September. This fire was particularly notable as it burned vigorously despite record breaking rainfall during the prior month.

Many members of the audience at that conference were already working diligently with local USFS managers to devise plans that would produce not only sustainable forests, but sustainable livelihoods for local people. In the process they are building trust, crafting community, and with the appropriate top down policies that recognize the need to manage these forests and make a living, they will also be able to provide renewable energy that will help to meet the energy needs and greenhouse gas reduction goals outlined in federal policy.

SUMMARY

We have experienced a decade of unprecedented mortality in our western forests, and much of that mortality is concentrated on federal lands. Broad scale mortality means that forests are emitting carbon rather than sequestering it, thus exacerbating our current greenhouse gas emissions profile. The current rate of mortality is unsustainable and may well lead to a tipping point wherein additional uncontrolled damage can be expected. It is doubtful that any one scientist or group of scientists has any idea where that tipping point is and what reaching it might cause. With policies and management approaches that pull us back from that brink by reducing risk and building resilience we can ensure that these forests remain a part of our heritage and serve a vital role as carbon sinks into the future.

Senator WYDEN. We will have some questions——

Senator RISCH. Mr. Chairman, I have to go to an Ethics Committee meeting——

Senator WYDEN. Would you like——

Senator RISCH [continuing]. Because we have a vote at 4 o'clock. I have a question for Dr. Law and Dr. Oneil. I'm going to state it, but they can answer it after Mr. Wood's testimony, and I'll get it from the record.

But, they both touched on the question of the balance of uptake versus production of carbon, and I was wondering if they agreed with Chief Tidwell's assessment, or his statement, of the fact that the lands were—we were in a 12-percent-positive situation, as far as taking up carbon that is produced. I'd like your comments on that, or any other statistical information you can give me in that regard.

Senator WYDEN. Why don't we—if Mr. Wood doesn't have any objection, why don't—Senator, I think it's a very important question. Dr. Law, Dr. Oneil, what—if you could, can you give a response to the Senate now, and perhaps furnish anything extra in writing?

Dr. Law.

Senator RISCH. Mr. Chairman, I really apologize, but I've got to——

Senator WYDEN. Oh.

Senator RISCH [continuing]. Vote right at 4 o'clock.

Senator WYDEN. Oh, I see.

Senator RISCH. So, I'm going to have to run.

Senator WYDEN. OK. We'll get it in writing.

Senator RISCH. I apologize for that, and I'll pick up Mr. Wood's statement out of the record. I would just note, for the record, that Mr. Wood is here, purporting to be a conservationist, but I know for a fact that he's been attempting to make the elk extinct in my State, one animal at a time, for a number of years.

[Laughter.]

Senator RISCH. So, in any event, thank you, Mr. Chairman, and I will pick this up out of the record.

Senator WYDEN. Thank——

Senator RISCH. Thank you very much.

Senator WYDEN. Thank you, Senator.

Senator RISCH. Thank you. I apologize, Chris; I've got to run.

Senator WYDEN. Mr. Wood.

STATEMENT OF CHRISTOPHER A. WOOD, CHIEF OPERATING OFFICER, TROUT UNLIMITED, ARLINGTON, VA

Mr. WOOD. Thank you, Chairman Wyden. Good to see you, Senator Risch.

I appreciate the opportunity to provide Trout Unlimited's views on managing public forests in response to climate change.

Public lands are crucial sources of drinking water for more than 60 million Americans. They provide vital habitat for fish and wildlife, and a host of other social and economic benefits. These lands can play a key role in preparing natural resources and human communities for the impacts of climate change.

Others here today, and my written testimony, cover how climate change is likely to impact our national forests, with an emphasis on coldwater fisheries, which is our bias at Trout Unlimited. I'd like to spend my time describing a policy framework within which these problems can be solved if we act quickly.

A healthy watershed performs three basic functions. It catches, stores, and releases water over time. Healthy watersheds are better equipped to withstand the predicted effects of climate change—the more intense fires, the prolonged drought, the more intense floods that we're anticipating. The problem is that many of our lands and waters are already under stress. Climate change adaptation may be most simply defined as repairing the damage and helping the land to recover its natural resiliency.

Former Forest Service employee Alda Leopold once described the oldest challenge in human history as to live on a piece of land without spoiling it. Leopold's challenge became a motivation for the wilderness movement and a host of other environmental activity over the past 25 years. The effects of climate change challenge traditional methods of land protection, as fires, floods, and droughts won't stop at wilderness borders.

The Forest Service and the BLM should develop integrated landscape-level strategies to protect, reconnect, and restore resilient watersheds for the benefit of human communities and natural resources.

First, we must protect the highest quality lands and waters. In a warming climate, national forests, particularly roadless areas, are thermal refuges. Protecting these lands protects fish and wildlife, maintains groundwater recharge, and reduces the costs of filtering and treating water for communities downstream.

Second, we must reconnect landscapes. Because it is not enough to manage protected lands as museum pieces, we must reconnect them, both upstream and downstream. Protecting instream flows in important wildlife corridors and allowing rivers to access their flood plains will recharge aquifers, minimize the potential for downstream flooding, and improve soil productivity for farmers and ranchers.

Third, we must engage communities in restoration. Restoring the ability of watersheds to withstand the effects of climate change is essential. Thinning bug-killed forests near communities, for example, has been mentioned, can generate biomass and protect communities from fire, while also securing high-paying family wage jobs.

This model of protecting, reconnecting, and restoring landscape and watershed health should be used to guide development of the Forest Service's proposed planning rules. It should provide the rationale for protection of roadless areas. It should drive the thoughtful siting of transmission lines for renewable energy, and reform of outdated oil and gas regulations. It should influence implementation of farm-bill conservation programs on privately owned forests.

I'd like to close with an example of how this approach can work. In 2009, thanks to your leadership, Mr. Chairman, 15,000 acres of the headwaters of the Elk River in southwestern Oregon, with some of the finest salmon and steelhead runs in the Lower 48, was designated as wilderness. However, more than a mile of outstanding habitat in Blackberry Creek, a tributary to the Elk, is blocked by an impassable culvert. Inadequate funding has prevented the Forest Service from replacing that culvert. Plugged culverts are a ticking timebomb across the national forest system right now. They must be repaired.

Funding this type of work is vital. Dedicating 5 percent of the total allowance values of revenues under climate change legislation to the type of natural resource adaptation work I just described is essential. The actions described above are not inexpensive, but they also create jobs and have a very high likelihood of success. The time to act is now. Public forests are national treasures that are irreplaceable in our lifetime.

Thank you for the opportunity to be here.

[The prepared statement of Mr. Wood follows:]

PREPARED STATEMENT OF CHRISTOPHER A. WOOD, CHIEF OPERATING OFFICER, TROUT UNLIMITED, ARLINGTON, VA

Chairman Wyden and members of the Subcommittee, I appreciate the opportunity to appear before you today to provide my views as Chief Operating Officer for Trout Unlimited (TU) on managing public lands in response to climate change. Prior to working for TU, I served as the senior policy and communications advisor to the Chief of the US Forest Service, and on the fish and wildlife and ecosystem management staffs for the Bureau of Land Management.

Public lands are crucial sources of drinking water for well more than 60 million Americans. They provide habitat for fish and wildlife species of substantial economic, ecological, and spiritual value. Public lands also provide wood fiber, energy resources, and other commodities that help to fuel our nation. These lands can also play a key role in preparing natural resources and human communities for the impacts of climate change. I appreciate your concern in addressing this issue in a timely manner.

Trout Unlimited is dedicated to the protection and restoration of our nation's trout and salmon resources and the watersheds that sustain them. TU has more than 140,000 members in 400 chapters across the United States. Our members generally are trout and salmon anglers who give back to the waters they love by contributing substantial amounts of their personal time and resources to fisheries habitat protection and restoration. The average TU chapter, for example, donates 1,300 hours of volunteer time on an annual basis.

In my testimony today, I would like to focus on three major points.

First, I will briefly describe how climate change is likely to impact our National Forests and public lands. These impacts already are being felt across the country and will become more pronounced and severe in coming years.

Second, I will describe how these impacts are likely to affect natural resources and the people and nearby communities that use these resources. It is important to recognize that a broad spectrum of user groups will be impacted and that the risks are not just restricted to fish, wildlife, rivers, and forests.

Third, I will describe a policy framework within which these problems can be solved—if we act quickly, and in concert. I will provide specific examples of what needs to be done and how to do it. If we fail to act, costs will be considerable and our National Forests and other public lands will be irreparably harmed.

IMPACTS OF CLIMATE CHANGE ON NATIONAL FORESTS AND PUBLIC LANDS

The effects of a changing climate are already being felt on public lands in the form of intense wildfires, drought, proliferation of invasive species, and earlier spring runoff. As climate change continues, it is likely to alter weather patterns and storm events across the United States dramatically with significant negative consequences for National Forests and other public lands. A general warming pattern will result in increased evaporation rates and drying of forest and grassland vegetation. These effects will increase wildfire intensity and frequency, especially at mid-elevations. In turn, as we are now seeing throughout the Rocky Mountain West, these changes will spark surges in forest pest species and invasive weeds, triggering a cascade of further alterations in natural ecosystems.

River flows and hydrologic regimes also will be altered, with consequences not only to fisheries but also to water supplies in general. More winter precipitation will fall in the form of rain than snow, especially at lower and mid-elevations. This will reduce snowpack and increase the probability of rain-on-snow events, likely resulting in increased winter flooding. With more rain during winter and reduced snowpack, peak stream flows will occur earlier in the spring and low or base flows during summer and autumn will be reduced. Stream flows will be less consistent from year to year.

Overall, storm intensities will be greater. Floods, drought, and wildfires are all likely to increase. The increased variability and longer duration of wet cycles and dry cycles will cause considerable additional stress to natural ecosystems.

In all cases, impacts of climate change on federal lands must be viewed within the existing management context and conditions of natural systems. Watersheds, riparian systems, and streams that are in better condition will be more resistant to disturbance and more likely to rebound quickly. On the other hand, habitats that are degraded and fragmented will be less able to adapt to climate change risks.

NATURAL RESOURCES, USER GROUPS, AND COMMUNITIES WILL BE SUBSTANTIALLY IMPACTED

Trout Unlimited and our members are especially concerned about the impacts of climate change on coldwater fishes and the habitats that support them. We also are concerned about impacts to the recreational pursuits, such as fishing, hunting, camping, and nature watching, for which our public lands are well known. However, we also realize that the impacts from climate change will be felt far more broadly.

The affects of climate change on federal lands is likely to negatively impact many natural resources, user groups, and communities, creating problems for:

- Drinking water supplies—both quantity and quality
- Fisheries
- Wildlife
- Overall biological diversity
- Outdoor recreational opportunities
- Livestock grazing, timber harvest, and other resource extraction
- Agriculture
- The safety and economic well-being of nearby communities

In short, a very broad range of species, people, and communities will be under increasing risk unless we take immediate proactive management actions to prepare. The costs of failing to adequately plan and prepare will be high, and will be measured in substantial economic costs to fight large wildfires, deal with multi-year droughts, and repair damage from broad scale floods, and possibly in increased injury and loss of life.

While it is critically important that we reduce carbon emissions in order to stave off the worst future affects of climate change, we must also realize that climate-driven disturbances will be felt on our national forests and public lands for decades to come. It equally is important to realize that we can moderate the impacts of these changes and reduce stress on our natural resources and adjacent human communities.

RESPONDING TO CLIMATE CHANGE

Federal climate change legislation that takes five percent of the total allowance value from a cap and trade program and dedicates it for climate change adaptation work is vital.

It is, however, well within the existing mandates of agencies such as the Forest Service and the BLM to develop climate change adaptation strategies to protect, reconnect, and restore resilient landscapes for the benefit of human communities and natural resources. The statutory authority to protect watersheds, flows, and water resources is well spelled out in the Organic Act of 1897, the Multiple Use Sustained Yield Act, the National Forest Management Act, the Federal Lands Policy and Management Act, and other federal land statutes. In fact, one could argue that not making the recovery of healthier, more productive, and more resilient landscapes a central focus of federal land management would place federal agencies in violation of their organic or governing federal statutes.

Federal land management agencies should not wait for the passage of climate change legislation to implement strategies to recover the resilience of lands and waters. Here's what the Forest Service, and other federal land managers, can do to lead on climate change adaptation (see graphic below).*

First, protect the highest quality lands and waters. In a warming climate, national forests, and particularly roadless areas, are thermal refuges. Protecting these lands protects fish and wildlife, maintains groundwater recharge, removes carbon dioxide from our atmosphere, and also reduces the costs of filtering and treating water for downstream communities. Private ranch-lands also harbor important big game habitats, many of which are threatened by development. The departments of

*Graphic has been retained in subcommittee files.

Agriculture and Interior should work with landowners and provide incentives to those who help conserve highvalue lands.

Second, reconnect landscapes. If fish and wildlife habitats are fragmented, the species they support they won't survive floods, fire and drought predicted to increase with climate change. Identifying and protecting important wildlife corridors on public lands and allowing rivers to access floodplains are not only good for fish and wildlife; it's good for human communities. A healthy landscape will recharge and replenish underground aquifers that supply municipal drinking water, minimize the potential for downstream flooding, filter pollutants and improve soil productivity for farmers and ranchers.

Third, engage communities in restoration. Recovering the ability of our lands to withstand the effects of climate change is essential. Reconnecting people, children and communities to the landscapes that provide their food, energy resources, and recreation opportunities is important to our nation's well being. Restoration activities such as tree planting, trail maintenance, and river clean-ups improve ecological resiliency and bind us to the lands and waters that sustain us.

This model of protecting, reconnecting, and restoring landscape health should be applied through the Forest Service's proposed new planning rules. They should, for example, 1) protect the highest quality habitats and highest quality sources of water; 2) ensure that land management activities do not impede wildlife migration corridors, degrade streamside areas, and disrupt natural processes; and 3) emphasize the restoration of degraded landscapes where restoration activities will yield the highest return.

Protecting, reconnecting, and restoring landscapes describe the biological imperative of climate change adaptation. The social imperative is to sustain these efforts over time. The greatest threat to National Forests and other public lands may lie in public ignorance of their extraordinary values and a generation of children more connected to video games and computers than they are to the lands and waters that sustain them. Investing in youth education and getting kids out of doors is vital to building tomorrow's constituency for conservation.

Watersheds that are in better condition are more able to withstand disturbances, or if disturbed, are more resilient to damage from the disturbances. Areas that may be especially important to protect include roadless areas, and other unroaded lands, habitat currently acting as native population strongholds, and areas of watersheds that produce high quality supplies of cold water.

The economic benefits to our communities of a Forest Service and other federal agency agenda that stresses climate change adaptation cannot be overstated. Benefits include high-wage jobs in rural areas that most need them. Reducing hazardous fuels within our forests will also reduce the cost of fire fighting and make communities safer. Cut trees and brush also could be utilized as biomass, offsetting demand for oil and gas.

Coordination is important. The White House should issue guidance to provide the federal agencies with a policy framework that defines how protecting, reconnecting, and restoring landscapes will be coordinated with state and federal agencies and interested private partners. Such an integrated and landscape scale approach to conservation will ensure that fish and wildlife resources and human communities can cope with a changing climate. Connecting public land efforts with associated private lands will also be essential. For example, incentives should be given to private landowners participating in Farm Bill conservation programs with projects that protect, reconnect, or restore watershed health and function.

Below are specific areas that the Forest Service and other federal agencies should emphasize in managing for healthier, more resilient lands and waters.

> Water resources and water quantity.—To help protect water supplies and maintain stream flows, the Forest Service and BLM should emphasize the restoration of high elevation wet meadows, wetlands, riparian areas, and floodplains. These habitats act as natural hydrologic sponges that slow water discharge and recharge groundwater aquifers, which in turn increases dry-season stream flows. The proper function of these habitats will be increasingly important as snowpacks diminish.
>
> Water quality.—To protect water quality, agencies should designate adequately sized streamside—riparian—buffer zones and adopt management standards that emphasize aquatic system protection. These riparian zones should be large enough not only to provide shade to streams, but also to buffer from upslope erosion and allow fallen trees to enter the stream channel providing the complex stream habitat critical to aquatic species. As stated earlier, protecting water quality in headwater streams such as roadless areas serves to diminish downstream drinking water filtration and treatment costs. Agencies also should

protect landslide prone areas. Inadequate protection of these areas will increase siltation and erosion, which will degrade stream systems, water supplies, and fisheries.

Flooding.—To help guard against flood damage, agencies should reconnect rivers to their floodplains. That is, rivers should not be confined into narrow channels but rather allowed access to broader floodplains. We also should seek to restore floodplains and streamside vegetation. These measures transfer flood energies into well-vegetated floodplain zones while dissipating flows and protecting soils from erosion. In addition, federal agencies should improve culverts and other stream/road crossings, and decommission poorly maintained or poorly designed roads. Inadequately sized or designed culverts and poorly maintained road/stream crossings act like time bombs that will plug up then blow out during intense storms causing massive landslides and debris flows. Severe flooding has substantial consequences not only to fisheries and wildlife, but also to downstream communities and recreation opportunities.

Invasive species.—Weedy and invasive species are more likely to flourish in degraded habitats and to be favored during highly fluctuating environmental conditions. Some invasive species will spread more quickly during warming trends and will cause greater harm and be more expensive to control if left untreated. To better manage invasive species, we should become more aggressive in programs to detect new species invasions and in programs to control established exotic species—both terrestrial invasive weeds and aquatic non-native species.

Biodiversity.—To prevent the loss of plant and animal diversity, lands and waters should be managed to provide adequate habitat to support native species. Agencies should manage to protect genetic diversity, including weak stocks and peripheral populations. High levels of genetic, life history, and ecological diversity will be necessary for species to adapt to rapid environmental change.

Wildfire.—Wildfires are increasing in western forests because of reduced snowpack and earlier vegetative drying during summer. To deal with more frequent and intense wildfires, agencies should selectively thin forests, primarily in wildland-urban interface zones and plantations. To prepare aquatic systems, we also should improve road networks and stream crossings, restore up-and downstream connectivity, and recover degraded riparian areas. Finally, we should adopt strong post-fire logging standards that protect soils and stream systems while providing for adequate recruitment of large wood to streams. These actions will result in less wildfire damage and decreased erosion and stream sedimentation. Riparian habitats, old growth and mature forests, and unroaded areas should be protected as well because these are the most fire resistant habitats.

The Elk River watershed along the Oregon coast offers an example of how protection of intact habitat and reconnection of migration routes can help improve the resiliency of a watershed in the face of climate change. In 2009, thanks to your leadership, Mr. Chairman, the 15,000 acre Copper-Salmon area in the Elk River headwaters was designated as wilderness. This will help maintain water quality and intact spawning habitat for one of the healthiest salmon, trout and steelhead rivers in the lower 48.

Intact headwaters help moderate streamflow, maintain water quality, and keep water temperatures cool, which is particularly important to coldwater species such as trout and salmon. Downstream of the Copper-Salmon area, trout and salmon access to Elk River tributaries is limited by impassible culverts. One such culvert is on Blackberry Creek. It restricts access to more than a mile of upstream spawning and rearing habitat for steelhead and Chinook and coho salmon. Furthermore, the headwaters of Blackberry Creek, like most streams, are cooler in the summer than the downstream reaches. The ability of trout and salmon to access these cooler upstream waters can be of critical importance during the summer. To date, the Forest Service has not been able to replace the Blackberry Creek culvert due to inadequate funding. Similar barriers to fish passage exist across the National Forest system and must be addressed in order to improve the resilience of coldwater fish populations in the face of climate change.

Implementing the actions needed to enable fish, wildlife and human communities to adapt to changes in climate will require a substantial and reliable stream of funding. Dedicating a portion of allowance revenue under climate change legislation to natural resources adaptation can provide funding for the type of work described above. It is our hope that five percent of the total allowance value will be dedicated to natural resources adaptation through climate legislation. Furthermore, funding

must be dedicated and not subject to annual appropriations in order to enable long-term planning. Both S. 1733 and S. 1933 include dedicated funding.

CONCLUSION

The actions described herein have a considerable price, but they also have broad benefits not only to maintaining biological diversity, but to sustaining the ecological services critical to meeting the needs of recreationists, ranchers, and other user groups, and to ensuring the well-being of nearby communities. The actions described are very low risk steps that have a very high likelihood of substantial benefit to multiple parties. Many create jobs as well.

In the end it is important that we ask ourselves: What is the cost of inaction? What will it cost to repair damage to our National Forests and public lands? What will it cost in private property loss and public safety? It is less costly and more beneficial to address these concerns in the near-term than it would be to wait until increased climate change driven disasters befall our lands and nearby communities. The time to act is now. Our National Forests, National Grasslands, and BLM public lands are national treasures that are irreplaceable in our lifetimes.

Senator WYDEN. Thank you, Mr. Wood. That was very helpful.

All 3 of you gave excellent testimony.

Let me start with the topic of thinning. The committee has had a lot of hearings on the role of thinning for fuels reduction and ecological restoration, so we have talked at considerable length about where and when thinning makes sense from the standpoint of reducing wildfire, dealing with ecosystem protection. But, I think it would be helpful to get on the record what you think about thinning as it relates to carbon sequestration. This is an area that we haven't spent a lot of time on. Why don't we just kind of go down the row, ask each one of you when you think thinning makes sense, from a carbon sequestration standpoint, and also, as part of the question, your idea of how big a role carbon sequestration can play as part of the solution.

Begin with you, Dr. Law.

Ms. LAW. OK. Thinning—the fuels that carry fire are the fuels that are—there's the continuity in the amount on the ground and it's the fuel ladders that get the fires up into the crowns. So, it has to be strategic within an area. Dry areas are more prone to wildfire. They were, historically burned infrequently—well, frequently, maybe every 12 to 20 or 30 years, and they had less fuel buildup.

When you're talking about carbon sequestration, it's—that kind of removal, if you don't know really know where the fires might occur, you're going to be removing more wood than will actually burn, because you're trying to guess where that's going to occur. So, you're definitely removing wood. If it goes up to merchantable wood, that's definitely reducing carbon sequestration.

So, it would be—when I talked about being strategic, it behooves us to be very strategic on knowing what areas are going to go up in smoke.

Again, the—what burns is primarily the small materials. We've found, on several fires that we've worked on, less than 1 to 5 percent of the bold mass is actually burned, is charred, and that char is long-term carbon sequestration.

Senator WYDEN. How big a role? How big a role can carbon sequestration, in your view, play as part of a solution to the climate change challenge?

Ms. LAW. I think it's one of the many tools out there that makes sense to use. We're talking about, in the short term, while we change to different energy sources and carbon—less carbon-based

energy. So, while we have carbon sequestration in the places that are doing a good job of storing carbon, it makes sense to keep that up.

This is, again, a short-term bridge until we get things in place to change our fossil fuel emissions, the amount of carbon that's going into the atmosphere.

The number that was asked about earlier—the U.S. Carbon-Cycle Science Program wrote a report on the state of the carbon cycle for North America, and I was a coauthor on that report. Our estimates were around 16 percent for the total land-based sink as being about 16 percent of the equivalent of fossil fuel emissions for the country.

Senator WYDEN. You were one of the authors, so you stand beside that, 16——

Ms. LAW. That's the best we can do right now.

Senator WYDEN. That's a significant role.

Ms. LAW. Yes.

Senator WYDEN. OK.

Dr. Oneil, same question. What do you think about when you believe thinning will make sense, from a carbon sequestration standpoint, and your, kind of, ballpark estimate of how big a role carbon sequestration can play in climate change solutions.

Ms. ONEIL. My perception of this is a little bit more expansive that Dr. Law's, in that I think, on these dry forests, we should—we could actually be expanding our thinning between four to five times what we're currently doing on national forests.

I recently worked on a project for one of my—one of the organizations I work for, Coram, and we looked at the Inland West—portions of the Inland West, where we still had active harvesting operations going on, and we had active mills going on in that region. So, we looked at how much the current harvest—of the current harvest came from public lands and how much came from private lands under a base case. Then, we also looked at how much could potentially come off of national forestlands if we thinned the forests that were considered—historically, would have considered low-and moderate-severity fire regime. That just means the forests that would have typically burned every 10 to 15 years, or perhaps burned in a mosaic in a—maybe, a 30-year—over every 30 years. So, these are the forests that are currently at the highest risk of being burned in some kind of a wildfire. So, we looked at that and said, on these forests, given the amount of area and the current amount of volume, based on FIA data—so, national census data—we could increase the removals from four to five times what we're currently doing now.

Now, those estimates were based on essentially thinning from below to a target density, which was—which is currently accepted in most national forest plans. So, that's a fairly substantial increase in the amount of volume we could be—that could be removed.

Then, when we think about carbon sequestration potential and carbon storage potential, you have to look at your landscape, in terms of, Where is your high risk for storage? I mean, all forests will sequester the forests in the west side. Wet forests, they sequester a lot more than the dry forests. They also can store it a lot

longer, because they don't have to deal with these kinds of disturbance events.

So, in terms of broadening the perspective or—broadening the boundary conditions, as it were, our work suggests that if you remove these products and turn them into long-lived wood products, augmenting the manufacturing emissions with carbon-neutral biofuel, you can actually do almost as good or better than if you leave that stuff in the forest, where it has a high risk of burning.

Senator WYDEN. All right. Anything else, in terms of the potential ballpark question, that we ought to know?

Ms. ONEIL. The potential ball—I don't have a number, as Dr. Law did, but one of the things that—one of the numbers that is tossed around is that we have 20 billion board feet of growth in the national forests, and about 8 billion board feet of mortality, and 2 billion board feet of removals in a particular year. So, that means that, on average, if we're—if our growth is twice—or, basically half of it is lost to mortality and removals, that would suggest that it looks like a carbon—it's still a carbon sink, we're still doing a good job there. But, those numbers, if you look at specific regions—like, we looked at Washington State—eastern Washington—as part of a 2007 timber supply analysis, and the FIA numbers there said that, well, half of the material in national forestlands—half of the growth was offset by mortality in other regions. That was before we had these big mountain pine beetle outbreaks starting, in 2000, where between 2000 and 2004 we lost 9 million trees just on national forestlands.

So, the question there, in my mind, is a little bit fuzzier as to whether or not we're still being a carbon source or a carbon sink in that particular region. But, that's specific to that region.

Senator WYDEN. OK.

Mr. Wood, let's hear your thoughts on carbon sequestration, from the—excuse me—thinning, from the standpoint of carbon sequestration, and then your estimates, in terms of the ballpark.

Mr. WOOD. I'm afraid I'm a little bit outgunned, in terms of the estimates for the ballpark, so I probably won't——

Senator WYDEN. All right.

Mr. WOOD [continuing]. Won't go there, with your leave.

I think, as Tom Tidwell—as Chief Tidwell was suggesting, it's difficult to segregate out what the—approaches that the Forest Service might employ, climate change mitigation strategies, and climate change adaptation strategies, because they can have complementary benefits. You might thin directly adjacent to a community, specifically to protect that community, which has an adaptation benefit, but you can then utilize the biomass, as you were suggesting, sir, and offset your oil and gas demand, which would have a mitigation benefit.

I will say, though, that, as a matter of priority, the strong emphasis for thinning likely should be around human communities, what people sometimes refer to as the wildland/urban interface, because our first priority has to keep people—has to be to keep people safe.

As a general statement, I clearly think, and Trout Unlimited supports, the thinning of overdense, overgrown stands that have

missed fire-return intervals, where thinning can be used to help recover forest vigor.

Two other points that are far less technical than my colleagues, here, referred to. I think, one, it's a question of funding, the Forest Service having the necessary resources to do the kind of thinning they need to do.

Then, second—and this is perhaps a softer, more of a social science issue—and I wanted to commend Senator Risch, when he was here earlier—getting people to the table, a diversity of interests to the table to talk about appropriate kinds of thinning, recognizing that everyone wants forests to remain healthy, makes a big difference in the completion of successful projects. Senator Risch was intimately involved in the development of the Idaho roadless rule, which I think was heavily influenced by a diversity of interests that was brought together by the previous administration that helped guide and inform that rule. I think that—there's probably some lessons there for the Forest Service, in terms of if they're going to take a more expansive approach to thinning.

Senator WYDEN. OK.

Let's go to the question of offsets, beginning with you, Dr. Law. What's your assessment about including Federal lands in a cap-and-trade offsets program? What are some of the policy questions that have to be looked at?

Ms. LAW. I suppose that—I mean, it's up to you what you decide to do on this, but there—I guess the only concern I might have is if there is so much emphasis on revenue that it takes us away from the ultimate goal of sustaining ecosystem function. So, I think that's my main concern about that idea.

I think the idea of additionalities was based on, Would you do things—are you doing things differently than you had been before, on business as usual? If the Federal lands are to be managed in the public interest of carbon sequestration, and that's saying we are managing for the way we would have managed—in other words, we might not qualify for additionality. That would need to be sorted out, too.

Senator WYDEN. What would be some examples? Because this question of an additional contribution—I've always try to explain it in English, and every time I've used the word "additionality," everybody just kind of falls asleep, because I'm trying to get a sense of what is really going—what would be some examples, in your view, of an additional contribution that would warrant it?

Ms. LAW. I suppose it would be those who have managed lands before very actively—say, having a harvest cycle of 40, 50 years for a forest that could live to 600 years, and they've been doing that for a long time, and then they change their practices to allow carbon to accumulate there. That's a form of additionality.

Senator WYDEN. That's too logical for government.

[Laughter.]

Senator WYDEN. But, I mean, that's what we're going to be looking for, and I'm sure that's going to be the test, so I'm going to want to have some further discussions with you on it.

Same point, Dr. Oneil, the question of including Federal lands in cap-and-trade offset program. What are some of the policy issues for this committee and the Senate?

Ms. ONEIL. I think if we're looking at baselands additionality, we also have to think about permanence and leakage. Right now national forests, at least the—for the areas that I've looked at—are carrying a lot of volume and, therefore, a lot of carbon. They look really good, in terms of their baseline. So, how do you improve on that while you're facing these catastrophic fires and these mountain pine beetle epidemics would suggest that your baseline is going to be higher than you might actually be able to accomplish in—when you're addressing permanence.

So, that is—that's going to be a difficult thing to work around, in terms of a cap-and-trade. But, I think, in the broader context, Should we treat national forestlands differently than we do other lands, in terms of accounting for the carbon benefit that can accrue for them?—I think we should treat them similarly. Obviously, with different—you're going to have to apply different kinds of standards, but you're still going to have to meet your baseline, your—define your baseline. Do you define your baseline net of all the expected mortality? Do you define your baseline as what's currently occurring, and then, if you increase your treatments to reduce fire risk, is that counted as a—additional to the baseline, or is it counted as a reduction from the baseline?

So, it's very complicated when you're looking at these Inland West forests. I'll have to think about it a little bit more, in terms of what else I could offer there.

Senator WYDEN. OK.

Mr. Wood.

Mr. WOOD. I would only offer that the overriding objective, the goal, has to be to restore healthy, diverse, and more resilient forests. If you can manage carbon as a byproduct of achieving that ultimate goal, I think, as the Forest Service testimony suggested, that's a good and logical thing. I think we should be, given the enormous backlog, due to bugkill, due to fires, due to hurricanes and other natural disasters, that we have on replanting on the national forest system, you know, we should be open to good, creative ideas for incentivizing that work. I think the way the National Forest Foundation, which had a little—I think it was a pilot program, started in 2007—handled this question of additionality, which, honestly, was not a term I had heard of until the other day—was that, they defined that as work that wouldn't otherwise be done by appropriated dollars.

Senator WYDEN. Said. If I wasn't having to chase healthcare and a couple of other crises this afternoon, I would ask, particularly you, Dr. Oneil and Dr. Law, about full carbon accounting, because I know you both have written on this. We'll save that for the next time.

I will give you all the last word. Anything you'd like to add, Dr. Law, Dr. Oneil, Mr. Wood?

Ms. LAW. I can't think of anything.

Senator WYDEN. Very good.

Ms. ONEIL. On this topic of full carbon accounting, what we have found is that when you start to account for the forest and the ability to maintain the productivity of the forest through time, whether or not you're harvesting it, you're—basically, your resource is your soil. You want to maintain your soil productivity. You can remove

the crop and grow another one, and you're still continuing to sequester carbon at a relatively high rate. You're not storing it there, you're—in this case, you're using the forest as a carbon pump, and, instead, you're taking your products and you're storing it as solid wood products, like you see in this room. You're using the biomass—the pieces of the log that are not used for solid wood products, you're using as biomass to offset fossil fuels. There is the opportunity to remove some of the material—not all the material, but some of the material that is currently left behind because it doesn't have a market—to supplement or to try to reach some of our goals, in order to renewable fuels and renewable energy.

What you find, if you consider those benefits in addition to comparisons between using wood as a building product, as opposed to some other fossil-intensive material, that you can actually have a substantial carbon benefit, above and beyond the forest, by using it as a carbon pump, as opposed to a carbon storage unit.

Now, that's an opportunity—the Inland West forests—we could take advantage of in the inland west forests, because they are at such high risk when you have very large amounts of wood left in the woods.

Senator WYDEN. Mr. Wood, you're not compelled to say anything, but you're welcome to have the last word.

Mr. WOOD. All I'll say is, thank you, Senator, for holding this hearing. It's particularly important to TU and its members, as research has demonstrated or indicated that up to 40 percent of salmon populations in the Pacific Northwest could be lost by 2050 due to climate change.

I also want to take a moment just to thank you for your leadership on the—and your staff's leadership—for the—for passing that copper salmon wilderness bill.

Senator WYDEN. Thanks, to all three of you. We're going to be calling on you often.

With that, the subcommittee's adjourned.

[Whereupon, at 4:20 p.m., the hearing was adjourned.]

APPENDIXES

APPENDIX I

Responses to Additional Questions

RESPONSES OF KIT BATTEN TO QUESTIONS FROM SENATOR WYDEN

Question 1. My understanding is that both the Forest Service and Department of the Interior have explored marketing tree-planting projects to generate funds from private sources based on the trees' ability to sequester carbon. Do you have any regulations or formal policies on those projects or on participating in existing carbon markets in general? If so, please cite them.

Answer. There has been discussion within the Department of the Interior about the ability of our land managing bureaus to sequester carbon on the lands managed under their jurisdiction. However, much of the discussion has taken place within the context of existing authorities. For example, National Park Service laws and policies require NPS to maintain naturally functioning ecosystems, which often provide a range of services, including but not limited to biological carbon sequestration. The Southeast Region of the U.S. Fish and Wildlife Service has for the past 12 years been building a program of carbon sequestration projects funded through partnerships with energy companies, land trusts, and conservation organizations, to bolster the bureau's conservation goals.

Question 2. Across the country, there are countless examples of fish and wildlife adaptation projects that have benefitted both the ecosystem and the surrounding community. For example, when headwaters are protected, drinking water filtration costs are reduced and rivers get reconnected to floodplains. Do you prioritize adaptation projects based on the ecosystem services they render or have the potential to render?

Answer. Among the Department's land managing bureaus, prioritization of adaptation projects is carried out based on the specific authorities that the bureaus operate under. Ecosystem services are one of many determinants of habitat conservation, restoration, and/or adaptation priorities. Likewise, adaptation, restoration, and conservation projects provide both direct and indirect benefits for a multitude of ecosystem services, including, but not limited to: fish and wildlife habitat, clean water, pollinator services, biodiversity, biological carbon sequestration, recreation, and many more.

For example, the FWS undertakes specific adaptation actions through a variety of programs, including land acquisition through the National Wildlife Refuge System, habitat restoration through the Partners for Fish and Wildlife Program, and stream restoration through the National Fish Passage Program. Within each of these programs, conservations actions are prioritized based on the significance of their contribution to the conservation of target species or habitats, cost-effectiveness, and other considerations that are outlined in program guidance documents and strategic plans, which can include important ecosystem services including, but not necessarily limited to, the provision of fish and wildlife habitat and/or biodiversity. Habitat conservation priorities are increasingly being developed in a landscape context, through application of our Strategic Habitat Conservation framework.

The Bureau of Land Management has a long history of prioritizing projects that improve land health and ecosystem resilience and contribute to achieving multiple beneficial ecosystem objectives across all land ownerships. In addition, BLM has initiated a process for conducting eco-regional assessments to identify and develop adaptation projects and strategies. Finally, NPS policies guide the determination of what sorts of resource intervention actions are undertaken in parks and most adaptation projects to date have been for ecosystem restoration.

RESPONSES OF KIT BATTEN TO QUESTIONS FROM SENATOR BINGAMAN

Question 1. Your testimony mentioned that USGS expects to complete the methodology for conducting the carbon sequestration assessments required by the 2007 Energy Bill next year. Can you clarify whether both the geologic sequestration methodology under section 711 and the ecosystem methodology under section 712 are expected to be completed next year? When do you expect the assessments themselves to be completed under both sections?

Answer. The process of developing a methodology for a national assessment of biologic carbon dioxide sequestration resources was begun in FY 2009 and should be completed in 2010. The methodology to assess geologic resources for geological carbon dioxide sequestration was completed in March 2009 and the U.S. Geological Survey is planning to carry out the assessment during this fiscal year (2010).

Question 2. Managing forests for adaptation and carbon sequestration can be complimentary—for example, through forests ecosystem restoration projects. But, in other cases, managing to maximize sequestration may be counterproductive from an adaptation standpoint, and vice versa. Can you explain what your current policies are for addressing the latter situation—where managing to maximize adaptation and sequestration are competing goals?

Answer. In those instances where this tension exists—competition between managing to maximize for adaptation or sequestration activities—it is important to note that the Department and its bureaus must carry out those mission-related functions that are required by statute. For example, the National Park Service is required to manage our national parks to prevent impairment of park resources and values. The U.S. Fish and Wildlife Service is required to manage our national wildlife refuges to fulfill the mission of the Refuge System, the purposes for which the individual refuges were established, and for any wildlife dependent recreational uses that are compatible with that mission and those purposes.

RESPONSE OF KIT BATTEN TO QUESTION FROM SENATOR MURKOWSKI

Question 1. In early 2001, it was reported that several Fish and Wildlife Service and Forest Service employees planted the hair of a Lynx from a game park on scratch posts in Washington State that were designed to check for the presence of Lynx in the area. As a result both the Departments of Agriculture and the Interior were forced to develop a code of professional ethics for their employees. Was this the type of sound science that the Secretary is suggesting be used?

Answer. Secretary Salazar has made clear his expectation that science-based decision-making will to be conducted with scientific integrity, in an atmosphere of openness and under the highest ethical standards, and without political interference. Science should be used as a tool for crafting smart natural resources policies, and tampering with science will not be tolerated.

RESPONSES OF KIT BATTEN TO QUESTIONS FROM SENATOR BARRASSO

Question 1. Dr. Batten, at the hearing, I raised my concerns about Secretarial Order 3289, which injects climate change into Department of the Interior decision-making. In response, you highlighted Secretary Salazar's responsibilities for land and resources management, and stated that "as a result, all of those land management decisions, resource management decisions, we need to considering climate change as the driving force in making decisions as how best to protect those resources and those lands for our communities." How can the Secretary of Interior make climate change the driving force in land management decisions above all others through a Secretarial Order, without any Congressional approval or authorization?

Answer. The Department and its bureaus must carry out those mission-related functions that are required by statute, and such required statutory obligations cannot be waived by Secretarial Order. To the contrary, Secretarial Order 3289 establishes, working within the context of existing bureau and Departmental authority, a framework through which Interior bureaus will coordinate climate change science and resource management strategies. Section 6 of the Order specifically notes that the document does not alter or effect any existing duty or authority of individual bureaus. Given the unprecedented scope of climate change impacts, Secretary Salazar believes it is simply good management for scientists, land managers, and policy makers at all levels of government to work together with landowners to understand climate change impacts and develop landscape-level strategies for responding to those impacts.

Question 2. Dr. Batten, I asked if Secretarial Order 3289 would affect existing land management agreements. You stated "there is nothing in the Secretarial Order

that discusses anything to do with altering existing agreements or arrangements between the Department of Interior and any of our partners as a result of this Secretarial Order." When I asked you again, can you assure me no existing land management agreement will be changed because of the Secretarial climate change order, you stated "there is nothing in this Secretarial Order that addresses any existing agreements." Would the Secretarial Order affect the renewal of any permit for any existing land management agreement or activity on public lands? Would the Secretarial Order lead to the changing of any existing land management agreement or activity through the updating of resource management plans? What current authorized public land management activities, whether energy extraction or recreational use, would be impacted by rules or policies promulgated as a result of Secretarial Order 3289?

Answer. As noted in the response to the previous question, Secretarial Order 3289 establishes within the context of existing bureau and Departmental authority a framework through which Interior bureaus will coordinate climate change science and resource management strategies. As I noted at the hearing, the Secretarial Order does not address any existing agreements. While the Order lists several general examples of actions that the impacts of changing climate could require, it is premature at this point to speculate results at the very specific level of detail addressed in this question.

Question 3. Dr. Batten, you are aware that I am concerned about Secretarial Order 3289, as well as Secretary Salazar's October 30th response to our letter. In that reply Secretary Salazar indicated that DOI only wanted to ensure that all bureaus and agencies have access to sound science and are in a position to respond to climate changes in a coordinated way. Given the history of some decisions that relied on questionable science, could you help me better understand who's sound science the Secretary wants to rely upon?

Answer. Secretary Salazar has made clear his expectation that science-based decision-making will to be conducted with scientific integrity, in an atmosphere of openness and under the highest ethical standards, and without political interference. Science should be used as a tool for crafting smart natural resources policies, and tampering with science will not be tolerated.

Question 4. Over the last decade the National Park Service has worked to close an oyster farm at Point Reyes National Seashore. Superintendent Don Neubacher and one of his scientists were accused of relying on science that was unrelated to Point Reyes when justifying the closure of the Drake's Bay facility. In fact, both the National Academy of Science and your own department Office of Inspector General reported on this. Was that the type of sound science that the Secretary is suggesting be used?

Answer. As noted in response to the previous question, Secretary Salazar has made clear his expectation that science-based decision-making will be conducted with scientific integrity, in an atmosphere of openness and under the highest ethical standards, and without political interference.

Question 5. In early 2001, it was reported that several Fish and Wildlife Service and Forest Service employees planted the hair of a Lynx from a game park on scratch posts in Washington State that were designed to check for the presence of Lynx in the area. As a result both the Departments of Agriculture and the Interior were forced to develop a code of professional ethics for their employees. Was this the type of sound science that the Secretary is suggesting be used?

Answer. As noted in response to the previous question, Secretary Salazar has made clear his expectation that science-based decision-making will to be conducted with scientific integrity, in an atmosphere of openness and under the highest ethical standards, and without political interference.

Question 6. I see from your title that you are the Science Advisor to the Deputy Secretary. Can you help me better understand what criteria the Department will use to assess just what sound science is on climate change vs. what is junk science?

Answer. President Obama addressed this issue in his March 2009 memorandum on scientific integrity, which states that "[w]hen scientific or technological information is considered in policy decisions, the information should be subject to well-established scientific processes, including peer review where appropriate, and each agency should appropriately and accurately reflect that information in complying with and applying relevant statutory standards. . . ." Secretary Salazar has stated that decisions in the Department will be based on sound science and the public interest.

Question 7. As you well know we currently have hundreds of thousands of forested acres that have been killed by the Mountain Bark Beetle in Colorado, Wyoming, and Montana. I suspect you also know part of the reason is that the age class distribution of our Lodgepole Pine stands is completely out of whack. All forest science that

I am aware of would recommend that the Lodgepole Pine should have been harvested over the last 50 years to have avoided the situation we now are suffering. But that would have required heavy timber harvesting which the federal land management agencies have resisted. Given that science and seeing the result of no action, does the Department of the Interior now advocate for more clear-cutting of the Lodgepole Pine that has not yet been killed by the insects?

Answer. Current science recognizes that a combination of warmer winters over the past decade, drought stress, and a loss of demographic diversity at the landscape scale have created conditions that are ideal for a proliferation of bark beetles. As the Department has noted in the past, no effective treatment for suppression of large-scale pine beetle outbreaks currently exists, and the Department's two largest land managing bureaus in the west are approaching this problem in a variety of ways based upon their missions, policies, laws, and the management mandates under which they operate. Selective removal of trees is being carried out in our national parks in order to protect visitor safety, dependent wildlife, and habitat. However, because commercial timber sales are not authorized on park service lands much of the beetle-killed trees will remain standing and, in accordance with the Organic Act and National Park Service Management Policies, natural recovery of these areas will be allowed.

The Bureau of Land Management has management jurisdiction over approximately 800,000 acres of lodgepole pine and has approached this epidemic by treating, in fiscal year 2009, 9,500 acres to mitigate impacts of the mountain pine beetle outbreak. The treatments are focused on protecting high-value areas, such as around communities and in and near established recreation sites, through placement of pheromone traps to prevent tree mortality, and reducing the risk of catastrophic wildfire events by reducing fuels through salvage of dead and dying trees.

RESPONSE OF ELAINE ONEIL TO QUESTION FROM SENATOR WYDEN

Question 1. If I understood your testimony, you both agree that a "full-carbon accounting" should be employed when considering the effects of forest management on carbon. But I have the sense that just about everybody has a different view of what exactly that means in practice. Is my sense on this accurate and, if so, where does that leave this Committee in crafting Federal forest management policy? To give one example, I wonder if the amount of credit to give wood products for carbon sequestration is widely accepted and how that would be quantified? Do you have any suggestions for how to standardize full-carbon accounting?

Answer. There should not be a significant difference in opinion on what is meant by full carbon accounting but there will be differences on what the implications are to policy.

Life Cycle Analysis has been accepted for some time as the best way to characterize full accounting which in this case requires tracking the carbon in the forest, into product uses (if any), and including how the uses may displace other uses such as the use of wood materials to displace steel and concrete or the use of biofuel to displace other fuels. It also includes issues of changes in land use. International Standards (ISO 14040 etc) have been designed specifically to provide a protocol for acceptable use of life cycle inventory and assessment methods (LCI/LCA).

Most of what might be considered different views are actually deviations and failed transparency in meeting the standards. But the standards do leave some room for variation while still requiring full disclosure. The EISA 2007 passed by Congress requires Life Cycle Analysis of synthetic fuels to compare the emissions of products like corn ethanol to common fossil fuels. This LCA requirement exposes the minimal carbon benefit that comes from corn-ethanol compared to sugarcane-ethanol or other sources and will help place the use of biofuels in a full carbon accounting perspective. You can expect that the carbon benefits for cellulosic ethanol to be much better as research is underway. This LCA requirement was not extended to the emissions from construction materials, which have a substantially larger leverage for reducing carbon emissions than using wood as a biofuel. Certified green buildings could easily be producing more emissions than non-certified buildings since there is no science based protocol for rating them.

The science basis for wood's impact on emissions has been studied for 15 years by a consortium of 15 research institutions, The Consortium for Research on Renewable Industrial Materials (CORRIM) and there is peer reviewed life cycle inventory data available on all the main structural and non-structural wood products (lumber, plywood, OSB, glulams, LVL, particleboard, MDF, trusses). Oregon State University provided much of the oversight for the development of these product LCIs and University of Idaho and the University of Washington were directly involved in har-

vesting and forest management impacts. CORRIM is currently working on LCIs for biofuel collection and processing which will be available soon. Comparable data for steel, concrete and other materials have also been collected such that all the inputs and emission outputs for all commonly used primary products are now available in the DOE NREL managed US LCI database for primary products.

However differences of opinion can easily arise when applying this information to policy. For example the tax credit for ethanol essentially results in the processor being able to steal the feedstock from other processors to make ethanol even though the other alternative will likely be reducing carbon emissions more effectively. This is a counter-productive policy result. The USDA Biomass Crop Assistance Program (BCAP) makes sawdust and other materials that are used to make particleboard and MDF eligible for fuel subsidies, which will redirect the feedstock away from its highest and best use thereby increasing carbon emissions by requiring other substitute products. If the subsidy only supported using currently unused feedstock the impact might be positive, but if so why not use it for its best use, which may or may not be fuel? There are many such counterproductive policies exposed by Life Cycle Analysis. The example you use on how much credit to give wood products cannot be answered and is probably the wrong question. The carbon mitigation objective is to drive out the use of high carbon emitting products and processes, which can be done directly by a tax on fossil emissions. That way the incentive is highest for those uses of wood that drive out the most fossil emissions. Using wood as a fuel will get the smallest incentive compared to other uses of wood like wood I-Joists which displace 9 times as much carbon as burning the wood for fuel. The market could determine the best efficiency by passing on the cost of carbon emissions.

Neither cap and trade, which involves millions of different products that cannot be treated separately, or incentives, which can't be properly designed for multiple uses, will be as effective as a carbon tax on emission that can easily be designed for income neutrality. Many proposed policies appear to be counterproductive but it is easier to find the flaws than to design a system to avoid them all. Perhaps the worst forest carbon policy is carbon exchanges that pay tree farmers to not harvest and save the wood in the forest as this assures the substitution of other materials, which produce higher emissions than any savings in forest carbon.

There is a wealth of additional information on full carbon accounting at the CORRIM website, www.corrim.org.

RESPONSES OF ELAINE ONEIL TO QUESTIONS FROM SENATOR MURKOWSKI

Question 1. Ms. Oneil, in your testimony you said: "No one wants to see another 'timber war' or extractive industry with little thought to long term sustainability of the federal lands in their region."

If you look at the clear cuts that occurred over the last 50 years and compare that to the amount of dead trees in the Medicine Bow and Big Horn National Forests that are the result of the Mountain Pine Beetles, The old clear cuts remain green and I have to ask myself if harvesting was really that bad.

I know that it seems to be politically incorrect for anyone in academia to admit that management of our federal forests has been a good idea. However, what has brought more damage to our forests over the last two decades in your mind—timber harvesting or the fires and insect epidemics we are currently suffering?

Answer. It appears that a few clarifying statements about 'timber wars' are in order. In the statement you quoted from my testimony, I am specifically referring to the discussions we had at the Plum Creek Conference on Forests and Energy in Missoula Montana in September 2009. At that conference participants were discussing the opportunities to create their own economic stimulus by biomass removal to reduce fire risks and address the mountain pine beetle epidemic. These were people working at the grassroots level that were sufficiently savvy to want it all: living wage jobs in the location they called home, but also a vibrant, healthy forest ecosystem to live near and recreate in. The fact that they live surrounded by National Forests that are dying and burning because they can't be cut is seen as a travesty but so is the idea that we could swing all the way in the opposite direction to wholesale biomass utilization without regard for other values on the forests. These concerns highlight how sustainability and management really have to be approached in the context of scale which is what dominated the discussions at the forum on biomass utilization. While there is a sense of urgency to get going on biomass removal operations before the forests all die and burn around them, there is a need to evaluate and determine not only how much can we take, but also how much should we leave. The core theme is the idea that the pendulum had swung from all out exploitation to essentially complete protection and that in this new opportunity for biomass to energy we needed to find a middle ground.

So what is more damaging: timber harvest or insects and disease infestations? It depends on two things—the scale of the disturbance and the effort made to ensure long term sustainability of forest attributes that are hard to replace if lost. If we can harvest in a way that leaves behind some big logs, snags, and trees as legacies in the regenerating stand, and most importantly soil conditions conducive to tree regeneration, then harvest is preferable to losing most of the soil horizon in a wildfire. While wildfires produce a lot of big logs and snags as legacies, but they also release tremendous amounts of greenhouse gases into the atmosphere and we have very little control over their eventual outcome. If maintaining forests as carbon sinks as well as for other values such as clean water, wildlife habitat and scenery is important then using harvesting offers much more control over the process of regeneration and renewal than we can ever expect from uncontrolled wildfire and insect infestations.

Question 2. Is forestry carbon neutral? In other words, how does sustainable harvest compare to some hot, destructive wildfires we've seen recently?

Answer. Forestry is better than carbon neutral. The Consortium for Research on Renewable Industrial Materials (CORRIM) has conducted life cycle inventory (LCI) and life cycle analysis (LCA) across 4 US timber supply regions and BC Canada which links what is happening in the forest through the milling process, to the use of the product and its eventual end of life. Results from CORRIM research show that harvesting wood for long term wood products generates a carbon benefit to the atmosphere that is better than if the forest is just left to grow, even if we assume the forest doesn't burn or die from insect infestations. In effect, using the forest as a carbon pump rather than a carbon storage site generates the maximum carbon storage gain. As part of the record I have submitted a 4 page factsheet* that summarizes 13 years worth of LCI work on this subject of whether forestry is carbon neutral.

These carbon neutral results are predicated on management that protects the resource and the resource is the soil. We cannot expect to see any kind of sustainability when the soils are losing over ½their carbon and a large percentage of their nitrogen as well during a hot wildfire. The sites are compromised as the pictures I showed you demonstrate and it may take centuries for them to return to their former carbon storage potential. In other cases it may take very little time for forest regeneration and soil carbon storage to return to pre-fire levels if there is limited impact on the soils. For example, after the Biscuit fire in Oregon, researchers found that 23 metric tons of carbon/hectare (62.5 US tons/acre) were lost from the soil which is almost double the estimate of carbon loss for the above ground vegetation of the 1 million SUV example I provided in the testimony. That means that the carbon emissions from that single wildfire with the million SUV impact may have been equivalent to the impact of 3 million SUV's driven over a 1 year period when we take into account the losses from below ground as well. That is a substantial impact on our forest recovery potential, on air quality and atmospheric carbon dioxide, and on our ability to meet future greenhouse gas targets.

Question 3. Will climate change affect National Forests differently in different regions of the country and if so, how should we structure policy to deal with those differences?

Answer. Climate change will definitely impact different regions of the country differently, and even different areas within a given region differently. For example in Washington State we looked at climate impacts for the forest sector as part of the Washington State Climate Impacts Assessment. Early on we decided to focus on eastern Washington as that is where all the action is in terms of climate impacts. While climate impacts may occur in coastal regions, they aren't something we can model at this time; the corollary is that it is difficult to recommend any mitigation actions for those regions either. The opposite case is true in the Inland West (Intermountain, Front Range, Southwest and eastern Washington) where climate impacts abound including increased wildfire activity, the 22 million acre mountain pine beetle outbreak across the west, and forest dieback from drought in the Southwest. We are anticipating the loss of 1 or more species at the lower forest margins in Washington State and when you realize that there are often only 1 or 2 species present, that is the same as saying we expect a forest dieback there also.

My experience as a field forester is that prescriptive policies that dictate how many trees to leave, how big a harvest unit should be, whether a clearcut is permissible or not, and what age, size, or species can be cut or must be left behind simply do not work. Policies that lead to these kinds of requirements or specifications in lower level plans are equally likely to fail. Here is an example to illustrate this point. Each site is different so the result of implementing the same prescription on

*CORRIM Fact Sheet has been retained in subcommittee files.

two sites that are separated by less than a mile can be quite different and neither may meet the objective set out in the prescription. Say we have a forest with mostly pine that is susceptible to mountain pine beetle outbreaks. Research from the 1970's conducted in the Black Hills of South Dakota suggests that to increase stand vigor so that the trees are more likely to be able to resist attack we need to lower the stocking to less than 150 square feet of basal area per acre. Overlay on this scenario a requirement to maintain the largest 50 trees in the stand that needs to be thinned to meet this requirement. Only if the 50 largest trees in the stand have an average diameter less than 24 inches per tree and they are well distributed across the acre can have meet both criteria; if the stand has all those trees clustered in once corner of the acre we may be able to meet both policy criteria but would not reduce the competitive stress on the trees to improve their ability to resist insect attack. In addition we relying on results taken from a single study in one region and applying them to the entirety of the west where different climates, climate impacts, and site productivities may dictate lower stocking levels (or permit higher ones) in order to achieve the reduced mountain pine beetle impact.

Just as important is the fact that there just aren't the physical or financial resources, or personnel, to tackle a problem of this magnitude by measuring every tree to ensure it is young enough or small enough to be removed. Rather than a prescriptive policy, we need a results based policy that highlights what we want to see as an outcome, not how to get there. The outcomes should be grounded in ecology and forest science so the basis of the policy should be ecology and forest science. The policy should direct land managers to evaluate the carrying capacity of their land base, whether trees, shrubs, soil, or animals, and assess how it might change with climate change. Using those predictions they should develop plans that describe how they plan to accomplish the result of creating (or maintaining) a forest ecosystem that has the necessary attributes to be resilient in the face of an uncertain climate future specific to their particular land base. That plan should be specific, but not prescriptive. The policy should direct land managers to describe contingency plans should particular aspects of the plan fail to meet its goals and objectives, and safeguards to minimize failures. While the plans should be open to public scrutiny and input, once they are approved, the mechanics of operations should no longer be open for discussion. We can expect to fail at least some of the time since we are dealing with many unknowns with climate change and land management, so if we want to accomplish something on the ground, it will be critical to provide a culture of support for managers and operational personnel that are willing to try new things to ensure the resilience of their forests.

Question 4. With all the money we are spending on fighting fires and all the news about mountain pine beetle are our national forests a carbon sink or a caron source at the present time?

Answer. The latest available Forest Service reports indicate that there is 20 billion board feet (BBF) of growth, 8 BBF mortality and 2 BBF of harvest on National Forests across all regions. These numbers suggest that nationally the forest is still a carbon sink, not a source. The questions to ask are whether this latest estimate incorporates current mortality events or not and whether substantial growth in one region is subsidizing substantial mortality in another. For example the most current complete dataset available when we started the Washington State timber supply analysis that was finished in 2007 was from prior to 2000. Using that data we calculated that mortality in eastern Washington National Forests was 49% of gross growth (so if applied nationally that would be 9.8 BBF of mortality instead of 8 BBF) but that did not include the massive spike in mountain pine beetle (MPB) mortality culminating in 9 million trees killed across 770,000 acres by 2004 as well as the wildfires in 2006 that affected over 400,000 acres of National Forest land. Since 1995 we have lost almost a million acres of National Forest land in Washington State to wildfire. If we continue at this rate it is equivalent to losing 1.7% of the forest area/year to wildfire. Other states will show greater or lesser impacts than this example, but the impacts are growing during each wildfire season. To highlight this growth rate consider this example. A recent study that looked at the relationship between wildfire extent and climate (Littell et al 2009b) found that for a region including Idaho, Montana, and eastern Washington we had experienced a fire rate of approximately 24% during the 20th century (meaning 24% of the National Forest lands would have experienced a wildfire during a 100 year period) or approximately 132,000 acres per year. National Interagency Fire Control (NIFC) statistics from 2002-2009 for this same area show almost 1 million acres/year of National Forest affected by wildfire which is equivalent to a 7.5x increase from the 20th century average. Add to these fire impacts, the mountain pine beetle outbreaks in all western states that literally dwarf the impact discussed for eastern Washington. In these regions with massive MPB outbreaks and extremely large wildfires,

I would suspect that since 2000 these National Forests are carbon sources, not sinks; however, to my knowledge no one has done the math on this question because the data in their entirety aren't available yet to do so.

Question 5. You state that "we should strive to prreserve mature and old growth forests to avoid losses of carbon associated with harvest". Mature forests are managed for a variety of reasons and objectives, including preventing catastrophic wildfire and improving habitat for T&E species. Doesn't stating that we should strive to preserve mature forests to avoid losses of carbon associated with harvest ignore the carbon sequestration that could be lost through other means, such as catastrophic wildfire, insects and disease, etc.?

Answer. Any loss of carbon associated with harvest can be more than offset with carbon storage in products and by using residual material not suited for products to replace fossil fuel use as an energy source. The Consortium for Research on Renewable Industrial Materials (CORRIM) has conducted life cycle inventory (LCI) and life cycle analysis (LCA) across 4 US timber supply regions and BC Canada which links what is happening in the forest through the milling process, to the use of the product and its eventual end of life. Results from CORRIM research show that harvesting wood for long term wood products generates a carbon benefit to the atmosphere that is better than if the forest is just left to grow, even if we assume the forest doesn't burn or die from insect infestations. In effect, using the forest as a carbon pump rather than a carbon storage site generates the maximum carbon storage gain.

Question 6. You state that most forest biomass is not consumed by fire, but isn't the larger issue whether there will be a loss of forest cover, loss of sequestration (because trees are dead unless the site is replanted), rehabilitation costs and watershed and stream problems? Should we consider all of these and other factors when managing forests or should we just look at carbon sequestration? Should we also consider the short versus long term impact of management?

Answer. Placing carbon sequestration potential into the context of disturbance rate is critical in maximizing carbon storage and offsets in both the near and long term. In areas with frequent fires, high fire risk, or on sites with high fuel loadings that are likely to burn under an altered fire regime brought on by climate change, harvesting can reduce the risk of leaving biomass in the forest with the co-benefit of using the harvested biomass to offset some other fossil fuel use that would have produced source emissions that still impact the atmosphere.

If the choice is to opt for maintaining the forests as carbon storage units, according to analysis by Weidinmyer et al (2006) for Inland Northwest forests we can calculate that about 30% of the tree biomass and about 90% of the shrubbery and duff layers (duff = decaying vegetation on top of the soil) are consumed during the actual fires. That which is not consumed by fire immediately begins to decay so emissions are either rapid during the fire or slow after the fire. Recent research on soil carbon suggests that there is always some component of the charred wood that remains for 100's if not 1000's of years but it is a small fraction compared to the total biomass on site prior to the fire. So fires do generate substantial greenhouse gas emissions at the outset and continue to do so as the vegetation continues to decay. As long as there is minimal soil damage and a seed source for regeneration the emissions can be offset in a relatively short period of time with new growth in both the shrub and canopy layers. The problem arises when the fire impacts on soil are severe, when there is no seed source, or where there is some other condition such as invasive weeds that prevent tree regeneration as is the case for a large portion of the Federal lands in California according to the latest fire analysis by Bonnicksen (2009). These factors should be taken into consideration when evaluating options for managing forests for carbon sequestration.

Question 7. You state that" fuel reduction techniques, especially those that remove half or more of the larger trees, could lead to increases in fire severity because of additional logging debris." Science shows that leaving the larger trees is best from a fire/fuel perspective and most fuels reduction work is needed on federal and public lands. What fuels reduction techniques recommend removing half or more of the larger trees?—this statement seems to be inconsistent with federal land management efforts to reduce hazardous fuels. Further, most hazardous fuels projects also include a prescribed fire component to reduce fire risk. Is your statement consistent with most hazardous fuels reduction projects?

Answer. Hazardous fuels reduction projects that remove over half the large trees are possible if the site was severely overstocked and/or if the largest diameter trees on site were not well suited to meet restoration goals. For example, some sites that were historically ponderosa pine forests may now have an overstory of white fir or grand fir that is fire intolerant. These overstory trees are sometimes the largest ones in the forest but they will not survive the re-introduction of fire and are often

experiencing substantial stress as the sites are too dry for optimal growth. In these cases, harvest could include removal of these large diameter specimens for processing along with concomitant fuels management of the residual material using either burning, grinding, or removal as a biomass feedstock. If logging debris is managed as part of the fuels reduction project, the risk of increasing fire severity is minimized or eliminated altogether.

Question 8. You also state that "fuel reduction can be effective to reduce fire severity but it results in decreased long-term carbon storage". If thinning helps prevent tree losses (and carbon) to bark beetles and fire, which will help the carbon-sequestration potential for the long term, should we not thin because of the short-term carbon loss?

Answer. If we only measure carbon stored on the forest without considering the carbon storage in wood products and carbon offsets by using wood to replace fossil fuel energy sources, there are probably some instances where this scenario of decreased long term storage might be true. For example in old growth PNW coastal forests with very long fire return intervals (over 250 years) it has been shown that fire risk reduction treatments that take only understory vegetation decrease long term carbon storage because the baseline of fire risk is so minimal and the product pools do not include solid wood products and their carbon offset values (Mitchell et al 2009). However examination of the full suite of stands from fire prone forests of the Inland Northwest shows that thinning these forests to reduce fire risks is both appropriate and it will not result in the loss of long term carbon storage (Oneil and Lippke, publish date 2010). If anything we need to be more aggressive in reducing forest stocking below carrying capacity when conducting forest thinnings. If we do so, the remaining trees will be able to regain vigor and resilience quickly, and then respond by growing up to that land carrying capacity which will sequester more carbon per tree while reducing the mortality risk.

Question 9. Should we manage forests with an ecosystem focus, to meet a multitude of objectives, including carbon sequestration, but by not maximizing one at the expense of another?

Answer. Given the multiple mandates that National Forests are expected to fill it only makes sense to manage them with an ecosystem focus that is designed to meet as many objectives simultaneously as possible while keeping in mind the constraints of the land base. It is important to recognize that while we can have it all, we can't have it all at the same place and at the same time and perhaps not at all on any given acre or forest. For example we can't have maximum forest stocking and low fire risk unless we are in areas that are too cold or wet to burn during fire season. The idea that we can force a particular outcome such as old forest habitat in a landscape with frequent stand altering (or now stand replacing) fires using aggressive wildfire suppression tactics has been demonstrated as an unworkable and expensive solution in recent years. Returning to an ecosystem focus would suggest that we do not insist on maintaining any particular forest condition where the incremental costs of keeping it as it is in the face of ecological processes escalate each and every year with concomitant diminishing returns.

Question 10. You mention that federal lands should be managed for the public interest of carbon sequestration and that 'if federal lands are managed for revenue from carbon credits, it will likely impact ecosystem functioning and other ecosystem services'—how? Are there any published papers on this topic?

Answer. Carbon credits are a double edged sword that should be approached very carefully, if at all. Credits in their current form rely on the concepts of baselines, additionality, permanence, and leakage. Currently they do not consider what happens to the products that leave the forest at harvest and they do not consider how those products might be better used to maximize the carbon benefit to the atmosphere. Perhaps the greatest difficulty with carbon credits is when they form part of a carbon exchange that pays the forest owner to not harvest and save the wood in the forest. This approach raises the demand of wood relative to supply, raises wood product price, and promotes the substitution of other materials for wood products which produce higher emissions than any savings in forest carbon. And if there isn't material substitution the demand for wood products that could have been met by that forest is met from some other wood producing region which means that the atmosphere experiences the perceived carbon consequences of harvesting anyway. In this case the landowner loses twice—first because they have limited their management options for a perceived benefit that doesn't actually provide a benefit to the atmosphere, and second because the incremental gain in carbon storage from a mature forest is small and therefore unless huge tracts are involved and the credit value is high, the costs of maintaining the forest in the face of disturbance may well outweigh the carbon credit value. A more viable approach to carbon mitigation objective that would promote the use of carbon efficient products and processes would

be to directly tax fossil fuel emissions. That way the incentive is highest for those uses of wood that drive out the most fossil emissions.

Difficulties in establishing baselines in the face of climate change, identifying how additionality and permanence would incorporate the huge uncertainties surrounding wildfire and insect outbreaks, and accounting for leakage from the system suggest that while carbon credit systems might be a way to obtain payment for ecosystem services, they need a lot of improvements before they can be implemented in a way that doesn't create perverse incentives.

Question 11. Currently, Germany exports 20% of its wood to the United States. Does it make sense to import wood products from other nations or would it be preferable to produce wood products sustainably in the United States? Considering the light carbon footprint of wood as compared to other non-renewable building materials and the abundance of heavily stocked (stocked beyond carrying capacity) federal and public lands in the west, should we sustainably harvest wood from public lands?

Answer. We could sustainably harvest wood from public lands, but a bigger question is how to do so within the current framework. Our analysis of Inland Northwest Forests, including Idaho, Montana and Eastern Washington state suggests that even if we only treated the forests with low and mixed severity fire regime and the dead and dying lodgepole forests, we would have to harvest 4 times more acres that we currently harvest in Eastern Washington and 5 times more than we currently harvest in Idaho and Montana (Oneil and Lippke, publish date 2010). Even increasing the harvest rate to this level would just treat the at risk forests on National Forest lands by remove only those trees less than 12 inches in diameter. In many cases these trees are too small to make into wood products used as building materials. This particular approach would reduce fire risk, but to implement such a strategy without economic return from marketable products would be economically prohibitive. In order to address the wood import issue it would be necessary to remove some larger diameter trees that can be processed into long-lived products which would have the co-benefit of subsidizing the removal of more non-merchantable material. Addressing wood imports and fire risk reduction requires re-thinking of our current focus of only taking young or small diameter material. Technologies are available to produce smaller dimension building products from smaller diameter wood (4-12 inches), but those technologies require substantial private investment that is only likely with a guaranteed wood supply. In many regions of the interior west we are losing mills, not gaining them because there is no guaranteed wood supply and the wood supply from federal lands is not considered as a viable guaranteed source. This suggests that it would be necessary to provide long term supply agreements to support the development of small diameter milling infrastructure. This option would serve a dual purpose of producing more wood products and removing the material that is currently placing these forests at high risk of loss to wildfire and insect and disease outbreaks.

Question 12. Is biomass harvest sustainable and renewable? What kinds of rules would we have to invoke to make it sustainable and/or renewable?

Answer. The same rules that apply to current harvesting could also apply to biomass-to-energy harvesting as in essence we are doing the same thing: entering a forest stand to remove some products while leaving others intact. It is important to realize the economics of biomass production can have an impact on the production of other wood products. As long as the price renewable fuel producers are willing to pay for biomass feedstocks is less than the market price for other wood products there is no competition between the sectors and in fact the wood harvesting can help offset some costs of the biomass feedstock acquisition. If the cost of bioenergy feedstock increases beyond the price for say wood chips for making pulp and paper then there is a direct competition which bids feedstocks away from a sector that is more efficient at turning wood into carbon offsets. At that point biomass harvest for energy becomes a counterproductive activity from a carbon emissions standpoint.

This suggests that biomass harvest is sustainable and renewable with certain caveats. First, we need to be intelligent about connecting feedstock availability to the scale of facility. If a facility requires 600,000 BDT/year (BDT = bone dry tons) and the forests within 50 miles can only provide 300,000 BDT without compromising existing manufacturing operations and ecological function, then we need the rethink the scale of the facility or the kind of facility to integrate the ecological and energy needs. The travel distance (i.e. 50 miles) is critical because economic viability is contingent on obtaining a feedstock at a reasonable price and haul distance is the most critical factor in feedstock price for most studies that have been done on this topic. Probably more critical is the need to offer long term supply agreements if we expect to attract sufficient private investment for implementing biomass production from woody residues. In the west this is particularly critical because in many instances

any logical processing location has to include a substantial percentage of federal lands within the 50 mile radius in order to obtain sufficient feedstock supply for economically viable operations. There has been a tremendous amount of research on this question of sustainable biomass harvesting. A thorough synthesis of this research has recently been conducted by University of Washington researchers (Mason et al 2009). It is available at http://www.ruraltech.org/pubs/reports/2009/wood__to__energy/index.asp

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RESPONSE OF CHRISTOPHER A. WOOD TO QUESTION FROM SENATOR WYDEN

Question 1. Mr. Wood, you highlight the Elk River watershed along the Oregon coast as an example of how the protection of intact habitat and reconnection of migration routes can help improve the resiliency of a watershed. Do you believe the Federal agencies are prepared to do the scale and level of protection across the country that you discuss in this example? If not, what more is needed? Do you see opportunities for public/private partnership and/or coordination with states?

Answer. In the Elk River watershed, a culvert on Blackberry Creek (an Elk River tributary) impedes fish passage. The Forest Service identified the need to replace the culvert and completed the Environmental Assessment years ago, yet has been unable to do so because of inadequate funding. Such examples abound across the nation's forests and grasslands. Climate change legislation such as S. 1733 and S. 1933, which would provide revenue from the carbon market to fund natural resources adaptation, and could enable federal agencies to complete adaptation projects at the scale and level needed to safeguard fish and wildlife. Furthermore, these climate change bills call for the development of adaptation strategies that can help prioritize actions and focus state and federal agencies and private partners on high priority projects in a coordinated fashion. Trout Unlimited has long worked with state and federal agencies and private partners such as timber companies to replace culverts and improve fish passage, from New Hampshire to the coast of California. We believe that partnerships to capitalize on the strengths and resources of public and private entities will be essential to completing adaptation projects on the scale necessary to enable fish and wildlife to cope with changes in climate.

RESPONSES OF CHRISTOPHER A. WOOD TO QUESTIONS FROM SENATOR MURKOWSKI (AND SENATOR BARRASSO)

Question 1. Your suggestions generally fall into the categories of protecting or rehabilitating terrestrial and aquatic ecosystems on public lands from the impacts of climate change. I am interested in exploring ideas about how the management of public lands can be used to reduce greenhouse gasses and abate climate change.

Should public lands have a role in the growth of wind and solar power? If so, how should this be done, and how should any public land impacts be mitigated?

Answer. Trout Unlimited supports the responsible development of energy resources on public lands. In order to ensure that development is done right, we must learn from our experiences in developing traditional energy resources on public lands. Mistakes in the management of traditional energy development, such as the extensive use of categorical exclusions, failure to adhere to protective stipulations, and inadequate monitoring and mitigation to name a few, should not be repeated in developing renewable energy.

Among the policy changes needed to ensure that fish and wildlife are not unduly harmed by renewable energy development are changing renewable energy permitting from a system of special use permits and rights-of-way to a leasing program. This would enable the generation of a revenue stream that could be used for fish and wildlife habitat mitigation and enhancement, monitoring, and restoration. In addition, the agencies should delineate important migration routes, streamside corridors, and other areas where development should and should not occur, and where transmission should be sited.

The useful life of a solar or wind facility is likely to be much more than 30 years. With this in mind, renewable energy lessees and operators should be required to complete interim reclamation. We also believe that no onsite mitigation alone will be adequate to sustain the ecological function of public lands on which many renewable energy facilities are located. Unlike oil, gas, and coal, the wind and sun are renewable sources of energy which will not be exhausted. The landscapes impacted by renewable energy facilities will not be restored to their current condition for the foreseeable future. Therefore, the only way to mitigate the impact of these facilities is to require the restoration or acquisition and preservation of comparable ecological resources elsewhere along with on-site actions to minimize the severity of impacts to natural resources.

It is vital that state and federal agencies have the resources necessary to properly manage energy development. Thousands of miles of transmission lines may be needed to move renewable energy to market. Funding must be made available to avoid fish and wildlife damage and for mitigation and restoration.

The federal government should collect royalties for renewable energy development and establish a Renewables Mitigation Fund. The fund could include federal and state accounts to support mitigation, monitoring, inventory, and management associated with conserving fish, wildlife, and water resources affected by renewable energy development; help local communities to mitigate the effects of renewable energy development; and enable non-profit entities to mitigate and restore areas affected by renewable energy development.

Question 2. What role should public lands play in the creation of carbon credits and in the functioning of carbon markets?

Question 3. Could carbon credits generated by planting to reduce the reforestation backlog on public lands be used to insure private carbon credits generated by planting trees on private lands?

Question 4. Could the insurance premium (which allows the private credits to be sold at full value) be used to help reduce the public land reforestation backlog?

Answer. The challenge in allowing public lands to play a role in the carbon markets is one of additionality. That is, how can you credit sequestration that is already occurring? Similarly, care should be given so that public land sequestration activities should occur in the context of managing for healthy, diverse, and productive landscapes so as to be consistent with the agency's underlying legal mandates. Using carbon credits generated by planting to reduce the reforestation backlog on public lands as a hedge or to insure private carbon credits generated by planting trees on private lands is an idea that Congress, industry, the agency, and conservationists should carefully explore. We should be open to trying a diversity of approaches and ideas in managing for healthy, diverse, and productive forest landscapes.

Question 5. In your testimony you indicate that fiber from fuels reduction on public lands should be used to generate biomass. Does this mean that you would oppose any definition of biomass that would exclude all fiber from public lands?

Answer. Fiber from fuels reduction on public lands should be used to generate biomass where it is generated in an ecologically sustainable fashion. We must avoid creating incentives to generate biomass from federal forests in ways that may be ecologically unsound. With that in mind, the proper definition of biomass will be influenced by the context in which it is placed.

Mr. Wood in your testimony you mention protecting the Copper-Salmon area in wilderness. In 2002, the Biscuit fire raged in the Kalmiopsis Wilderness for over two months burning almost every acre in that wilderness along with another 350,000 plus other acres. I believe that occurred during your time at the Forest Service.

Efforts to fight that fire were hampered by a lack of access and initial indecision on whether or not to fight the fire, since it was close to the Wilderness.

Question 6. In hindsight, did the Wilderness designation help maintain and improve the conditions of those watersheds when the Biscuit fire ravaged them?

Answer. The 500,000 acre Biscuit Fire burned at varying intensities. The Forest Service estimated that 63 percent burned at low or very low intensity; 23 percent at moderate intensity; and 14 percent at high intensity. Although nearly all of the Kalmiopsis Wilderness was within the Biscuit Fire Boundary, much of the wilderness itself actually did not burn, and much of what did burn burned at low intensity. As a result, the impacts to watersheds within the wilderness were varied. The areas that did burn at higher intensities were mostly very minor long-term impacts because of the good condition of the watershed. Other impacts occurred later as a result of salvage logging.

The remoteness of the area, including wilderness designation, influenced the early decision by the Forest Service not to suppress the fire, but the major rationale not to attack the fire immediately stemmed from the large number of other high priority fires burning across the West at the time. In its early stages, the fires that were to combine to form the Biscuit fire simply were very low priority compared to other big fires that were immediately threatening communities in other parts of Oregon and elsewhere in the West.

Question 7. When fire or insects and disease kill most of the trees in a National Forest have we improved the headwaters of the streams that flow from those lands?

Answer. No. Impacts such as fire, insects and disease are expected to intensify as the climate changes. In order to enable trout and salmon to cope with changes in climate, we must protect, reconnect and restore habitat. This comprehensive approach helps ensure that there are intact habitats to serve as strongholds for fish

and enough connectivity that fish can move about a watershed to escape localized impacts or recolonize impacted habitat after a catastrophic event.

Question 8. Understanding your strong desire to improve the watersheds and the streams as well as fishing in the forest, why is it acceptable to stand by and refuse to mechanically thin these forests when the potential for wildfire carries such risk to these lands and waters?

Answer. "Standing by" is not acceptable. Neither should we approach these problems with a willy-nilly, drop the blades and let the chain-saws rip approach. Thinning overly dense forest stands in order to reintroduce fire and rebalance fire return intervals is logical, and sorely needed across many national forests. The first priority for such treatments should be where forests and human communities intersect.

You also pushed for protecting roadless areas.

Question 9. When a roadless area burns and the A and B horizons of the soil are destroyed is that better or worse than building roads into an area so the fire fighters can access the area when fires start?

Answer. Native trout and salmon across the West, and the ecosystems of which they are part, have evolved with fire. Trout and salmon thrived for thousands of years in these natural ecosystems without the intervening hand of man. Furthermore, it has been demonstrated that roadless areas comprise a disproportionately high percentage of native trout habitat. On many western landscapes, native trout have been eliminated from most roaded areas and persist only in roadless headwater areas. These lands harbor sensitive native species precisely because they are free of roads and the attendant impacts such as habitat degredation and non-native species introduction. The protection of roadless areas is an important component in a comprehensive approach to conserving trout and salmon.

Question 10. After an area burns and then the area is hit by a rain storm that washes thousands of cubic yards of soil and rock into the streams is that better or worse for the streams and fish than those plugged culverts that you discussed at the hearing?

Answer. Events such as those described in the question above underscore the importance of restoring fish passage at blocked culverts. By restoring connectivity, we enable fish to move when faced with such habitat impairments. Watersheds with adequate habitat connectivity are more resilient to the effects of fire and flood.

RESPONSE OF BEVERLY LAW TO QUESTION FROM SENATOR WYDEN

Question 1. If I understood your testimony, you both agree that a "full carbon accounting" should be employed when considering the effects of forest management on carbon. But I have the sense that just about everybody has a different view of what exactly that means in practice. Is my sense on this accurate and, if so, where does that leave this Committee in crafting Federal forest management policy? To give one example, I wonder if the amount of credit to give wood products for C sequestration is widely accepted and how that would be quantified? Do you have any suggestions for how to standardize full carbon accounting?

Answer. I am involved in methods development and providing recommendations for improving national and international estimates of forest carbon sources and sinks (NRC committee report on Verifying Greenhouse Gas Emissions for a Climate Treaty (in review), Group on Earth Observations (GEO) Carbon Report, Law et al. 2008 Terrestrial Carbon Observations: Protocols for Vegetation Sampling and Data Submission). Forest carbon accounting includes the land-based net of carbon uptake by photosynthesis and losses from respiration by plants and microbes, and decomposition. This portion of the budget is best measured by the eddy covariance method (an atmospheric measurement representing an area of <1 square kilometer), but it is attempted partially through summing up inventory data on changes in carbon stocks in soil and in live and dead biomass above and belowground between two measurement periods (e.g. 5 years, which needs to be reduced to annual; Law et al. 2008). Other carbon losses must be accounted for, including that from land use (thinning, complete harvest) and emissions from fire. When a forest is thinned, more debris is typically added to the surface (decomposition ensues) or an underburn treatment is applied and most of the small dead material on the surface is emitted to the atmosphere (pulse emission loss). When a forest is harvested, about 25-50% of the harvested amount of carbon is released to the atmosphere during the manufacturing process (the value within this range depends on the type of wood product). Long-lived harvested wood products are a potential CO_2 sink, although the average lifetime of wood products is relatively short (20 years) and the UNFCCC accounting rules for them have not yet been agreed upon. In addition, there are carbon costs

of burning fossil fuel to harvest material, transport it to mills and in manufacturing. This must be included in evaluating the merits of biofuels harvesting (Jaeger et al. 2009. Biofuels in Oregon from an Economic and Policy Perspective). In addition, there is a time factor—it takes about 20-50 years to grow the wood that is harvested for biofuels, and it may take only a few years for that carbon to be released to the atmosphere. So, the net of both biological processes on site, and transport and manufacturing carbon costs should be included in the analysis. Again, these accounting methods are being recommended internationally (see citations).

International assessments should include reporting of emissions and sinks should include all lands, not just managed lands, which would allow credit for maintaining carbon in mature and old forests (NRC 2009).

RESPONSE OF BEVERLY LAW TO QUESTION FROM SENATOR BINGAMAN

Question 1. Dr. Oneil's testimony discussesd the C emissions produced by wildfires, specifically articles published by Mason (2006), Wiedinmyer & Neff (2007), and Bonnicksen (2009). It is my understanding that you have studied and published on this issue.

Can you briefly discuss the best available science on carbon emissions produced by wildfires?

Answer. The best available science on carbon emissions from wildfires is field observations of changes in live and dead pools, surface litter and soil after wildfires of different severities (low to high). We conducted such a study and quantified combustion of the pools in the different severities. These data are desperately needed for the calibration of remote sensing data and models that are used to produce estimates for landscapes, states, regions, the U.S., and globally. Unfortunately, our data were not published or used by the references cited by Dr Oneil. Those references have large uncertainties associated with them, and I had contacted one of the authors to let them know their estimates were large overestimates. Our emissions estimates from measurements before and after fire showed that emissions from litter and duff ranged from 70-100% depending on fire severity (the high value is for high severity), whereas Wiedeinmyer & Neff (2007) used values of 80-90% over N America. Our emissions estimates for tree stems were <1% to 3% for stems less than 7.6cm in diameter (~3 inches), depending on fire severity. Our measured values are somewhat lower than those used by modelers. Wiedinmyer & Neff (2007) used 30% for tree stems (compared to our measured 3% for high severity fire) when modelling high severity combustion across N America (Campbell et al. 2007). If we applied those percentages to one of the fires on which we made these measurements, it would lead to a large overestimation of pyrogenic emissions, in part because a significant portion of the biomass in large trees experience very little wood combustion. On the Biscuit Fire, we found that 57% of the total pyrogenic emissions were from the litter layer plus duff and mineral soils. The next largest source was dead wood (19% of total emissions). For Oregon, our estimate of fire emissions based on our observations were used to calibrate a carbon cycle model and we used Landsat remote sensing date that identified fire area and severity annually over the state. Our estimate of wildfire emissions averaged 1.07 Tg carbon per year over 10 years, which averaged 7% of the equivalent of Oregon's fossil fuel emissions.

We are currently working on an analysis and publication that provides new estimates of fire emissions and the effects of fire on the North American carbon budget. This is a synthesis activity that is part of the North American Carbon Program, and it will be submitted to a peer reviewed journal and likely will be included in the next State of the Carbon cycle report.

RESPONSES OF TOM TIDWELL TO QUESTIONS FROM SENATOR WYDEN

Question 1. What is the Forest Service doing to promote biomass utilization?

Answer. Our Nation's forests are a sustainable, strategic asset in achieving and enhancing U.S. energy security, economic opportunity, environmental quality, and global competitiveness. A sustainable renewable bioenergy and biobased products sector is a growing source of jobs in the U.S. economy that contributes to energy security and greenhouse gas emissions reduction. Biomass has the potential to supply an increasing proportion of U.S. liquid transportation fuels, chemicals, and substitutes for fossil fuel-intensive products.

One of the greatest challenges facing forest landowners and managers in the United States is restoring, maintaining, and enhancing the health and productivity of forest systems. Restoring forests to increase resiliency and reduce the risk of loss from fire, insect or disease, often entails the use of thinning and prescribe fire which involves the removal of large quantities of small-diameter and low-quality wood that

currently has little or no commercial value. This woody biomass is a potential feedstock for bioenergy and biobased products.

The Forest Service has developed a strategy to promote woody biomass utilization. The strategy was developed in 2006 and 2007 with national effort to look at how to utilize woody biomass at all levels of the agency. We gathered employees from all levels of the agency to ensure this was a grass roots effort to provide a realistic strategy on the key components field units needed:

- This strategy is focused on:
  - —Ensuring a reliable and sustainable biomass supply;
  - —Helping develop new and expanded markets for bioenergy and biobased products; and
  - —Providing the science and technology for: sustainable and economical forest biomass management and production systems, competitive biofuels and biopower conversion technologies and high-value bioproducts, and information and tools for decision-making and policy analysis.
- Forest Service accomplishments in wood-based bioenergy and biobased products include:
  - —A Woody Biomass Utilization grants program targeted toward small businesses to help build capacity for biomass utilization in support of fuel reduction and restoration. Since its inception in 2005, the program has provided over $26.3 million (110 grants) towards projects ranging from biomass boilers for schools and prisons, to helping businesses acquire equipment that improves processing efficiencies. These grants have been awarded to small businesses, non-profits, tribes and local state agencies to improve forest health, while creating jobs, green energy and healthy communities.
  - —A system of Coordinated Resource Offering Protocol (CROP) studies, including 10 sites across the US, which makes biomass supply information available to potential investors. (http://forestsandrangelands.com)
  - —A multi-partner consortium (Consortium for Research on Renewable Industrial Materials) conducting life cycle analysis of wood products and forest biomass-based fuel products (http://www.corrim.org/).
  - —Proposed innovation platform for multi-feedstock bioenergy pilot plant to investigate biorefinery concept at the Forest Products Laboratory (FPL). This facility would be the central source for the building's heating and electrical system along with producing a liquied bio-fuel as a byproduct. Excess power produced by the facility could be sold back to the community's power grid. This is currently in the planning stages.
  - —Cooperation with DOE on BioMax, a small scale combined heat and power system for supplying heat and electricity from wood for localized applications and sole source supply in remote areas.
  - —Report: Increasing Feedstock Production for Biofuels: Economic Drivers, Environmental Implications, and the Role of Research, an economic assessment encompassing feedstock production from agriculture and forestry sources. (http://www.usbiomassboard.gov/pdfs/8__Increasing__Biofuels__Feedstock__Production.pdf).
  - —Report: Economics of Biomass Feedstocks in the US: Review of the Literature. (http://www.usbiomassboard.gov/pdfs/7__Feedstocks__Literature__Review.pdf)
  - —Fuel Reduction Cost Simulator, a tool that simulates the cost of forest operations that are undertaken to reduce fuel loads by cutting and removing trees for solid wood products or chips (http://www.fs.fed.us/pnw/data/frcs/frcs__home.htm)
  - —Life cycle analysis of woody biomass to energy systems as part of a wildfire and climate mitigation strategy ("Biomass to Energy: Forest management for wildfire reduction, energy production and other benefits," http://www.energy.ca.gov/2009publications/CEC-500-2009-080/CEC-500-2009-080.PDF)
- Examples of turning biomass into energy include:
  - —Fuels for Schools (Montana, Vermont, Pennsylvania)
  - —Use of wood fuel at power generating plants of 10 MW to >50 MW capacity (California, New Hampshire, Vermont, Michigan, South Carolina)
  - —Historical and continuing use of surplus wood, bark, and black liquor for heat and electricity at primary wood manufacturing plants (Nationwide)

- MOU between ARS and FS R&D to cooperate on research and development that focuses on synergistic applied research, development, and deployment of forest and agricultural biomass-to-bioenergy technologies.
- Biofacilities Initiative: An interagency working partnership between DOI, DOE, and FS to complete feasibility studies on 113 potential sites on Federal, State and Tribal facilities. The Biomass technology included in the potential sites range from thermal applications, combined heat and power to large scale power projects. Each site analysis will include a resource assessment, market evaluation, environmental planning steps required, technology evaluation, and financing options. This project is scheduled for completed by October, 2010.

Question 2. My understanding is that both the Forest Service and Department of the Interior have explored marketing tree-planting projects to generate funds from private sources based on the trees' ability to sequester carbon. Do you have any regulations or formal policies on those projects or on participating in existing carbon markets in general? If so, please cite them.

Answer. We currently do not have regulations or formal policies specific to participation in carbon markets for tree-planting carbon sequestration projects. In May of 2008 the Chief of the Forest Service sent a letter to the regional foresters stating that at this time, the Forest Service is not engaging in partnerships that involve the selling and trading of carbon credits in the market. The letter also discusses the Memorandum of Understanding between the Forest Service and the National Forest Foundation to work together to develop demonstration projects that quantify biological carbon sequestration through targeted reforestation projects. Donations to the NFF's Carbon Capital Fund are used to replant areas on National Forests that have been so severely altered by wildfire that these formerly forested areas will be difficult to regenerate naturally. These reforestation demonstration projects are projected over the next decades to sequester a measurable and verifiable amount of carbon beyond what would occur without the planting. Donors may voluntarily report the expected carbon uptake and storage associated with the specific reforestation project.

Question 3. Across the country, there are countless examples of fish and wildlife adaptation projects that have benefited both the ecosystem and the surrounding community. For example, when headwaters are protected, drinking water filtration costs are reduced and rivers get reconnected to floodplains. Do you prioritize adaptation projects based on the ecosystem services they render or have the potential to render?

Answer. The Forest Service has a long history of implementing watershed and ecosystem restoration projects. Adaptation projects are prioritized through a variety of modeling and valuations. They generally consider the ecosystem services/ecological values in a given area, the existing condition of those resources, the scale of threats to them, and the technical, legal, political, social, and institutional opportunities and limitations for addressing those threats. We are currently assessing methods to prioritize watershed restoration in a more consistent way across the Nation. This Watershed Condition Framework Assessment has been tested and reviewed. Each Forest will complete these assessments this fiscal year. Region Five (California and Pacific Islands) is currently developing an ecosystem services framework that will inform program design, national forest plan revisions and cooperative forestry activities.

Question 4. America's forests, farms and ranches provide a significant supply of drinking water for our country. I understand that protecting water resources is a top priority for the Forest Service, especially in light of climate change and the need to manage natural resources so that they can withstand the ongoing and expected impacts. Given the already existing stresses on our water resources, how do you plan to prioritize the protection of clean sources of water on National Forest lands in the face of climate change?

Answer. Climate change and its effects on water are expected to intensify freshwater scarcity. The Forest Service developed is a Watershed Condition Assessment. This identifies vulnerable watersheds at risk from hydrologic changes due primarily to climate change and will provide a method of prioritization for restoration.

In addition, we have a variety of prioritization models for our watershed restoration program and we have efforts underway to do that in a more consistent manner across the country. Some administrative units have begun efforts to evaluate their existing strategies to incorporate metrics for climate change risk. For example, the Pacific Northwest (PNW) Region is working with scientists at PNW Station and University of Washington to conduct a regional-scale vulnerability assessment for water and aquatic resources. Other vulnerability assessments have been initiated on the Shasta Trinity, Ouachita, White River, and Apache-Sitgreaves National Forests.

Our more recent Land Management Plans include ecosystem restoration as a key outcome. As we continue to implement those plans we will make strides toward ecosystem health and resiliency that will be more adaptable to changing climate. The National Forest Management Act requires the Forest Service to revise its management plans for each national forest on a regular basis, using the Planning Rule as a consistent guide. We are currently working on a new Planning Rule that will allow National Forest and Grasslands to produce updated Plans that address today's demands and conditions, as well as anticipate future conditions due to climate and other changes. Ecosystem services will play an important role in helping the national forests to set priorities, strengthen their stewardship relationships with adjacent communities and ensure the sustainable provision of environmental benefits.

The Forest Legacy Program, in State and Private Forestry, uses conservation easements to prevent the development of high value forests that are critical for watershed and wildlife habitat protection and is a prime tool for climate change adaptation through connectivity of protected lands for species movement across the landscape. Tracts of land are selected based on a State Assessment of Need that evaluates important ecosystem services and critical habitats. Since 1991, Forest Legacy has protected almost 1.6 million acres in 46 states and territories.

Question 5. In a Forest Service Environmental Analysis from 2001, the agency stated that it could potentially decommission as many as 120,000 to 186,000 miles of unneeded roads and unauthorized routes. Has the Forest Service ever studied how much carbon could potentially be sequestered if these unneeded roads and unauthorized routes were re-vegetated?

Answer. This issue has not been studied.

Question 6. Congress has appropriated $90 million in FY 2010 for the Forest Service Legacy Roads and Trails Remediation Program. Can the road decommissioning and storm-proofing work accomplished under this program help to ameliorate flooding and other impacts of climate change on national forest watersheds and on downstream communities?

Answer. The Legacy Roads and Trails Program is playing an essential role in achieving the Secretary's vision of managing our forests to protect and restore the Nation's water resources and make them more resilient to climate change. This program is funding many critical activities, including road decommissioning, stormproofing, relocation, critical maintenance, and restoration of fish passage at road-stream crossings. Strategic and large-scale implementation of these activities can, over time, provide numerous benefits.

Perhaps the greatest benefits of road restoration will result from reducing the consequences of floods, fire, and other disturbances likely to be exacerbated by climate change.[1] [2] For example, relocating roads away from floodplains and improving road drainage systems can reduce damage to infrastructure.[3] Road treatments can also reduce storm-driven delivery of fine sediment to streams, which can lower treatment costs and improve the reliability of some water supplies. Road restoration can also improve the health and resiliency of aquatic habitats, which are already stressed and will be adversely impacted by climate change.[4] [5] For example, reconnecting aquatic habitats at road-stream crossings and reducing existing sediment and temperature impacts, are perhaps among the most important things we can do to protect our fisheries in light of climate change.

RESPONSE OF TOM TIDWELL TO QUESTION FROM SENATOR BINGAMAN

Question 1. Managing forests for adaptation and carbon sequestration can be complimentary-for example, through forest ecosystem restoration projects. But, in other cases, managing to maximize sequestration may be counterproductive from an adaptation standpoint, and vice versa.

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[1] Gucinski, H., M.H. Brookes, M.J. Furniss and R.R. Ziemer. 2001. Forest Roads: A synthesis of scientific information. PNW-GTR-509. Portland, OR: USDA Forest Service Pacific Northwest Research Station. 120 p.

[2] Rhee, J., W. Chung, J.A. Efta, W.J. Elliot and R.B. Foltz. Under Review. Assessing the Impacts of Future Climate Changes on Forest Road Erosion using the Water Erosion Prediction Project (WEPP) Model: Case Studies in Lake Tahoe, NV and Mica Creek, ID. Pullman, WA: Washington State University.

[3] Elliot, W. J. and L. M. Tysdal: 1999. Understanding and reducing erosion from insloping roads. Journal of Forestry. 97(8): 30-34.

[4] Gucinski, H., M.H. Brookes, M.J. Furniss and R.R. Ziemer. 2001. Forest Roads: A synthesis of scientific information. PNW-GTR-509. Portland, OR: USDA Forest Service Pacific Northwest Research Station. 120 p.

[5] Foltz, R.B., K.A. Yanosek, and T.M. Brown. 2008. Sediment concnetration and turbidity changes during culvert removals. Jour. of Environmental Mgt 87:329-340.

Can you explain what your current policies are for addressing the latter situation-where managing to maximize adaptation and sequestration are competing goals?

Answer. Carbon management is a complex issue and the amount of carbon stored on a given site is only part of the picture. A "one-size-fits-all" approach cannot be successful in this increasingly complex and dynamic management environment. Instead, our strategy for the National Forest System focuses on sustaining ecosystem processes and functions, which are the foundation of ecosystems. This involves restoring and maintaining the resilience and adaptive capacity of terrestrial and aquatic ecosystems. Thinning overly dense stands and reintroducing controlled use of fires are examples of tools to restore ecosystem processes and functions.[6] [7] [8] This strategy requires actively managing resources and infrastructure so that stressors, threats, and vulnerabilities are reduced or eliminated. Examples of stressors and vulnerabilities include non-native invasive species, lack of disturbance or management causing overly dense forests, and undersized road culverts and bridges too small to handle increasing storm flows caused by winter precipitation falling as rain rather than snow.

RESPONSES OF TOM TIDWELL TO QUESTIONS FROM SENATOR BARRASSO

Question 1. Chief Tidwell, welcome to our Committee and congratulations on being selected to serve as the Chief of the Forest Service. We welcome you and thank you for your service.

Do you agree that higher concentrations of carbon dioxide in our atmosphere will likely increase plant growth, provided the soil and water conditions are right?

Answer. Some studies suggest that rising CO_2 increases net primary productivity by 12-23% over all species studied, but it is uncertain whether this is a lasting effect[9]. Studies also suggest that rising CO_2 will very likely increase photosynthesis for forests, but this increase will likely only enhance wood production in young forests on fertile soils.[10] The response of forest ecosystems to elevated CO_2 is complex with variation across systems, and it is an active area of research.

Question 2. Do you agree that for some shorter lived species like Lodgepole Pine and Aspen that there needs to be some management to avoid catastrophic collapse of those species in some areas?

Answer. In some specific cases, active vegetation management programs are important not only for species such as lodgepole pine and aspen, but for a vast array other species found in forest ecosystems on the national forests. We need to manage these stands to aid in adaptation. We have had extensive research and practical application of knowledge regarding this type of active management. However, even as we apply what we know, we still encounter areas of uncertainty and will continue our efforts to address ecosystem complexities. Below is a summary of our knowledge regarding management in lodgepole and aspen forests:

LODGEPOLE PINE RESEARCH

Forest Service Research and Development on has been putting research emphasis on developing and evaluating ecosystem-based treatments for sustaining produc-

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[6] Fettig, Christopher J.; Klepzig, Kier D.; Billings, Ronald F.; Munson, A. Steven; Nebeker, T. Evan; Negron, Jose F.; Nowak, John T. 2007. The effectiveness of vegetation management practices for prevention and control of bark beetle infestations in coniferous forests of the western and southern United States. Forest Ecology and Management, Vol. 238: 24-53.

[7] Johnson, Morris C.; Peterson, David L.; Raymond, Crystal L. 2007. Guide to fuel treatments in dry forests of the Western United States: assessing forest structure and fire hazard. Gen. Tech. Rep. PNW-GTR-686. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 322 p.

[8] Graham, Russell T.; McCaffrey, Sarah; Jain, Theresa B. 2004. Science basis for changing forest structure to modify wildfire behavior and severity. Gen. Tech. Rep. RMRS-GTR-120. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 43 p.

[9] Birdsey, R. A.; Jenkins, J. C.; Johnston, M.; Huber-Sannwald, E.; Amiro, B.; de Jong, B.; Etchevers Barra, J. D.; French, Na.; Garcia-Oliva, F.; Harmon, M.; Heath, L. S.; Jaramillo, V. J.; Johnsen, K.t; Law, B. E.; Marin-Spiotta, E.; Masera, O.; Neilson, R.; Pan, Y.; Pregitzer, K. S. 2007. North American forests. In: King, A.W.; Dilling, L.; Zimmerman, G.P.; Fairman, D.M.; Houghton, R.A.; Marland, G.; Rose, A.Z.; Wilbanks, T.J., eds. The First State of the Carbon Cycle Report (SOCCR): The North American Carbon Budget and Implications for the Global Carbon Cycle. National Oceanic and Atmospheric Administration, National Climatic Data Center, Asheville, NC: 117-126, 173-176.

[10] CCSP. May 2008. Synthesis and Assessment Product 4.3 (SAP 4.3): The Effects of Climate Change on Agriculture, Land Resources, Water Resources, and Biodiversity in the United States, P. Backlund, A. Janetos, and D. Schimel, lead authors. A report by the U.S. Climate Change Science Program (CCSP). Executive Summary.

tivity and biodiversity of lodgepole pine forests and watersheds since 1961. The research topics covered are:

1. Evaluate and quantify the ecological and biological effects of alternative silvicultural treatments and prescribed fire in lodgepole pine forests by creating reserve stand structures that emulate those created by natural disturbances.
2. Evaluate damage to reserve trees relative to alternative stand densities and structures and examine regeneration and understory vegetation changes associated with alternative silvicultural treatments.
3. Develop linkages between vegetation management activities and hydrologic responses at the sub-watershed level.
4. Manage and integrate the knowledge gained from the variety of studies to improve ecosystem-based management in lodgepole pine forests.
5. Develop demonstration sites for education of the general public, students, professional, and researchers.
6. Test and verify hydrologic and vegetation models and evaluate harvest costs and product recovery values associated with alternative silvicultural prescriptions and harvest systems.
7. Contribute to the scientific knowledge through publication of results in appropriate outlets.
8. Integrate knowledge gained from these studies into ecosystem management guidelines that enhance the function and sustainability of lodgepole pine forests in the Northern Rockies through a variety of technology transfer products.

ASPEN RESEARCH

The development of aspen forests is closely linked to fire or disturbance. After a stand-replacing disturbance by fire, the root systems of aspen usually survive and send up new stems to regenerate the forest. One of the restoration strategies forest researchers and managers have pursued is modifying the fire cycles, such as determining the frequency of fire required to sustain aspen in areas where fire has been suppressed in the past.

Aside from regeneration following fire events, aspen stands sometimes regenerate following a massive die-off of mature trees. But in some cases the root system is completely dead, which results in a complete die-off of the aspen stands, a phenomenon called Sudden Aspen Decline (SAD) that is currently pronounced in western Colorado, southern Utah, and southwest Wyoming. Researchers are looking at the impact that insects and diseases have on regeneration associated with SAD as well as the effect of drought. Researchers and managers are focused on finding ways to restore aspen throughout the West.

Question 3. The President recently signed an executive order that all management will be undertaken with climate change in mind. Can you give me a couple of examples of the specific changes your agency will make to respond to that Executive Order?

Answer. President Obama recently issued Executive Order 13514, Federal Leadership in Environmental, Energy and Economic Performance. This executive order focuses on improving energy efficiency, water use, waste streams and related environmental footprint parameters associated with federal buildings, motor vehicle fleets and federal contractors/ permit holders. Section nine of the executive order also requires agencies that manage federal lands to "consider and account for sequestration and emissions of greenhouse gases resulting from Federal land management practices." The executive order tasks the Department of Energy with recommending the reporting and accounting procedures under Section Nine. The Forest Service is currently working with the Department of Energy and other land management agencies on implementing the executive order.

Question 4. In January Chief Gail Kimbell released direction on how to deal with climate change in forest planning and project NEPA documentation development. Within that direction I found a table that says:

Forest stands are at stand densities and of species composition such that they wille resilient under a variety of potential future climates. Lower densities are moreikely to survive future drought stress, fire, and insect and disease problems.he following residual stand densities should be used for thinning stands ofifferent forest types and seral stages. These residual densities are based onossible annual precipitation reductions of 10-20 percent and possible increasesn evapotranspiration during peak periods of 5-10 percent.

Residual Density Ranges (TPA) by Forest Type and Seral Stage

Forest Type	*Young Stage*	*Mid-Stage*	*Old Stage*
Ponderosa Pine	*100-200*	*70-90*	*30-50*
Douglas-fir	*150-250*	*100-125*	*50-80*
Lodgepole Pine	*200-300*	*60-150*	*20-60*

I want to focus on the two predominant species in my State, Ponderosa Pine and Lodgepole Pine.

Understanding that the guidelines reflect a desired future condition, of having 20 to 60 old Lodgepole Pines per acre can you give me a ballpark figure of how many Lodgepole Pines there currently are per acre on the Routt and Medicine Bow National Forests?

Answer. This hypothetical table was included in the document for illustrative purposes only to assist planners in visualizing how this information could be presented in plan revisions. To actually construct this table for use in forest planning would require data collection and careful analysis to ascertain appropriate levels of residual stand density for a given species under specified conditions. The number of live lodgepole pine per acre presently found on the two forests varies from zero to in excess of one thousand trees per acre depending on location and stand age.

Question 5. Can you tell me how much mature timber would have to be removed, if those trees were still alive to meet that guideline?

Question 6. Can you tell me if the projected funding for FY 2010 in the Region Two timber program will allow your Regional Forester to meet that goal and if so on how many acres of treatments have you tasked him with?

Question 7. How about Nationally? How much funding would you need to reduce stand stocking to the levels called for in the January direction?

a) And, How much combined timber, vegetation management and hazardous fuels funding do you have in FY 2010 to implement these guidelines?

b) Can you provide us with a table that displays the approximate number of acres in the National Forests that do not meet these guidelines and how much funding it will take to bring those acres into compliance with the guidelines?

Question 8. Could you provide me the same information (in Wyoming) for all species listed in the table and respond to each of the questions I asked on Lodgepole Pine?

Question 9. Could you provide me the same information for all National Forests (collectively)?

Answer. Question 5 through 9 all reference implementation of the example data intended for illustration only. The residual stand densities shown in the example table were not intended to be used as guidelines and doing so would lead to erroneous information and conclusions.

Question 10. In your testimony you expressed the need to undertake all landownership restoration. Given the conditions on the federal land and the apparent difficulty the agency is having even putting out fires on the federal land, can you explain why you would think most rational private land owners would be willing to listen to the Forest Service or the federal government about how to best manage their forest lands?

Answer. The Forest Service respects the diverse range of objectives and values for which private forest lands are managed. Threats to those objectives and loss of values from wildfires, insect and disease epidemics, invasive species, and climate change are being experienced by all landowners.

To make measurable and effective progress in addressing the vulnerability of forests and water resources to these threats, Secretary Vilsack's "all-lands" approach to restoration requires the involvement and support of many partners, including States, tribes, and willing private forest land owners. Examples of this approach already in place are the many Community Wildfire Protection Plans collaboratively developed and implemented across all ownerships throughout the country.

The Forest Service leadership is developing a response to implement Secretary Vilsack's all-lands approach to restoring priority landscapes. The Forest Service's State and Private Forestry and Research and Development programs have been providing valuable support to private landowners since the 1920s. Both programs offer to landowners the best available science and technology in silviculture, forest pest management, fire and fuels management, wood technology and marketing, and other key information and support services, including funding of land management activities through the States.

Many of the issues related to wildland restoration, like climate change, are not bounded by who owns the land. We engage our partners to address common conservation goals. There are numerous ongoing efforts at both national and local levels:

- The Congress has provided the Forest Service with many tools, like the Collaborative Forest Landscape Restoration Program and the Healthy Forests Restoration Act, that will help us work more effectively across boundaries to achieve common objectives. The Food, Conservation, and Energy Act of 2008 (Farm Bill) also provides programs like the Forest Stewardship Program which helps private landowners achieve their objectives to sustain the health of private forested lands.
- Through our State and Private Forestry programs, and new authorities provided in the Farm Bill we are currently working with state partners to assess the condition and health of forest lands. These assessments will help the Forest Service and our partners identify landscapes that have priority restoration and conservation needs. These State Forest Resource Assessment and Strategies will be completed and submitted to the Secretary of Agriculture by June, 2010 We also engage in active partnerships to offer technical and financial assistance to rural forest landowners and private conservation groups, and to communities concerned about forests and open space in urban areas.
- The Forest Service is developing a strategic framework to guide the integration of climate change into the programs, policies, processes, and partnerships of the agency. I have asked our field leadership to apply this guidance in development of broad level, integrated landscape conservation strategies that focus on water and water-related services in light of climate change. Concurrently, we will work with state and local partners to assure that our approach is effective in achieving partner objectives on landscapes that cross multiple ownerships.

The cross-boundary coalitions that we build through these efforts will help us restore our wildlands in ways that achieve national broad-scale restoration objectives.

APPENDIX II

Additional Material Submitted for the Record

STATEMENT OF H. STERLING BURNETT, PH.D., SENIOR FELLOW, NATIONAL CENTER FOR POLICY ANALYSIS

Chairman Wyden, Ranking Member Barrasso, and other members of the subcommittee thank you for allowing me the opportunity to testify today. I represent the National Center for Policy Analysis (NCPA) a nonprofit, nonpartisan public policy research organization dedicated to developing and promoting private alternatives to government regulation and control, solving problems by relying on the strength of a competitive, entrepreneurial private sector.

Global warming is a reality. But whether it is a serious problem—and whether emissions of carbon dioxide (CO_2) and other greenhouse gases from human fossil fuel use are the principal cause—are uncertain. The current debate over the U. S. response to climate change centers around greenhouse gas emissions reduction policies, which are likely to impose substantially higher costs to society than global warming might.

The question remains; what should be done about the threat of global warming? Unfortunately, many proposals—including mandatory limits on CO_2 emissions—would be much more costly to society than the danger it seeks to avert. Fortunately, there are policies that could be adopted that are desirable in their own right and are commendable, even if there were no threat of global warming. I outlined several of these policies in a report called 10 Cool Global Warming Policies that was published by the NCPA this past June. These policies would reduce greenhouse gas emissions, increase energy efficiency, reduce harms associated with global warming or increase the world's capabilities to deal with climate-change-associated problems. One of these policies is an alternative forest management strategy that, among other things, can reduce wildfires and increase forest health.

Forests are carbon sinks: As trees grow they remove carbon dioxide from the atmosphere and store it in their trunks, limbs and roots. In addition, forest soils, made up of dead organic matter built up over time, store a large amount of carbon. The canopy provided by densely packed tropical and temperate forests slow the decay of fallen leaves and other organic matter, slowing the release of carbon and facilitating its incorporation into the soil.

A 40-year study of African, Asian and South American tropical forests found that each year tropical forests absorb as much as 18 percent of all the CO_2 emitted by burning fossil fuels. Temperate forests in the United States also absorb and store carbon. In 2004, the Environmental Protection Agency (EPA) estimated that forests sequestered 10.6 percent of the CO_2 released by the combustion of fossil fuels, with urban trees absorbing another 1.5 percent. Other research indicates that U.S. forests may sequester as much as 40 percent of U.S. human greenhouse gas emissions.

FOREST FIRES ARE A GROWING CLIMATE CONCERN

Unfortunately, poor forest management in the United States and other countries contributes to wildfires, which directly add carbon to the atmosphere and reduce the amount of CO_2 absorbed by forests. For instance:

- Wildfires in the United States release about 290 million metric tons of CO_2 into the atmosphere every year—equaling as much as 6 percent of the nation's annual emissions from burning fossil fuels.
- Pine beetle infestations have killed so many trees in Western Canada that they have contributed to a rise in large wildfires, turning Canadian forests from a net carbon sink that absorbs 55 million tons of CO_2 per year into a net emitter of up to 245 million tons annually.
- The Australian government calculated that wildfires in 2003 released more than 190 million tons of CO_2; accounting for one-third of the country's total

emissions, and it found that fires in 2006 and 2007 released an additional 360 million tons of CO_2.
- In terms of total CO_2 emissions, Indonesia is the third-largest emitter worldwide due largely to its annual wildfires—which emit nearly five times as much as its energy, agriculture and waste sectors combined.

HOW GOVERNMENT OWNERSHIP CONTRIBUTES TO FOREST FIRES

Large-scale forest fires are primarily the result of poor management of publicly owned forests. Federal mismanagement of U.S. forests has increased the number, size and cost of wildfires over the past decade. Historically, the national forests have been logged to provide lumber for commercial activities, to prevent wildfires and to promote forest recreation, species protection and land management. In recent decades, political pressure and lawsuits from environmental lobbyists prevented or delayed both commercial and salvage logging, turning much of our national forests into tinderboxes.

POLICY RECOMMENDATIONS

Changing the management structure of national forests could enhance the quality and value of these lands.

Privatizing the forests

The private sector currently preserves, protects and promotes many historically important properties and manages the majority of the country's forests and rangelands in ways that promote environmental quality and benefit the owners and the public. The United States can safely and perhaps profitably sell some of the hundreds of millions of acres of national forests for market value, giving the owners of adjacent properties priority for ownership.

Possible buyers include forest product companies, sportsmen's clubs and environmental groups. While these lands will no longer be public forests, many and perhaps most will be managed sustainably, in ways that protect their natural character and enhance their environmental and economic value because of the incentives of private ownership. Private companies do not have the general treasury to bail out money-losing operations and therefore seek to maintain the value of their lands. Furthermore, privatizing public lands would increase the tax base in rural areas and reduce the strain on the federal budget.

Public versus Private Management

Private property owners have flexibility in managing their lands, whereas federal forest management is too often hampered by rigidity. For instance, when a wildfire struck near Storrie, Calif., in August 2000, more than 55,000 acres burned, mostly in the Plumas National Forest (28,000 acres) and Lassen National Forest (27,000 acres). About 3,200 acres of private forestland managed by W.M. Beaty and Associates also burned. However, the Forest Service and Beaty's responses couldn't have been more different. By 2001, Beaty foresters had:

- Reduced the chance of a future catastrophic wildfire by removing smaller dead trees and woody material—generating enough clean biomass to fuel 3,600 homes for a year.
- Harvested larger dead trees suitable for lumber processing—amounting to 64.5 million board feet, enough to build 4,300 homes.
- Spent millions of dollars to reforest the burned land, planting nearly one million seedlings of seven different tree species.

By contrast:

- The Forest Service removed dead trees and other fuels from only 1,206 acres and replanted 230 acres in the Lassen National Forest.
- In the Plumas National Forest, the Forest Service was prevented from removing dead trees and reforested only 181 acres.

Private forest owners are not hindered by bureaucratic federal rules requiring multiple studies, public hearings, comment periods and court challenges. Thus, they are better able to prevent infestations and respond quickly to disease outbreaks. Promptly removing dead and dying timber can prevent infestations from spreading to other areas and prevent potentially catastrophic fires. Private companies keep the number of trees per acre at an optimal level. This reduces fire hazards and lets sunlight reach the forest floor, which helps re-growth and biodiversity.

Alternatives to Outright Privatization

For political reasons, it may be impossible to sell certain national forests, but there are various mechanisms or institutional arrangements that would confer many of the benefits of ownership without removing land entirely from public control.

For instance, following a suggestion by economists Richard Stroup and John Baden, Congress could establish Wilderness Endowment Boards to own and manage national forests lands. These government-chartered, nonprofit entities, whose board members would be approved by Congress, would have a narrowly defined fiduciary duty to protect and enhance the natural values of the land under their charge. Activities such as oil and gas production, commercial hunting and other resource production could enhance forests without hurting the environment; such is the case with properties managed by the Audubon Society and the Nature Conservancy.

Each individual board would decide how to balance use, recreational access and strict "off-limits" preservation, bound only by their understanding of what is necessary to preserve and enhance the land while generating the revenues necessary to manage it.

Reintroducing Competition

Public lands retained by the federal government could still receive some of the environmental benefits of private ownership if federal, state and local governments competed for control of these lands within the public system. For example, teams of experts from federal and state agencies, environmental organizations and the timber industry in Montana and Minnesota compared the environmental effects of state and federal forest management practices. They all concluded that state foresters better protected watersheds and waterways from the impacts of logging and other activities:

- In Minnesota, 90 percent of county lands had the highest compliance rate with "best management practices" for protecting water quality; federal forests had a slightly lower compliance rate at 87 percent.
- In Montana, 99 percent of the watersheds in state forests were protected from all impacts from logging, compared to 92 percent in federal forests.

Congress could allow any state or county that demonstrates superior economic and environmental performance to take over the management of the national forests within their state or area. Congress could give fixed but declining block grants during a transition period to the forestry agencies that apply and allow them to retain any revenues generated. The program should be allowed to run for several years so state and county foresters could counteract the effects of federal mismanagement.

At the end of the trial, states and counties that have improved a forest's economic and environmental performance could be granted the forests outright and federal payments ended. If forests have not improved, they could be returned to federal control and new management experiments implemented. This program would provide Forest Service managers with an incentive to improve performance or risk losing control over the lands.

WHY IS THIS A NO-REGRETS POLICY?

Any of the management regimes suggested above should decrease the size, intensity and frequency of wildfires, meaning less CO_2 will be pumped into the atmosphere each year and more carbon stored. Also, where there are currently more dead or dying trees or in burnt-over areas, trees will be replanted at a more rapid rate, increasing the carbon uptake of the nation's forests.

When pest infestations and fires do occur, the incentives for the new "owners" will be to help the forest recover as soon as possible in order to help wildlife recover, reduce soil erosion and stream destruction, restart natural ecological cycle and/ or make a profit.

Lastly, what about international forests? Despite the various legal systems and property rights regimes around the world, all forests should benefit from a no-regrets solution suggested in the paper mentioned previously: the widespread adoption of agricultural biotechnological innovations. Scientists are genetically engineering trees that grow faster and can store carbon at a higher rate than existing varieties. Such trees can be planted in forests where commercial timber producers are operating and in tropical forests previously lost to slash-and-burn agriculture. In addition, the adoption of new biotech crops that increase yields, improve nutrition and/ or reduce the need for such inputs as fertilizers should also reduce stress on tropical forests by reducing the need of farmers to move from one forest plot to the next to maintain annual production.

STATEMENT OF DAVID MOULTON, THE WILDERNESS SOCIETY

Thank you Chairman Wyden and Ranking Member Barrasso for this opportunity to address our concerns regarding the use of offsets on public lands. The Wilderness Society shares your concern for maintaining the health of our public lands in the face of global warming. America's public lands—some 635 million acres of land and 150,000 square miles of protected waters—are a legacy we hold in trust for generations to come. Global warming poses an unprecedented threat to the nation's iconic landscapes—our national parks, forests, wilderness areas, desert lands managed by the Bureau of Land Management, and wildlife refuges. At the same time, our country's parks and other public lands offer one of our best hopes for sustaining the plants, animals, birds, clean water and air, and recreational opportunities that are important to our heritage. They store carbon and provide large core protected areas that will be essential in adapting to a changing climate. These lands also provide critical services for our communities, including filtering the air we breathe and the water we drink, and play important roles in our nation's economy. Protecting these natural places is more important now than ever.

You have asked about the advisability of authorizing private carbon offset projects on land owned by the American public.

The Wilderness Society is not opposed to offsets in principle. Private offsets markets, if well-designed and well-regulated, could become a powerful tool for steering resources into land protection. However, we believe that extending this powerful tool into the arena of federal land management raises numerous unexamined issues that need to be thoroughly vetted and understood before moving aggressively in such a direction.

We are aware of the limited offset experiments that have already been undertaken by the Fish and Wildlife Service and the Forest Service. It is important to understand that this experience has been gained in the unregulated voluntary carbon market. Much of what has enabled those projects to go forward would not be allowed in a regulated carbon market because it would not meet standards of additionality, permanence or measurement rigor that will be needed to keep offsets from undermining emissions targets.

At the same time, these early experiments have demonstrated the willingness of private parties to supplement public appropriations in return for the right to carbon credits hosted on public lands. It is apparent that if offsets on public lands are allowed, they could become major sources of new revenue for resource-starved public agencies. It is also apparent that they could entangle public land managers and agencies in potential liability associated with enforcement intended to maintain the integrity of a regulated carbon offsets market.

Here is a list of the issues that we believe your subcommittee would benefit from examining in detail:

1. Effect on the cap on emissions.—Offsets on public lands expand the availability of offsets generally. Offsets are seen as an economically efficient method of accomplishing what otherwise might be a direct reduction in emissions. But their viability in a mandatory cap-and-trade regime remains to be demonstrated. We believe that the Subcommittee should seek an analysis from EPA regarding the pros and cons of expanding the offsets playing field in this unprecedented way to assure itself that it is not undermining the emissions caps.

2. Effect on private land protection.—Offsets undertaken on public lands could become a substitute for offsets on private lands, especially if having a public agency on one side of the deal is seen as providing an imprimatur in the marketplace. This raises the prospect of reducing the incentive to protect vulnerable private parcels. Adjacent private land might have been saved from conversion by a carbon offset project, but now is not.

3. Effect on the private carbon offsets market.—Flooding the market with offsets on public lands could impact the price of offsets generally, leading to less private land protection overall.

4. Lack of additionality.—Our public lands are already managed under laws that require that their health be maintained. Thus it seems difficult to meet the requirement of a regulated offsets market that the carbon sequestered through reforestation of certain acres, for example, would not have occurred anyway under prudent public land management. Indeed, to the extent that the project occurs on land already prioritized by land managers for reforestation, it would seem that many offset projects would be sited where the next dollar of appropriations would have been spent anyway. This lack of additionality has not seemed to matter in the voluntary market, but it will matter a great deal in the mandatory market.

5. Lack of permanence.—Most of the contracts undertaken in the voluntary market to date by the Fish and Wildlife Service have involved durations of 50 years or less. In the mandatory market, this is insufficient to achieve the level of "permanence" that justifies allowing a polluter to buy an offset.

6. Impact on appropriations.—The perceived increase in resources available for reforestation or wetlands restoration from these contracts could become illusory if the appropriations committees simply reduce public appropriations by the amount attributable to this new private source. The financial benefit to the agency would be wiped out.

7. Impact on Management Flexibility.—Forest Service Chief Tidwell has stressed in his testimony the inadvisability of managing a public forest only for carbon. Instead, carbon storage should be the natural byproduct of managing for the longterm health of the forest. Offsets contracts with private parties run directly counter to this prudent approach. Climate change implies the need to change management techniques over time. Offset contracts lock in the preservation of a carbon sequestration in a particular place as part of a mandatory compliance regime. The potential for these two tensions to become irreconcilable over time seems obvious. As your public witness, Dr. Beverly Law, has stated "Federal lands should be managed for the public interest of carbon sequestration, not revenue from carbon credits."

8. Legal concerns.—Various solicitors' offices have issued varied legal interpretations regarding proposals to have the managers of our public lands bind themselves to a contract with a private sequestration project developer in the voluntary carbon market. In any event, these opinions will have to be rewritten once the compliance market begins because the compliance market will create liability, enforcement and management issues not present in the voluntary market.

9. Use of offsets contract revenues.—Should revenues flowing from efforts to mitigate climate change emissions be spent only on mitigating climate change emissions? The agencies have huge climate adaptation needs which would be directly related to the purposes of climate legislation. On the other hand, diverting the money to non-climate related activities within the relevant agency, such as regular operations and maintenance, or outside the agency itself, would potentially undermine the climate purposes of the revenues.

For all these reasons, The Wilderness Society believes that it would be preferable to provide direct funding for carbon sequestration activities on the public lands through non-offset mechanisms. The pending climate bills include a Natural Resources Adaptation title which would supplement agency budgets to accomplish adaptation purposes, much of which will have major sequestration benefits even if not undertaken solely for that purpose. In addition, Senator Stabenow has proposed a Carbon Conservation Program outside of the offsets market that could provide resources to public land managers to protect sequestration value without becoming entangled in long-term contracts with individual private carbon projects. As Dr. Beverly Law has testified "To manage federal lands in the public interest of carbon sequestration, we should strive to preserve mature and old forests to avoid losses of carbon associated with harvest. Many of the mature and old forests are on public lands, so they are uniquely positioned to act as carbon reserves." Non-offsets funding from the climate bill could and should be used to support this type of carbon storage on public lands.

Finally, let me suggest that one model for taking advantage of the offsets market that could be viewed as a middle ground was developed by the Fish and Wildlife Service and The Conservation Fund for the Theodore Roosevelt NWR in Mississippi. Agricultural land was reforested adjacent to the refuge according to native species specifications provided by the FWS. The carbon credits were sold into the voluntary market. The proceeds were used to facilitate not just the project itself, but also the conveyance of title to the USFWS after the restoration work is complete. Note that the offsets were done on private land, not public. The carbon encumbrance was ultimately conveyed with the land, so many of the concerns expressed above would still apply, but the critical new element of this model is that the taxpayer received an expansion of protected acreage. In contrast, most of the other experiments with offsets on public lands have involved no such addition to the amount of acreage protected from conversion.

Thank you for this opportunity to place this information in the record of your hearing.

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