To The Honorable Congressman Mark Udall

December 8, 2005

Dear Congressman Udall,

Re.: Comments from Forest Scientists on Draft Bark Beetle Legislation

This letter forms the third letter regarding your efforts to design legislation that focuses on forest insect populations in different forest types, and reflects a number of additions and changes to better reflect the most current state of knowledge.

As is emphasized in the draft legislation, extensive outbreaks of tree-killing forest insects are being seen in many parts of the West. In combination with recent high-intensity forest fires, these insect outbreaks are raising concerns about the health of our forests and our ability to deal with these issues. The visual impact of a high-severity bark beetle outbreak or fire does give the impression that we are in a crisis situation and that we must take dramatic steps to deal with the emergency. However, recent scientific research on the ecology of forest disturbances, by scientists in Colorado and elsewhere, leads us to interpret these recent events in a much more nuanced manner.

Because we believe that responses to insect outbreaks and fires will not be effective unless those responses are consistent with the basic ecology of the affected forest ecosystems, we are writing this letter to inform you of the current state of knowledge about forest insects and fires in Colorado and other parts of western North America. The authors all have extensive research experience in forest ecology, with particular expertise in the ecology of natural disturbances. The current draft legislation being developed by Representatives Udall and Salazar contains many statements, either explicit or implied, about the ecology and impacts of insect outbreaks and fires. Although some of these statements are consistent with our current scientific understanding, many others are based on untested assumptions or on older literature that has subsequently been superceded by more recent and more rigorous studies. Therefore, in this letter we address the science of forest insects and fires in three levels of detail. First, we provide a very brief summary of our key points in the paragraph below. Then we elaborate on these points in a series of bulleted statements (page 3). Finally, we provide a detailed summary of the science behind each of the bulleted statements, including references to the peer-reviewed scientific literature (page 5).

In brief, we wish to emphasize that there is *no* evidence to support the idea that the levels of bark beetle activity in Rocky Mountain lodgepole pine and spruce-fir forests are unnaturally high (though the intensity of current outbreaks may be unprecedented in some other forest types, e.g., whitebark pine forests in the northern Rockies). Nor is there any rigorous scientific evidence that bark beetle outbreaks in lodgepole pine and spruce-fir forests increase the risk of crown fire, though there is some evidence that outbreaks may modify fire characteristics. In these kinds of forest ecosystems, weather conditions have a far greater influence on the probability of crown fire than do fuel loadings, whether those fuels originated from insect-caused mortality, blow-down, or other causes. This is not to say that high-intensity fires will not occur in these forests. On the contrary, high-intensity crown fires are the *normal* type of fire behavior in lodgepole pine and spruce-fir forests, whether affected by insect outbreaks or not, and such fires have shaped these ecosystems for thousands of years. Additionally, even though bark beetle outbreaks do often kill a large number of trees, forests almost always recover. For every square foot of canopy opened by bark beetles, new growth will emerge, creating a more varied forest mosaic and habitat for wildlife. Thus, the idea that the current outbreaks constitute an ecological "emergency" is *not* supported by the science in most situations.

Finally, it is widely agreed among entomologists that *no* treatment can stop the course of an insect outbreak once the population has shifted into an eruptive phase of population growth. Nevertheless, a number of things *can* be done to reduce the probability of a local population erupting into an uncontrollable outbreak. We note, however, that preventive measures such as forest thinning need not be carried out in an "emergency" framework, but can be a part of a long-term program of good forest stewardship. We therefore suggest that the most effective legislative response to the current insect outbreaks across the West may be to implement programs that will facilitate good long-term forest stewardship -- rather than responding in a crisis mode to ecological events that in most cases do *not* actually represent "emergencies" from an ecological perspective. Several recent books and articles have addressed the question of managing natural forest disturbances in ways that emulate these vital natural processes while providing necessary goods and services for human communities (e.g., Kohm and Franklin, *Creating a Forestry for the 21st Century*; Perera et al., *Emulating Natural Forest Landscape Disturbances*; Friederici, *Ecological Restoration of Southwestern Ponderosa Pine Forests*). We will be most happy to continue this conversation, to share with you pertinent insights and suggestions from these recent publications on how to manage fires and insects in ecologically sound ways.

Thank you again, for the opportunity to provide input. Because scientific information is not always easy to obtain, we invite you to share this information with other interested parties. If asked, we will share this information also. If you would like further information, please call Jessica Clement (719) 486 1420, who is coordinating this collaborative effort.

Yours sincerely,

(The undersigned submit this document as their professional opinions and not those of their respective institutions.)

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In reference to the proposed "Rocky Mountain FIRES Act", we elaborate below on our key points, and then provide additional scientific detail in the section that follows this list:

1. The dense forest stands that we see in the West today are **not all** the unnatural consequence of past fire suppression and/or lack of timber harvesting. Some forest types, e.g., ponderosa pine forests in parts of Arizona and New Mexico, have indeed been altered substantially by past human activities. However, most lodgepole pine and spruce-fir forests in the Rocky Mountains remain within their historical range of variability with respect to stand structure, density, and fire behavior (Section 1(b)(3)A, HFRA of 2003 Sec. 101 Definitions).

2. Wildfires in dense forest stands are **not all** unusually severe as a result of either fire suppression and/or lack of timber harvesting. Again, different forest types are different. Some recent wildfires in ponderosa pine forests of Arizona and New Mexico have been of unprecedented severity, but recent fires in lodgepole pine and spruce-fir forests in the Rocky Mountains have behaved just as fires have always behaved in these types of forests (Section 1(b) (2) and (3)A).

3. Drought **does** make trees more susceptible to insects and to fire. Indeed, the combination of drought and unusually high temperatures (especially the warm minimum temperatures of the past decade) is probably the most important reason for the widespread insect outbreaks now being seen across the West (Section 1 (b) (3) B).

4. Large insect outbreaks do **not** constitute an 'Insect Emergency' in all or even most situations. Insects, and periodic insect outbreaks, are normal components of forest ecosystems. The trees and the insects have co-existed for thousands of years (Section 3 (a)(3) and (4) and Section 3(d)(2)).

5. Forests with large amounts of insects and dead trees are **not** necessarily unhealthy. Dead trees and dead wood are normal constituents of any healthy forest ecosystem, and quantities naturally fluctuate over time (Section 3 (a)(3)).

6. There is no substantial evidence that the spread of insect outbreaks in lodgepole pine and spruce fir can be effectively reduced once the population has shifted into an eruptive phase of population growth by thinning. At this stage, the insects are so numerous that they can overwhelm the defenses of even the healthiest trees. However, prior to an outbreak, treatments aimed at making trees more resistant to insects may reduce the probability of insect populations moving into an eruptive phase of population growth (Concern #2, Section 3 (a)(3) and Section 3(d)(2)(a)).

7. Removing the insect-killed trees and thinning dense stands will **not** restore forests to a more natural and healthy condition. Again, dead wood is a normal component of a healthy forest ecosystem. The dead trees provide habitat for a variety of birds and other wildlife, while they still stand and after they fall, and the decomposing wood enhances soil fertility and water-holding capacity (Section 3 (a)(3) and Section 3(d)(2)(a).

8. The process of removing dead trees and thinning dense stands **will** run the risk of impairing other values of the forest. For example, roads may facilitate invasion by weeds and may increase human impacts on wildlife by providing access to previously remote areas. In addition, many people prefer forests in which human alterations have been minimal.

9. Outbreaks of mountain pine beetles and other forest insects do **not** necessarily lead to increased risks of unusually severe wildfires. This is especially true in forests where high-intensity crown fires are the *normal* type of fire behavior, whether affected by insect outbreaks or not, e.g., in lodgepole pine and spruce-fir forests in the Rocky Mountains (Concern #2, Explanation of Bill, Section 1 (b)(2), Section 2(d) Section 3(a)(4)).

10. Harvesting trees **cannot** effectively reduce the risk of severe wildfires in ecosystems where fire frequency and fire behavior are controlled mainly by weather conditions, *not* by fuels, e.g., in lodgepole pine and spruce-fir forests in the Rocky Mountains (Concern #2, Section 3(c)).

11. The rapid human population growth in forested areas of the West **has** increased the risk of loss or damage due to wildfire (Section 1 (b) (3) C).

12. Although most local logging industries in the West do not have the capacity to harvest all of the dead material now available as a result of recent insect outbreaks, some form of federal subsidy would be helpful **if warranted**. We caution that public opinion *does* favor treatments for the sake of truly healthy forests and protection of lives and property, but *not* just for expanded economic benefits. We suggest reviewing social science literature for a clearer understanding of public values on this subject, as well as a definition of "healthy".

13. Insect-killed trees **do** need to be harvested soon after death if their economic value is to be optimized.

In the sections below, we provide more thorough documentation of the science behind each of our 13 bulleted points above. Please use the numbers in front of each point as a reference. These points have been organized as follows: First, we evaluate ten ideas in the draft legislation, either stated explicitly or implied, that are **inconsistent** with our best scientific understanding. Then, we address three ideas in the draft legislation that **are supported** at least in part by the science.

IDEAS IN PROPOSED LEGISLATION THAT SHOULD BE CHANGED *AS NOTED* TO ACCURATELY REFLECT THE CURRENT SCIENCE

1. The dense forest stands that we see in the West today are ***not all*** *the unnatural consequence of past fire suppression and lack of timber harvesting.*

Not all dense stands are the unnatural consequence of past fire suppression. It is necessary to distinguish among different forest types in considering the effects of past fire suppression on current stand density.

Ponderosa Pine: Dry, low elevation ponderosa pine stands in the Rockies generally adhere to the southwestern ponderosa pine model, where suppression of historically frequent low-severity fires has contributed to unnaturally dense stands and increased fire severity (Covington and Moore 1994, Mast et al. 1999, Moore et al. 1999). Although fire suppression has contributed to very dense stands of southwestern ponderosa pine, previous grazing (Belsky and Blumenthal 1997, Savage and Swetnam 1990), high-grade logging (Kaufmann et al. 2000, Gruell et al. 1982), and climate (Mast et al. 1998) have also contributed.

The southwestern ponderosa pine model may not apply throughout moister, cooler forests at higher latitude and elevation, even though ponderosa pine may still dominate. For example, in moister ponderosa pine forests of the Colorado Front Range, tree-ring and other evidence demonstrates that the historic fire regime included both low-severity (i.e. surface fires that thin the forests) and high-severity fires (i.e. that kill canopy trees and often result in dense regeneration; Mast et al. 1998, Brown et al. 1999, Kaufmann et al. 2000, Veblen et al. 2000, Huckaby et al. 2001, Ehle and Baker 2003, Sherriff 2004). Less than 20% of the ponderosa pine zone in the northern Colorado Front Range appears to have historically experienced frequent, low-severity fires (Sherriff, 2004).

Lodgepole Pine: Dense stands are normal in lodgepole and other high-elevation forest types such as spruce-fir (Parker and Parker 1994, Kashian et al. 2005, Schoennagel et al. 2004). In these forests, fires occur relatively infrequently (on the order of centuries) and generally are crown fires that kill the majority of the trees, which contrasts with frequent surface fires of dry, low-elevation ponderosa pine forests that predominantly thin forests by killing primarily small, fire-intolerant trees. The effect of fire suppression has been minimal in these high-elevation forests, which are difficult to access for fire-fighting, especially prior to the 1950s. Furthermore, the length of the fire exclusion period (~50 years) is short relative to the fire return interval. As a consequence, exclusion has not significantly lengthened fire intervals, which is in marked contrast to frequent, low-severity fire regimes. The most important point, however, is that these forests were dense historically and they are dense today. High density in these forests is not related to fire suppression in any way, and is a natural feature of their ecology.

Both forest types: Timber harvesting (i.e. thinning) indeed decreases the density of forest stands in the near-term. However, research shows that past timber harvesting in ponderosa pine forests, for example, is responsible, in part, for the high densities we witness today (Kaufmann et al. 2000, Gruell et al. 1982). We caution that thinning or removal of dead and dying trees, when not followed by repeated prescribed burn treatments or repeated removal of small diameter trees, may ultimately promote the high tree densities the legislation intends to reduce. Thinning without the maintenance of repeated prescribed burns encourages new growth, in turn creating ladder fuels. Although prescribed burns reduce fine fuels in the short-term, they also contribute to subsequent dead fuels by killing understory trees, which can exceed pre-burn levels within a decade (Agee, 2003). Therefore, repeated or staged prescribed fire treatments are essential for maintaining lower forest densities, otherwise, thinning may facilitate dense tree establishment.

2. Wildfires in dense forest stands are ***not necessarily*** *unusually severe.*

Again we stress the importance of distinguishing among forest types. This statement is true, for example, in southwestern ponderosa pine, but is clearly not true in lodgepole pine or in spruce-fir. Even in the case of ponderosa pine forests in Colorado, not all areas follow the Southwestern pattern of increased stand densities following the reduction of fires associated with late 19th century grazing and 20th century fire suppression. For example, in the Colorado Front Range the ponderosa pine zone was characterized by an historic mixed-severity fire regime in which large areas were burned severely and regenerated to dense stands.

4. Large insect outbreaks do ***not*** *necessarily constitute an 'Insect Emergency'*

The term "insect emergency" suggests that insect outbreaks are unforeseen events that require rapid response. Insect outbreaks, even extensive ones that kill canopy trees over 100,000s of acres, however, are a natural component of forest systems in the Rocky Mountains and have been present for thousands of years (e.g., Swetnam and Lynch 1998, Lavoie 2001). Although recent climate has promoted increased populations of a number of forest insects, tree-ring studies document large, lethal outbreaks of bark beetles and spruce budworm prior to the mid-19th century (Veblen et al. 1991, Veblen et al. 1994, Swetnam and Lynch 1998, Eisenhart and Veblen 2001). Furthermore, research does not indicate that insect infestations necessarily promote unusually severe fires (see section 9), so a rapid silvicultural response does not appear warranted, while their effectiveness in reducing fire severity and home ignitability is questionable (see section 10).

The definition of insect emergency in the proposed legislation is, "an insect infestation in the Rocky Mountain region of an intensity that has caused affected Federal lands identified for hazardous fuel reduction treatments in a community wildfire protection plan to be in a condition class 3" (see definition of Condition Class 3 in the Healthy Forest Restoration Act of 2003). We know that these insects are native and that outbreaks have occurred extensively in lodgepole pine. We also know extensive outbreaks have happened in spruce-fir forests prior to 20th century climate change and fire suppression. However, the frequency of outbreaks is currently under investigation. Furthermore, although insects may affect the economic value of forest resources, they do not pose a threat to forest ecosystem components, as infestations are natural disturbance agents that play an important ecological role in Rocky Mountain forests. Widespread insect infestations, therefore, would not by the above definition necessarily define an insect emergency.

*5. Forests with large amounts of insects and dead trees are **not necessarily** unhealthy.*

The concept of forest "health" is ambiguous. Standing dead trees and fallen logs (coarse woody debris) play important roles in wildlife habitat, soil development, and nutrient cycling, and are a defining characteristic of old-growth forests. Salvage of dead and dying trees is inappropriate from an ecological standpoint, and the effect on reducing burn potential is questionable (unless fine fuels are also removed).

The issue of dead trees and forest "health" may be more an aesthetic issue than a scientific one. Dead trees are unattractive to many people, especially when those dead trees are abundant, and consequently property values may be reduced in areas affected by extensive insect outbreaks. Ecological education may modify aesthetic preferences somewhat, by pointing out that the insect outbreaks are normal forest events, that many trees will survive the outbreak and will grow faster, and that the dead trees will become less conspicuous over time as they fall and are surrounded by fast-growing young trees. E.g. in Lake County, thanks to the contributions of scientists in 2004, such scientific education is of significant help in creating a Community Wildfire Protection Plan because residents and stakeholders are receiving information that carries a high level confidence, in turn reducing conflicts (Romme, Regan and Clement, 2004).

6. Harvesting of trees (thinning or salvage) cannot effectively reduce the spread of insect outbreaks once the populations have shifted to an eruptive phase of population growth.

Harvest of large, old trees is unlikely to stay the spread of large insect outbreaks. Insects typically attack older, large-diameter trees. Large, (dead) trees are often the target (consequence) of insect attacks and are significant components of old growth stands. Although such treatments might successfully reduce the threat of insect attack at the stand level (Cole et al. 1976), spatially extensive outbreaks are not likely to respond at the landscape scale to salvage efforts as sufficient habitat and host trees will always be available in large forested landscapes. In general, only the underlying causes of the outbreak (primarily climatic conditions) are likely to effectively reduce the spread to insect outbreaks over large areas.

7. Removing the insect-killed trees and thinning dense stands will not restore forests to a more natural and healthy condition.

We would emphasize again the importance of distinguishing among forest types. Thinning may contribute to restoration in southwestern ponderosa pine, but not in spruce-fire or lodgepole pine forests. Removing dead trees, by itself, will do little or nothing to restore natural or "healthy" conditions, and probably impoverish these sites ecologically.

8. The process of removing dead trees and thinning dense stands will run the risk of impairing other values of the forest.

Other values to consider would be maintenance of "natural" forest structures and processes, protection of soils and water quality, preservation of species at risk from roads, exotic species invasion, fragmentation, and habitat alteration. For example, the pine marten requires large fallen logs especially in the winter. The three-toed woodpeckers feeds on bark beetles in dead and dying trees, and nests most successfully in areas of recent fire or beetle outbreak; withdrawing large dead trees may reduce habitat quality for these species.

However, timber harvest can be done in ways that minimize damage to these and other forest values. These ideas are developed in some detail, for example, in the recent books by Kohm and Franklin (1997, Creating a forestry for the 21st century), Friederici (2003, Ecological restoration of southwestern ponderosa pine forests) and Perera et al. (2004, Emulating natural forest landscape disturbances).

9. Outbreaks of mountain pine beetles and other forest insects ***do not necessarily*** *lead to increased risks of unusually severe wildfires*

Although this is commonly assumed to be true, there is little scientific evidence to support it, and substantial scientific evidence to contradict it. The few studies that have critically examined the connection between insect outbreaks and subsequent fire severity have found that the relationship is weak at best. The interactions between forest fires and bark beetles are complex and variable. Fire regimes vary substantially among the different forest cover types impacted by lethal insect outbreaks, and it is likely that the potential effects of insect outbreaks on subsequent fire risk also varies among cover types affected by the different insects.

Spruce beetle in subalpine spruce-fir forests. It is well established that in the subalpine forest types of spruce-fir, extensive fires are highly dependent on infrequent, severe droughts. Under those extreme drought conditions, the role of dead fuels from insect outbreaks appears to play a minor role if any in increasing fire risk. For example, following the 1940s spruce beetle outbreak that resulted in dead-standing trees over most of the subalpine zone of White River National Forest, there was no increase in the numbers of fires compared to unaffected subalpine forests (Bebi et al. 2003). Large fires did not occur in these forests until the 2002 fires which coincided with the most severe drought of the past 100 years. The 2002 fires in western Colorado affected extensive areas of spruce-fir and lodgepole pine forests that were previously affected by outbreaks of spruce beetle and of mountain pine beetle. Despite the expectation that these outbreaks (both the 1940s and the post-1998 outbreaks) would have led to an increased risk of severe fires, the forests that were affected by the outbreaks generally did not burn more extensively or more severely than forests that were not affected (Bigler et al. 2005 Ecology; Kulakowski and Veblen *unpublished manuscript*).

Mountain pine beetle outbreaks in lodgepole pine forests. It is widely believed or suggested that bark beetle outbreaks set the stage for subsequent severe forest fires because of increased fuel loads (e.g., Geizler et al. 1980, Schmid and Amman 1992, McCullough et al. 1998). Although this interpretation is intuitive, we have very few rigorous analyses of post-outbreak fire occurrence and fire severity, and these analyses suggest a complex pattern. Turner et al. (1999) found that the likelihood of crown fire in a lodgepole pine forest, 5-17 years after an extensive mountain pine beetle outbreak, was increased where beetle-caused tree mortality had been high (perhaps because the fallen trees created heavy fuel loads), but was reduced where beetle-caused mortality was only moderate (perhaps because the dead trees interrupted the horizontal continuity of the canopy).

Spruce budworm defoliation. Massive outbreaks of western spruce budworm affected the Douglas-fir forests of the northern Colorado Front Range in the late 1970s and 1980s but there is no evidence that they resulted in increased fire occurrence. Recent widespread fires in these forests were associated with the extreme drought of 1998-2002, so that if any increase in fire hazard potentially associated with insect outbreak did not have an effect until at least 25 years later under extreme weather conditions. In Ontario, Canada, Fleming et al. (2002) found a significant increase in probability of fire 3-9 years after an outbreak (perhaps because of increased vertical fuel continuity), but probability of fire was not continuously elevated after the outbreak. In British Columbia, Canada, Lynch and Moorcraft (2005) found a significant decrease in risk of forest fire for at least ten years following a spruce budworm outbreak.

*10. Harvesting trees can**not** effectively reduce the risk of severe wildfires in ecosystems where fire frequency and severity are controlled primarily by weather conditions, not by fuels.*

The truth or falseness of this statement depends entirely on the details of the harvest process and on the weather conditions at the time when a subsequent fire occurs. Harvesting trees typically involves the removal of large fuels (tree trunks) rather than smaller fuels (branches and needles) due to economic and logistical constraints. These smaller fuels contribute to ignition and spread of fire (e.g., to start a campfire one begins with tinder and kindling). Smaller surface and ladder fuels are important precursors to crown fire initiation (Agee and Skinner 2005). Hence, harvesting tree trunks has little effect on the risk of fire ignition or spread, while management of fine surface of ladder fuels (which is very time-consuming and expensive) has the greatest impact of fire spread and potential high-severity crown fire.

Most traditional harvesting techniques (including overstory removal and individual tree selection) do not effectively reduce fire severity under high and extreme fire weather conditions (Stephens and Moghaddas 2005), when wildfires are most likely to occur. Removal of small trees, and old-growth and early-successional stand structure, in fact, lower expected fire severity compared to traditional harvesting techniques (Stephens and Moghaddas 2005, Agee and Skinner 2005). In general, the abundance of surface fuels affects the chance of a crown fire occurring (Agee and Skinner 2005). For example, in the Hayman fire, prefire harvesting where residual fuels (i.e. small, non-merchantable fuels) were not removed, contributed to higher severity fire compared to unmodified areas, which has been observed following other wildfires (Omi and Martinson, 2002, Schoennagel et al. 2004).

In many cases, extreme fire weather can over-ride fuels effects (e.g., Hayman 2002, Yellowstone 1988, Routt National Forest 2002). In the Hayman fire, most fuel treatments had very little impact on the severity or direction of the fire during the extreme weather conditions of June 9th and 18th, when the majority of the area burned (Finney et al. 2003). In the 1988 Yellowstone fires, once fuels reached critical moisture levels, the spatial pattern of burning was largely controlled by weather (wind direction and velocity), rather than by fuels (Minshall et al.

1989, Turner et al. 1994). A study of the 2002 fires in Routt National Forest in Colorado found that salvage logging had no detectable influence on fire extent or severity during the extreme drought conditions (Kulakowski and Veblen *unpublished manuscript*).

In contrast to the variable effectiveness of harvesting, Firewise activities—the removal of flammable material (including wood roofs and decks, woodpiles and burnable vegetation) from the immediate vicinity of a home or other vulnerable structure—has been shown to be effective in protecting the structure from wildfire, especially under low- to moderate-weather conditions (Cohen 2000). Home ignitability, rather than spatially extensive wildland fuels, is the primary cause of property loss. For example, crown fires will not ignite wooden walls at distances greater than 40 meters away (Cohen 2000). Thinning forests up to 1-1/2 miles away from structures does not effectively reduce home ignitability in contrast to Fireswise activities, which may be the best strategy to protect lives and property. Altering extensive areas of forest fuels may be more expensive and actually less effective at protecting settlements. Furthermore, altering forest structure on a large scale through thinning may not promote either ecological restoration (see Section 3) or fire hazard reduction in high-elevation ecosystems in the Rocky Mountains (see examples of Yellowstone and Routt National Forest fires above).

IDEAS IN THE PROPOSED LEGISLATION FOR WHICH THERE IS SCIENTIFIC EVIDENCE

3. Drought makes trees more susceptible to insects and to fire.

This is true. The recent drought in the West has been severe, and anomalously high temperatures have also contributed to current insect outbreaks. These facts have been documented by Breshears et al. (PNAS 2005) and Logan et al. (Frontiers 2003).

11. The rapid human population growth in forested areas of the West has increased the risk of loss or damage due to wildfire.

This is certainly true. Between 1990 and 2000 the Colorado Front Range was one of the fastest growing regions in the country, increasing by over 250,000 people, or 53% (U.S. Census Bureau 2002). Much of this growth has occurred in rural areas and the wildland-urban interface, which may have contributed to the record cost of the 2002 wildfire season in Colorado, where the Hayman Fire, for example, burned over 600 structures and cost over $39 million in firefighting (USFS 2002b, Rocky Mountain Insurance Asso. 2002). The increased loss or damage of property due to wildfire cannot be attributed only to fire suppression, but also to rapid human population growth in forested areas in the Rocky Mountains.

12. Because most local logging industries in the West are struggling to compete in the global timber market, and do not have the capacity to harvest all of the dead material now available as a result of recent insect outbreaks, some form of federal subsidy is needed if tree harvest is to increase.

Harvesting of trees on national forests, in the sense of withdrawing timber from forests for solely economic gain, does not appear to be supported by social science studies on this subject (Shindler, List and Steel 1993; Shields, Martin, Martin and Haefele 2002). On the other hand, there is strong evidence that the American public supports treatments for the sake of keeping national forests "healthy" and for keeping buildings and lives safe from fire, contingent on a number factors such as impacts on wildlife and skills of forest practitioners (Winter, Vogt and Fried 2002; Shindler and Toman 2003; Kneeshaw, Vaske, Bright and Absher 2004). To this end, a skilled, local logging community could be instrumental by conducting treatments that contribute to ecologically sustainable forests, and to enable that logging community to be able to so on behalf of the American people.

13. Insect-killed trees need to be harvested soon after death if their economic value is to be optimized.

This is true. Within about a year the wood begins to deteriorate.

References

Agee, J. K., and C. N. Skinner. 2005. Basic principles of forest fuel reduction treatments. Forest Ecology and Management **211**:83-96.

Agee, J. K. 2003. Monitoring postfire tree mortality in mixed conifer forests of Crater Lake. Oregon. Natural Areas Journal **23**:114-120.

Bebi, P., D. Kulakowski, and T. T. Veblen. 2003. Interaction between fire and spruce beetles in a subalpine Rocky Mountain forest landscape. Ecology **84**:362-371.

Belsky, A., and D. Blumenthal. 1997. Effects of livestock grazing on stand dynamics and soils in upland forests of the interior West. Conservation Biology **11**:315-327.

Bigler, C., D. Kulakowski and T.T. Veblen. 2005. Multiple Disturbance Interactions and drought influence fire severity in Rocky Mountain subalpine forests. Ecology 86 (11) 3018-3029.

Brown, P. M., M. R. Kaufmann, and W. D. Shepperd. 1999. Long-term landscape patterns of past fire events in a montane ponderosa pine forest of central Colorado. Landscape Ecology **14**:513-532.

Cohen, J. 2000. Preventing disaster - Home ignitability in the wildland-urban interface. Journal of Forestry **98**:15-21.

Cole, W. E., and D. B. Cahill. 1976. Cutting strategies can reduce probabilities of mountain pine beetle epidemics in lodgepole pine. Journal of Forestry **74**:294-297.

Covington, W. W., and M. M. Moore. 1994. Southwestern ponderosa forest structure: changes since Euro-American settlement. Journal of Forestry **92**:39-47.

Ehle, D. S., and W. H. Baker. 2003. Disturbance and stand dynamics in ponderosa pine forests in Rocky Mountain National Park, USA. Ecological Monographs **73**:543-566.

Eisenhart, K. and T. T. Veblen. 2000. Dendrochronological identification of spruce bark beetle outbreaks in northwestern Colorado. Canadian Journal of Forest Research 30: 1788-98.

Finney, M. A., R. Bartlette, L. Bradshaw, K. Close, B. M. Collins, P. Gleason, W. M. Hao, P. Langowski, J. McGinely, C. W. McHugh, E. Martinson, P. N. Omi, W. Shepperd, and K. Zeller. 2003. Fire behavior, fuel treatments, and fire suppression on the Hayman Fire. Pages 59-96 *in* R. T. Graham, editor. Hayman Fire Case Study Analysis. U.S. Department of Agriculture, Forest Service, Rocky MountainResearch Station, Ogden, UT.

Fleming, R. A., J. Candau, and R. S. McAlpine. 2002. Landscape-scale analysis of interactions between insect defoliation and forest fire in central Canada. Climate Change 55:251-272.
Geizler, D. R., R. I. Gara, C. H. Driver, V. F. Gallucci, and R. E. Martin. 1980. Fire, fungi, and beetle influences on a lodgepole pine ecosystem of south-central Oregon. Oecologia 46:239-243.
Gruell, G. E., W. C. Schmidt, S. F. Arno, and W. J. Reich. 1982. Seventy years of vegetative change in a managed ponderosa pine forest in western Montana: Implications for resource management. GTR-INT-130, USDA Forest Service Intermountain Forest and Range Experiment Station.
Huckaby, L. S., M. R. Kaufmann, J. M. Stocker, and P. J. Fornwalt. 2001. Landscape patterns of montane forest age structure relative to fire history at Cheesman Lake in the Colorado Front Range. Pages RMRS-P-22: 19-27 *in* R. K. Vance, W. W. Covington, and C. B. Edminster, editors. Ponderosa pine ecosystem restoration and conservation: steps toward stewardship.
Kashian, D. M., M. G. Turner, W. H. Romme, and C. G. Lorimer. 2005. Variability and convergence in stand structural development on a fire-dominated subalpine landscape. Ecology **86**:643-654.
Kaufmann, M. R., C. M. Regan, and P. M. Brown. 2000. Heterogeneity in ponderosa pine/Douglas-fir forests: age and size structure in unlogged and logged landscapes of central Colorado. Canadian Journal of Forest Research **30**:698-711.
Kneeshaw, K., J. Vaske, A. Bright and J. Absher (2004). "Situational Influences of Acceptable Wildland Fire Management Actions." Society and Natural Recources(17): 477-489.
Kulakowski, D., T. T. Veblen, and P. Bebi. 2003. Effects of fire and spruce beetle outbreak legacies on the disturbance regime of a subalpine forest in Colorado. Journal of Biogeography 30:1445-1456.
Lavoie C. 2001. Reconstructing the late-Holocene history of a subalpine environment using fossil insects. Holocene 11 (1): 89-99.
Lynch, H,J. and P.R. Moorcroft. 2005. Spatiotemporal Dynamics of Insect-Fire Interactions. Contributed Oral Session 130 of The Ecological Society of America Annual Conference, Aug. 7-12, Montreal, Canada.
Mast, J. N., T. T. Veblen, and Y. B. Linhart. 1998. Disturbance and climatic influences on age structure of ponderosa pine at the pine/grassland ecotone, Colorado Front Range. Journal of Biogeography **25**:743-755.
Mast, J. N., P. Z. Fule, M. M. Moore, W. W. Covington, and A. E. M. Waltz. 1999. Restoration of presettlement age structure of an Arizona ponderosa pine forest. Ecological Applications **9**:228-239.
McCullough, D. G., R. A. Werner, and D. Neumann. 1998. Fire and insects in northern and boreal forest ecosystems of North America. Annual Review of Entomology 43:107-127.
Minshall, G. W., J. T. Brock, and J. D. Varley. 1989. Wildfires and Yellowstone's stream ecosystems: a temporal perspective shows that aquatic recovery parallels forest succession. Bioscience **39**:707-715.
Moore, M. M., W. W. Covington, and P. Z. Fule. 1999. Reference conditions and ecological restoration: a southwestern ponderosa pine perspective. Ecological Applications **9**:1266-1277.
Omi, P. N., and E. J. Martinson. 2002. Effects of fuels treatments on wildfire severity. Final report, Joint Fire Sciences Program.Colorado State University, Fort Collins, CO.

Parker, A. J., and K. C. Parker. 1994. Structural variability of mature lodgepole pine stands on gently sloping terrain in Taylor Park Basin, Colorado. Canadian Journal of Forest Research **24**:2020-2029.

Pierce, J.L., G.A. Meyer, and A.J.T. Jull. 2004. Fire-induced erosion and millennial-scale climate change in northern ponderosa pine forests. Nature 432:87-90.

Romme, W., C. Regan and J. Clement 2004. Lodgepole Pine Ecology Forum Key Points. Results of the Lodgepole Pine Ecology Forum held in Leadville, May 27-28, 2004.

Savage, M., and T. Swetnam. 1990. Early ninteenth-century fire decline following sheep pasturing in a Navajo ponderosa pine forest. Ecology **71**:2374-2378.

Schmid, J. M., and G. D. Amman. 1992. Dendroctonus beetles and old-growth forests in the Rockies. Pages 51-59 in: Kaufmann, M. R., W. H. Moir, and R. L. Bassett (technical coordinators), Old-growth forests of the southwest and Rocky Mountain regions: proceedings of a workshop. USDA Forest Service General Technical Report RM-213.

Schoennagel, T., T. T. Veblen, and W. H. Romme. 2004. The interaction of fire, fuels and climate across Rocky Mountain forests. Bioscience **54**:661-676.

Sherriff, R. 2004. The Historic Range of Variability of Ponderosa Pine in the Northern Colorado Front Range: Past Fire Types and Fire Effects. Ph.D. Dissertation. University of Colorado, Boulder, CO.

Stephens, S. L., and J. J. Moghaddas. 2005. Silvicultural and reserve impacts on potential fire behavior and forest conservation: Twenty-five years of experience from Sierra Nevada mixed conifer forests. Biological conservation **125**:369-379.

Swetnam, T. W., and A. M. Lynch. 1993. Multicentury, regional-scale patterns of western spruce budworm outbreaks. Ecological Monographs **63**:399-424.

Turner, M. G., W. H. Romme, and R. H. Gardner. 1999. Prefire heterogeneity, fire severity, and early postfire plant reestablishment in subalpine forests of Yellowstone National Park, Wyoming. International Journal of Wildland Fire 9:21-36.

Veblen, T.T., K.S. Hadley, M.S. Reid, and A.J. Rebertus. 1991. The response of subalpine forests to spruce beetle outbreak in Colorado. Ecology, Vol. 72, pp. 213-231.

Veblen, T.T., K.S. Hadley, E.M. Nel, T. Kitzberger, M. Reid, and R. Villalba. 1994. Disturbance regime and disturbance interactions in a Rocky Mountain subalpine forest. Journal of Ecology, Vol. 82, pp. 125-135.

Winter, G., C. Vogt and J. Fried (2002). "Fuel Treatments at the Wildland-Urban Interface: Common Concerns in Diverse Regions." Journal of Forestry: 15-21.