Testimony of
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before the Senate Committee on Energy and Natural Resources
on Scientific Assessment of Effects of Climate Change on Wildfire

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1. Introduction

Chairman Bingaman, Ranking Member Domenici, and members of the Senate Committee on Energy and Natural Resources. Thank you for the opportunity to give testimony on scientific assessments of the impacts of global climate change on wildfire activity in the United States. My name is John A. Helms, Professor Emeritus of Forestry at the University of California Berkeley where I served as Head of the Department of Forestry and Resource Management. I am here today representing the Society of American Foresters for which I served as President in 2005. The Society has 15,000 members who are forest managers, consultants, academics, and researchers and promotes sustainable forest management for balanced and diverse values.

2. Likely Magnitude of Climate Change

This topic has been discussed at previous hearings, so I will not elaborate here. However, since there is a direct relation between climate and forests, and between the structure of forests and wildfire, it is important to understand the likely magnitude of changed climate.

Due to the complexity of General Circulation Models there is considerable uncertainty regarding the precise changes in climate. However, there is general agreement that temperatures will increase 1-4°C in the next century resulting in less snow, more heat-absorbing exposed ground and sea water, which lead to less reflectance or albedo and provide positive feedback. On the other hand, there is continuing uncertainty regarding the extent to which changes in clouds and precipitation patterns may ameliorate increased temperatures. Average temperatures have already changed several degrees especially in northern latitudes. Maritime climates are already becoming wetter and interior of continents drier. Glaciers and ice sheets are diminishing.

3. Effect of Climate Change on Forest Ecosystems

Throughout millennia, climate has been the principle determinant of vegetation distribution throughout the world. Animal and plant species are in a constant state of flux -- continuously adapting, changing distribution, evolving, and becoming extinct. At a finer scale, forests have considerable adaptive capacity and can, for example, grow well on both north- and south-facing slopes that have several degrees difference in climate.

Scientific literature clearly documents changes in growing season, phenology, and modified distribution of animals, plants, and insects. Of particular concern is the extent to which likely increases in temperature will cause changes in species distribution, how much climate changes are being affected by human activities, and whether the rate of change can be mitigated.

Projections of vegetation response to climate change are imprecise due to differences in model assumptions on temperature change, temporal patterns of rainfall, and likely responses of species to these changes. However, in general, effects of climate change are more likely to be seen in northern latitudes with loss of meadows, conversion of forest to grassland, and tree invasion into areas that were previously too cold. Forests are expected to move north in latitude and upward in elevation. Pine forests at low elevation are likely to be replaced by woodlands and grasslands. These shifts in biome boundaries are expected to be large. It has been estimated that a temperature change of +3.5°C in the Rocky Mountain zone is equivalent to vegetation habitat moving 2,000 feet up slope or 200 miles further north (Ryan 2003).

Climate change will have considerable effects on forest growth, which may increase or decrease depending on tree age, species, site quality, and location. Within a given forest there will be changes in ecosystem structure due to changes in species interaction and competitiveness. In general, climate change is expected to lower productivity in the west, and Alaska with higher productivity in the Northeast, Lake States, and parts of the Southeast.

Carbon dioxide in the atmosphere can also limit growth. Experimentally increasing atmospheric levels of CO_2 have commonly shown that tree growth increases up to 20 percent on fertile sites. Growth declines over time since other factors such as nutrient availability or water then become limiting. Interestingly, forest growth has increased in many areas of the world due to added nitrogen from industrial pollution, which further complicates analyses of tree growth responses to climate change.

As forests are placed under increased temperature and water stress the most observable feature will be loss of vigor and increased mortality as species are no longer able to survive in the changed climate. This decline in health and increased mortality and decay will add substantially to carbon emissions -- equivalent in some instances to that due to deforestation. As species die and are replaced, soils will be exposed, become warmer and subject to erosion, again releasing substantial amounts of carbon to the atmosphere and compounding climate change effects.

Already North American forests are showing evidence of stress and apparent effects of climate change. A prime example is the mountain pine beetle epidemic in lodgepole pine forests of British Columbia. Although this beetle is endemic and, overall, is a positive and useful component in the functioning of natural ecosystems, it appears that unusually hot, dry summers and mild winters have increased beetle attacks and in 2006 about 23 million acres were affected (BC Ministry of Forests and Range 2007). Of particular concern is that, due to climate change, the mountain pine beetle is likely to spread to Jack pine forests in Alberta thus causing potential for increased wildfire.

A second example is pinyon pine in the Southwest where in some states dieoff has reached 90 percent. The USDA Forest Service estimated in 2003 that about 3.8 million acres over six states were affected. Here again, the precipitous decline in pinyon pine is associated with climate change and drought. It seems that the winters have not been sufficiently cold to restrict build-up in bark beetle populations. In addition, the extensive tree mortality has been accompanied by a major decline of pinyon jays and other ecosystem changes. In evaluating the effects of climate change on forests, therefore, it appears that the area impacted by insects are greater than that affected by wildfire.

A third cause of catastrophic change in forest ecosystems is hurricanes. Increasing sea water temperature in the Gulf of Mexico is expected to cause increased hurricane frequency and severity. Again, in the context of climate change, the sudden removal of forests by hurricanes is likely to increase opportunities for species to invade that are more adapted to warmer conditions.

4. Effect of Climate Change on Wildfires

Lightning-caused fires have always been a major component of forest ecosystems in the West. In addition, it is well documented that Native Americans used fire extensively in controlling game, regenerating desired plants, and for preventing surprise attacks from enemies. Prior to the 1800s, it has been estimated that Native Americans in California burned about 4.5 million acres of wildlands annually (Stephens et al. 2007). The National Interagency Fire Center estimates that during the period 1825-1918 there were seven fires that were 1-3 million acres in extent. Although these historic fires were very large, they probably differed from contemporary fires which are more intense, crown fires that result in stand replacement. This difference is primarily due to past harvesting, regeneration, and fire suppression practices that have resulted, especially on national forests, in stands having a high proportion of shade-tolerant species, younger age classes, and higher density of smaller trees than were characteristic of forests prior to settlement. Similarly, major changes have occurred in plant species and structure of the nation's grasslands due to grazing.

The National Interagency Fire Center also reports that humans have had a major role in fire ignitions. In 2006, there were 96,380 wildfires of which 83 percent were human-caused and human ignitions exceeded lightning ignition in five out of 11 regions. Expressed in terms of area, 9.8 million acres burned in 2006 of which 45 percent were human-caused with human ignitions exceeding lightning ignitions in eight out of 11 regions.

Clearly, then, it will be difficult to separate the effects of climate change on wildfire occurrence from the effects of rapidly increasing human populations in forested areas and the change in forest conditions due to past forestry, urbanization, and other activities.

Never-the-less, weather is fundamentally important in influencing the incidence and severity of wildfires, which due to climate change are expected to increase in frequency and intensity (Keene et al. 1997, USFS PNW 2004). One estimate is that wildfires will increase 50 percent by 2050 and double by 2100, with estimates varying depending on the climate models used (Liu et al. 2004).

Higher temperatures and low humidity are important because they increase the drying rate of fuels and increase the likelihood of drought and length of fire seasons. Increased wind increases the rate of fire spread. And climate change will likely increase the incidence of thunderstorms and lighting. However, some areas will no doubt experience decreased fire frequency. Areas of increased precipitation may moderate fire behavior, but greater vegetation growth may also add to wildfire potential. Further complicating predictions is that wildfires emit considerable quantities of particulates that result in short-term cooling by reducing solar heating. At the same time, wildfires exacerbate climate change by emitting greenhouse gases to the atmosphere. In 2005, wildfires in the U.S. resulted in 126.4 Tg CO_2 (140 million tons) being emitted to the atmosphere (EPA 2007).

Although interactions among climate change, vegetation, human actions, forest conditions, and insect and disease vectors are highly complex and uncertain, wildfires will certainly be a major factor accelerating species change and changes in plant distribution.

5. Responsibility to Mitigate through forest management

Since incidence and severity of wildfires are to a large extent influenced by human ignitions and forest conditions, it is important to consider the extent to which social sciences and forest management can contribute to both understanding and mitigating wildfire occurrence and intensity.

Monitoring climate change and forest conditions should be aimed at separating out the complex factors and interactions that result in wildfires. Since both growth and mortality on national forests greatly exceeds harvest resulting in a build-up of fuels, it would be prudent to consider treatments and incentives aimed at fuel reduction and using excess biomass for societally-needed products and energy production. The aim of such treatments on national forests would be to create, as far as practicable, forest densities more suited to current societal usage so that forests can better withstand the inevitable increase in wildfires that climate change will cause.

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