Review and Comment on Hanson 2010 “The Myth of Catastrophic Fire”
Britting (7-26-11)

I reviewed Hanson (2010) with the objective of evaluating the positions advocated and the research identified in support of the statements. I focused my evaluation on phenomena specific to the Sierra Nevada with some consideration given to adjacent bioregions. Hanson’s thesis that high severity fire is an important aspect of ecological process or disturbance and that it must be included as a desired management outcome is an important issue to develop and refine.

Noted below are concepts and actions that Sierra Forest Legacy has been discussing and integrating into our work. Many of these ideas were raised in Hanson (2010). There are some related issues not addressed in Hanson (2010) that we have been discussing and note them in the final section.

I refer in the comments below to the white paper as “Hanson.” The full citation for the white paper is:


Concepts and Actions that Sierra Forest Legacy Supports

- It is critical to the achievement of the desired ecological goals that substantially more area in the Sierra Nevada be managed each year with fire.
- A range of fire effects (from low to high severity) is a desirable outcome of managed fire.
- Desired conditions for managed fire should include a range of fire effects at a pace and scale informed by patterns seen on landscapes in which fire has functioned as a disturbance factor in recent times (e.g., Yosemite National Park) and prior to fire suppression (e.g., Yosemite National Park or Thousand Lakes Wilderness Area).
- Severely burned forests are important and necessary for the persistence of certain wildlife species.
- Dead and living biomass (defined as wood fiber from vegetation not defined as commercial timber) includes structures that are critical to wildlife and contribute to heterogeneous stand structure that is desirable. Such biomass can also increase the fuel hazard and flammability of an area.
- Biomass removal can be an effective tool to improve forest resiliency and conserve forest resources when undertaken at a pace and scale that is ecologically appropriate for the specific landscape.
- Salvage logging following wildfire has not been shown to be necessary to sustain the process and function of the ecosystem.
• The logging of trees up to +/- 16” dbh may be necessary to reduce fire hazard, especially in locations where the application of managed fire is not feasible or it is desirable to reduce the severity of fire effects.

• The storage and emission of carbon is an essential process in forest systems and is especially important in fire dependent systems. Carbon is a fundamental building block in the creation of structure and habitat. The goal is to restore structure, process and function to forest systems. Carbon as a reserve to provide mitigation or offsets for greenhouse gas production is a collateral benefit of a functioning forest ecosystem and does not drive restoration objectives.

Additional Issues to Consider

Historic logging and fire suppression have altered the forested systems in the Sierra Nevada. The restoration of structure, composition, and process to forest systems in the Sierra Nevada is complicated by these past practices as well as the proximity of humans and human communities to these forests. These circumstances frame or constrain the restoration approach that can be applied.

The difference in structural composition (e.g., size and species mix) of forests today versus pre-fire suppression forests is a critical consideration. Bouldin (1999) evaluates these differences in his characterization of the historic and present condition of Sierra Nevada forests. Today there are far fewer large trees and far more small trees compared to the historic patterns. There has also been a shift in species away from pine (more fire resistant, shade intolerant and important to several at-risk wildlife species) to fir (shade tolerant, less fire resistant). The mechanical removal of wood fiber in combination with significant increases in managed fire may be important to correcting these deficiencies.

There are some areas where high severity fire of a large extent would be damaging to other attributes that are presently at-risk. The current distribution of Pacific fishers provides an example. South of Yosemite National Park fishers occur in a fairly narrow band of habitat that extends to the area just south of Bass Lake. High severity fire in this area has the potential to eliminate a highly productive area for fishers, thereby restricting the range of fishers and restricting the potential dispersal to suitable habitat to the north. This area is susceptible to high severity fire because the fuel loading is high in some areas and there is a high likelihood of ignition due to high levels of human occupation and use of the area. This is an example of an ecosystem that is highly vulnerable and where extreme changes in habitat conditions need to be avoided for a time.

There are limitations to our ability to apply managed fire. Safety issues limit the ability to use managed fire in close proximity to humans. In addition, smoke production is a strong limiting factor to the use of managed fire. SFL is actively working with a variety of agencies to maximize the use of managed fire.

Understanding the pace, scale and location of high severity fire effects is essential to identifying the desired/appropriate levels for this disturbance process. There are places on the landscape
where there is no deficit of high severity and additional high severity fire would not be beneficial. By comparison, there are locations where high severity fire may be underrepresented. For SFL’s purposes, it is important to focus on identifying the conditions desired across the landscape at the appropriate temporal and spatial scales and use this information to guide restoration projects. We are gathering information on fire effects and structural conditions for specific vegetation types that we intend to use to define desired conditions and further develop ideas about designing projects to achieve desired conditions.

**Specific Comments on Hanson 2010 “The Myth of Catastrophic Fire”**

The following comments are organized by the “FACT” that Hanson stated in the white paper.

**FACT 1 (p. 6): Commercial “thinning” logging projects do not protect homes.**

**Comment**

Properly designed thinning near homes can increase fire resiliency. Removing surface and ladder fuels around homes at a sufficient distance (100-200 feet) to cause incoming fire to reduce its intensity and drop to the ground can increase protection for a home (Cohen 2008). This activity must be coupled with increasing the resilience of the home itself to limit the damaging effects of firebrands and surface fire (Cohen 2008). Surface and ladder fuels can reach sizes of 16” dbh (North et al. 2009). Trees ranging in size from 6” to 16” DBH may have commercial value. The wood fiber that needs to be removed near to homes to increase their fire resilience can legitimately be included in a logging project that includes the removal of trees that may have commercial value. The issues of primary concern are what are the fuel objectives and how the treatments are designed to meet these objectives.

It should be recognized that presently little is done to enforce fuel treatment requirements around homes, especially in the Sierra Nevada. Indirectly, thinning that focuses on surface and ladder fuels at distances farther than the near home environment also can reduce risk to the home, especially in cases where the near home environment has not been properly treated. Resilient fuel conditions at a distance from a home site can change the behavior of a fire as it approaches a home site by reducing intensity and spread rates. Treatments outside the home site can result in insufficient surface and ladder fuels to carry fire within or near to the 200-foot buffer around a home.

Hanson does not address the need for evacuation routes. Safe travel routes to exit the forested area may require fuel reduction in areas that are outside the immediate home buffer.

Hanson (p. 6) states that only 3% of the fuel reduction projects in the U.S. are located within the wildland urban interface (WUI). The recent pattern in the Sierra Nevada has been markedly different from national trends. The table below indicates that from 2004 to 2007 24% to 53% of the area affected by fuel reduction treatments was in the WUI (data summarized taken from http://www.fs.fed.us/r5/snfpa/am/).
<table>
<thead>
<tr>
<th>Year</th>
<th>Total Area of Fuels Treatment (acres)</th>
<th>Proportion in WUI</th>
</tr>
</thead>
<tbody>
<tr>
<td>2004</td>
<td>169,190</td>
<td>50%</td>
</tr>
<tr>
<td>2005</td>
<td>67,014</td>
<td>48%</td>
</tr>
<tr>
<td>2006</td>
<td>53,468</td>
<td>53%</td>
</tr>
<tr>
<td>2007</td>
<td>99,942</td>
<td>24%</td>
</tr>
</tbody>
</table>

Reinhardt et al. (2008, p. 1997) which includes Jack Cohen as an author suggested that “while the potential of fuel treatment to reduce wildfire occurrence or enhance suppression capability is uncertain, it has an important role in mitigating negative wildfire effects, increasing ecosystem resilience and making wildfire more acceptable.”

**FACT 2 (p. 7):** High-intensity fire patches create habitat that supports some of the highest levels of native biodiversity of any forest type in western U.S. forests.

**Comment**

I agree that high intensity fire effects create important habitat and structures. These quotes form the white paper are especially important since they emphasize the importance of managing or providing for a range of fire severity effects (Hanson, p. 8):

Smucker et al. (2005) concluded: “Because different bird species responded positively to different fire severities, our results suggest a need to manage public lands for the maintenance of all kinds of fires, not just the low-severity, understory burns…”

…and concluded that: “Fire management that includes a broad range of natural variability (Allen et al. 2002), including areas of severe fire, is more likely to preserve a broad range of ecological functions than restoration objectives based on narrowly defined historic fire regimes (Schoennagel et al. 2004).”

The literature does not support Hanson’s unqualified claim (p. 8) that “There is strong consensus among ecologists that high-intensity fire, and resulting snag forest habitat, is something that must be preserved and facilitated, not prevented or destroyed.” The literature does not support preserving or promoting all high-severity fire. Rather the emphasis is on managing for a variety of fire effects that are appropriate to the specific site.

The discussion of wildlife benefits from the burned trees that result from fire of mixed severity is very good and provides a useful summary. There is additional research to consider regarding the use of burned forests by California spotted owls.

The Plumas-Lassen Administrative Study (PLAS) now includes an evaluation of post fire monitoring of owls on two fires: Moonlight and Antelope Complex Fire Area (MACFA; Plumas NF) and Cub-Onion Complex Fire Area (COCFA; Lassen NF). These studies are ongoing and results are summarized below.
The 2009 report suggests that these initial data indicate the following:

Largely low-moderate severity fires may have positive or neutral effects on CSOs and their habitat while high severity fires may result in greater negative effects. Our results into the acute, short-term response of CSOs to wildfire from the primarily high-severity MACFA and primarily low-moderate severity COCFA support this hypothesis.

(Plumas Lassen Administrative Study 2009, p. 142; selected maps appended to this review). The results presented above do not yet consider the effects of salvage logging that has occurred in the study area. John Keane told me that he is collecting vegetation data that will characterize the extent of salvage logging and that information will be incorporated into their study in the coming year. Bond et al. (2009) examined use by California spotted owl of burned forests following a mixed severity fire in southern Sierra Nevada. Four years following the burn, owls were radio-collared for the summer season. Foraging and nesting locations were evaluated for burn severity. They found that owls used burned forests for foraging and nesting. This study did not quantify the quality of the home range with respect to burn severity, but it did examine an area they called a “foraging area” defined as "foraging ranges of owls that we approximated for the primary..."
period for rearing young (May through mid-Aug) using a circle with radius that extended from a
nest or roost center to the furthest documented foraging location for each radiomarked owl”
(Bond et al. 2009, p. 1118). This approach is different than the one used to describe a home
range (probably explaining why they called them foraging areas instead). On average, the
foraging areas appear to have a significant amount of habitat that is unburned to moderately
burned (total of 45% of MC type) and a lot less that is high severity (7% MC type). The
distribution of burn severity in Bond et al. (2009) foraging areas appears to be more like the
distribution of burn severity in the Cub and Onion Complex Fire Area (COCFA) described above
(11% high severity) and less like the Moonlight and Antelope Complex Fire (52% high severity
fire). For mixed conifer type, high severity fire was about 7% of the foraging area, yet areas
affected by high severity were used more frequently than occurred in landscape (i.e., 12% of the
foraging detections were in areas affected by high severity fire). Bond et al. (2010) examined
winter movements of owls in the same landscape described in Bond et al. (2009). The results
from five radio collared birds indicated that “three of the five owls roosted in burned landscapes
during the nonbreeding season, and 30% of all roost locations were within the fire’s perimeter”
(Ibid., p. 174). The threshold above which fire effects to a home range result in abandonment or
reduced productivity has not yet been determined. The PLAS study may be able to provide
additional information about that relationship in the future.

FACT 3 (p. 12): High-intensity fire is the exception, not the rule; and long-unburned areas
are not burning more intensely.

Comment

This claim depends on the spatial scale and time frame over which one is looking at the trends.
It also depends on how one classifies the different states or conditions under evaluation. Rather
than getting mired in a debate about the current trends in fire severity (that in most cases are
influenced strongly by our current and historic approaches to fire suppression), it would be more
productive to focus on what conditions (e.g., type, amount, location, pace, scale) of fire severity
are desirable across the landscape and to plan actions to achieve them. This type of planning can
help define areas where high intensity effects are not desired for reasons of public health or
resource protection and consider the tools that can be utilized to move toward desired conditions.
This type of planning would also allow for the consideration of the effects of recent large and
severe fires (e.g., Moonlight Antelope complex, Plumas National Forest; 88,000 acres with 52%
high severity) and whether or not such events are within the range of variability desired on the
landscape.

The fire effects literature identifies a variety of conditions even for sites that are geographically
close to each other. In the Illilouette Creek basin (Yosemite National Park), Collins and
Stephens (2010, p. 934) found that:

…we indeed detected a large range of high-severity, or stand-replacing, patch sizes. While it
is clear that patches were generally small (<4 ha), large contiguous stand-replacing patches
did occur (Figs. 2 and 4). The fact that these patches in total accounted for 15% of the burned
area demonstrates that although stand-replacing fire is not the dominant process operating in
these upper elevation mixed-conifer forests, it is an important component of the fire regime.
Collins and Stephens (2010) also suggested that fire severity varied with forest type. This can be contrasted with work in a nearby site on the South Fork of the Tuolumne River (Yosemite National Park) by Scholl and Taylor (2010) who found that “there was no spatial variation in fire frequency related to topography in our study area. Fire frequency was similar at all elevations and slope aspects” (Ibid., p. 373) and that “there was no clear evidence of high-severity fire effects in our forest. Thus, application of high-severity prescribed fire would create novel conditions compared to fire effects over the last four hundred years.” (Ibid., p. 377) They infer from the patterns of vegetation that high severity effects caused openings in the canopy < 0.5 acre. The study area examined by Scholl and Taylor (2010) is an example of a landscape shaped by predominately low severity fire that was frequent.

In yet a different study in the Thousand Lakes Wilderness (Southern Cascades, Lassen National Park), Bekker and Taylor (2010, p. 67) found that “The 3 individual fires we could identify severity for (1883, 1889, and 1918) were mainly high-severity, and they were also widespread.” These fires ranged in size from about 1,000 acres to 4,000 acres (Ibid., Table II, p. 67). Further “in the nearby Cub Creek Research Natural Area, widespread and high-severity fires also burned in 1829, 1864, and 1889 (Beatty and Taylor 2001), and extensive fires occurred in these years in other locations in the Cascades as well (Taylor, Trouet and Skinner, 2008)” (Ibid., p. 68).

As a general matter fire patterns across the Sierra Nevada are highly variable. In some areas, mixed or high severity fire dominates and in others it does not. The size of a high severity patch under a natural fire regime in the past has generally been small (<10 acres) but has ranged upwards of 4,000 acres (Bekker and Taylor 2010).

There is some support in the literature for Hanson’s objection (p. 12) to claims that “forested areas become increasingly likely to have high-intensity effects the longer they remain unburned.” Odion and Hanson (2006 and 2008) used a variety of methods to evaluate fire severity in three recent fires and compared severity conditions to the number of “skipped” fire return intervals (“fire return interval departures” or FRID). For these three fires, they found no relationship between the four FRID classes (1, 2, 3, and 3+) and proportion of area affected by high severity fire. Odion et al. (2004 and 2009) evaluated the relationship between fire severity and time since burning in the Southern Cascades. Odion et al. (2009) found that beyond 75 years since burning, high severity fire affected less of the stand and median size of each patch was smaller compared to the effects in areas that had been burned 10 to 32 years ago. Caution needs to be applied when using information from regions outside the Sierra Nevada to evaluate phenomena in the Sierra Nevada. Weather patterns differ between regions and can influence fire behavior. For instance, the fire effects in the Klamath region are strongly suppressed by temperature inversions that occur during the summer.

Schwind (2008) found for all fires in PSW and PNW (forest and chaparral types combined) that the proportion of the area burned with high severity effects had not increased over time. From these studies, Hanson concludes that areas not experiencing fire for long periods are not burning more severely. The results of other studies also suggest that areas that have not burned in a long time may not necessarily experience extreme fire behavior. For instance, Stephens and Moghaddas (2005) found that predicted mortality from wildfire was similar in old-growth...
reserves and areas that had been thinned from below suggesting that resilience was an attribute of the long untreated old growth reserves.

In contrast, Safford et al. (2007) examined the same three fires evaluated by Odion and Hanson (2006 and 2008) using three FRID classes (1, 2, and 3; class3+ from Odion and Hanson (2008) was combined with class 3) and found there was a relationship between FRID and proportion of the area burned with high severity fire, i.e., the longer the time since burning (higher FRID class), the greater the proportion of high severity fire. Further, Miller et al. (2009) concluded that fire severity effects have increased in the last ten years for fire effects during the period 1984 to 2006. Quayle et al. (2009) (additional analysis of the Schwind (2008) data plus an additional year) found that the proportion burned with high severity fire for large fires (>50,000 acres) had increased in the last ten years compared to the earlier years in the fire history record. Miller and others have recently submitted a paper examining all fires >1,000 acres in the Klamath region for the period 1987 to 2008. Miller told me that their study found, similar to Odion et al. (2009), that severity in recent fires was relatively the same in closed forests composed of medium/large trees regardless whether they last burned before 1921 versus burned 1921-1986. However, they found that severity in open forests and those composed of small trees did increase when last burned more recently. I need to review this paper when available.

Hanson challenges the findings in Miller et al (2009) regarding an increasing trend in high severity fire. I reviewed Miller et al. (2009) and other published papers on trend in fire severity over time. For the Southern Cascades and Sierra Nevada regions, Miller et al. (2009) is the most comprehensive published paper on this topic. Hanson refers to his unpublished work to demonstrate that the trend found in Miller et al. (2009) does not exist "if all the data area used." I asked Hanson for the paper documenting his claims, but it is not available for circulation. I did speak to him generally about his analytical approach. My understanding of Hanson’s thesis is that had historic vegetation data from approximately 1984 been used to evaluate vegetation type (instead of current vegetation data) additional fires would have been included for the period examined in Miller et al. (2009). Using vegetation data from 1977 (CalVeg77), Hanson finds that some portion of the area that is chaparral type today, was actually conifer type in 1977. He believes that this change over time was due to high severity fire that occurred during the period 1984 to 2006 which converted a conifer type to chaparral. By excluding chaparral types (that he believes were conifer in 1984), Hanson believes fires inappropriately were excluded from the analysis in Miller et al. (2009). Hanson also says that his “in review” paper uses all of the available data, whereas Miller et al. (2009) only used 60% of the data. Hanson’s conclusion is that when accounting for early changes from conifer to chaparral vegetation (around 1984) and using all the fire history information, there is no increase over time in the proportion of a fire burning at high severity.

I also spoke to Jay Miller and Hugh Safford (authors on Miller et al. 2009) about Hanson's re-analysis of the fire trend data. They raised credible concerns about the data and methods Hanson used to develop that analysis. They discussed two issues regarding Hanson’s concern about under representing conifer stands in the Miller et al. (2009) analysis. First, they do not believe that their methods overlooked types that were conifer in 1984 and then converted to chaparral by disturbance. The vegetation data that they used (Eveg) adopts the convention that a label assigned to a forested type in a specific location does not change following stand replacing
events; any change in the quality of the area is indicated by revising only the labels describing vegetation structure (size class and density). The retention of the original label continues on even if the location begins to develop into another type such as chaparral. As a result, locations with a conifer label as of 1984 that have been affected by wildfire retain the conifer label in the current dataset. Second, Miller and Safford believe that it is inappropriate to use the vegetation data from 1977 to assess vegetation in their analysis. The scale of mapping for the 1977 data (1:250,000) is much coarser than the burn severity and vegetation data sets (1:24,000) used by Miller et al. (2009). For example, the minimum mapping unit for CalVeg77 is 400 acres (http://www.fs.fed.us/r5/rsl/projects/gis/data/calcoys/calveg77.txt) whereas the minimum mapping unit for the Eveg data (used in Miller et al.) is 2.5 acres (http://www.fs.fed.us/r5/rsl/projects/frdb/layers/ev_mid.html). The metadata for the CalVeg77 data indicates that “many important vegetation communities that occur in smaller units are not distinguished.” When the historic vegetation data (CalVeg77) are compared to the data collected today (Eveg), it is clear that the data are of a different resolution. Large areas in the CalVeg77 data are homogenously labeled as a single vegetation type, whereas the recent vegetation data (Eveg) detects various vegetation types within such areas. Miller and Safford’s conclusions are that one can not use the historic data (CalVeg77) to make inferences about areas suggested by Hanson to have been occupied by chaparral now that were previously forest since the historic data is too coarse and fails to detect variation at the finer scale used in their study. Also, the concern that some areas may have been previously forest but are now labeled as chaparral is resolved by the labeling convention adopted by the vegetation data (Eveg) used by Miller et al. (2009).

Hanson also raised the issue that Miller et al. assessed only 60% of the area burned, whereas his analysis using the historic data covers 100% of the area burned. Setting aside the problems associated with using the 1977 vegetation data, the area examined by Miller et al. (2009) is a sample of the region that was not randomly selected. Jay Miller told me that the original paper covered about 84% of the mixed conifer area burned in the region. Miller re-examined the mixed conifer data as a result of my questions about the trend analysis. He found that even with the addition of previously unmapped fires >1,000 there remained an increasing trend. He had some caveats: 1) he did not include fires in the 10-1,000 acre size, thereby still excluding a small portion of the area burned during the study’s time period; 2) he did not double check that the vegetation data were representative.

In a recent email, Hanson mentioned that “all other studies on this issue … have found no increase in fire intensity … within Sierra Nevada forests” with a reference to the white paper. I reviewed the three studies Hanson cited in the white paper (i.e., Schwind 2008, Collins et al. 2009, Hanson et al. 2010) and find that they provide no direct support for Hanson’s claim about the lack of increasing fire severity trend in the Sierra Nevada. Schwind (2008) reports on the burn severity trend for Pacific Northwest and Pacific Southwest together. It is not clear from the data if the finding of no trend in high severity fire effects would persist if PSW (California) or the Sierra Nevada bioregion were examined separately. Collins et al. (2008) found the proportion of the area resulting in high severity fire effects was stable over the last 30 years; this phenomenon was, however, present in an area that had experienced regular fire (it is a wilderness area in Yosemite NP) and should not be universally applied to areas not experiencing regular fire. I was not able to review “Hanson et al. (2010)” since it is not included in the reference list.
for the white paper. I looked at Hanson et al. (2009) in case there was an error in citation. Hanson et al. (2009) examines fire in the Klamath and Cascade ranges in California, Oregon and Washington. The paper focuses on the region covered by the Northwest Forest Plan and it is unclear if the Southern Cascades is included in the “California Cascades.” Lassen National Forest is in the Southern Cascades and is not in the NWFP. Further, the Sierra Nevada bioregion is not included in this study. Hanson et al. (2009) does not address fire severity trend in the Sierra Nevada at all and the study might not include the Southern Cascades. Even if the Southern Cascades is included it is combined with other parts of the Cascades in Oregon and Washington and can not be distinguished from other regions. These papers that Hanson uses in the white paper do not refute the increasing trend in fire severity noted for the Southern Cascade and Sierra Nevada regions reported by Miller et al. (2009)

One issue that remains for consideration is the approach used by Miller et al. (2009) to exclude chaparral types from the analysis. Since the current vegetation data used is displayed at such a fine resolution, areas within a fire perimeter that consisted of chaparral dispersed among forested areas were excluded from the analysis. Including such areas in the analysis presents methodological challenges. As addressed in Miller and Safford (2008; p. 29) the satellite data are highly sensitive to chlorophyll; any resprouting vegetation will mask the extent of high severity in shrub systems when those shrubs resprout in response to fire. It is not clear to me what the effect would have been to include all vegetation types within the perimeter of each fire. Doing so would yield information about the changes in fire effects within the entire fire perimeter during the period studied. Since the pattern of severity within a given area burned excludes some types, the estimates of the proportion of a fire burned by high severity fire or the patch sizes of high severity fire for a given fire can not be compared directly to studies such as Collins et al. (2009) and Collins and Stephens (2010) which examined the entire area within a fire perimeter, regardless of vegetation type.

It should be noted that with one exception the data used to evaluate fire severity patterns in the studies above included (and in some cases were dominated by) areas in which fire suppression had disrupted the fire regime. The ongoing study in the Illilouette Creek basin (Yosemite National Park; Collins et al. 2009; Collins and Stephens 2010) is the only study to focus on the fire severity patterns in an area with an undisrupted fire regime that has been affected by the changes in climate over the last 30 years. They found that the proportion of the study area affected by high severity fire has remained stable during the past 30 years.

Miller et al. (2009) and other recent studies evaluating fire size over time (Westerling et al. 2006, Westerling and Bryant 2008, Lenihan et al. 2008, Quayle et al. 2009) did not address how the changing approaches to fire suppression that began in the 1980s may have affected fire size or quality. For example, changes in suppression response may have led to larger fires and the use of back burning large areas as a control measure may have affected the time trends noted in their studies. These management actions, as opposed to biophysical phenomenon, may have contributed to the increases in fire size or quality beginning in the 1980s that were noted by these studies.
I am unable to complete an evaluation of Hanson’s claim until I can review the written documentation of his analysis. At this point, I am unresolved about whether or not there is an increasing trend in high severity fire effects, or the importance of such effects.

There are undesirable effects from fire not mentioned by Hanson that can occur in areas where the fire regime has been altered. Forests in which duff has accumulated around the base of large pines (due to the lack of more frequent low severity fire) can result in loss of large old pines even with low severity fire. Further, in areas where at risk species are highly dependent on old forests and dense canopied forest that is in limited supply, loss of such areas to high severity fire may substantially increase risk to the persistence of associated species.

FACT 4 (p. 13): Forest growth and regeneration is vigorous after high-intensity fire, and fire-adapted forests need fire to maintain productivity. In the few places wherein post-fire conifer regeneration does not quickly occur, these areas provide important montane chaparral habitat, which has declined due to fire suppression.

Comment

I generally agree with this. We need to understand that fire events are capable of sending the system in a different developmental trajectory. Transitions in state as a result of alteration in disturbance regime or the timing of disturbance can affect subsequent development of plant associations. Savage and Mast (2005) examining 10 high severity fires in southwestern ponderosa pine forest found that 50% of the sites experienced type conversion. Depending on the drought conditions or among year climate variability, conditions that favor conifer regeneration may be weak during the post fire establishment phase. This could result in a predominance of chaparral or oaks in an area previously dominated by conifers. Chaparral and oaks can occupy a site for a very long time. Depending on the future disturbance regime or climate trajectory, there is some chance that conifers or the previous species composition might not again establish in an area. This is not necessarily bad, but we need to recognize that such changes could occur.

FACT 5 (p. 14): We are in a major fire deficit. There is now far less fire overall, and less high-intensity fire, than there was historically.

Comment

I agree with this statement as a general principle and when applied across the Sierra Nevada bioregion as a whole without regard to fire severity. Recent estimates by Stephens et al. (2007) suggest that wildfire before the influences of Euro-American settlement affected about 4.5–12.0% of the state’s lands annually. By comparison, the average annual rate of wildfire in California for the period 1950 to 1999 was about 0.13% (Ibid.). The general concept must, however, be carefully considered when applied to different spatial or temporal scales. When the principle is applied at a sub-regional, watershed, or smaller landscape scale, it does not hold true in some areas. The temporal and spatial time frame over which this finding is applied, as well as the various forest and plant community types that are considered, are critical to evaluating the variance from past or desired conditions. Also, the historic data, as noted below, is confounded.
by the interplay between human versus natural ignitions. Our ability to characterize the historic patterns of fire is confounded by the active role humans have played by intentionally setting fires prior to and since European settlement.

Hanson cites Leiberg (1902) to support the view that patches produced by high intensity fire high intensity patches were (“20,000 to 30,000 acres in size, or larger, (Leiberg 1902, Hanson 2007a (Fig. 3.1)), greater than any current high-intensity patches” (Hanson, p. 15). I reviewed Leiberg (1902) and Hanson (2007) for information on fire effects. Leiberg (1902, Plate VII, p. 18) includes a map of burned areas of differing severity. The map does show extensive areas where over 75% of the timber was reported as burned. Some of these patches are greater than 20,000 acres in size. However, Leiberg does not report a specific date of each burn; this map reflects an aggregate of the area burned during the 100 years prior to Leiberg’s study (Ibid., p. 41). Thus, the Leiberg study does not provide information on the proportion of high severity fire for a given burn. Further, Leiberg attributes much of the area burned to the actions of humans throughout the 1800s:

When the miners came, fire followed them. Contemporaneous with the advent of the miners, or soon after, came the flock masters with their sheep. The belief is generally held that the sheep herders fired the country in all directions and have been responsible for most of the fires in recent years. However that may be, all the fires observed during the last summer closely followed the sheep camps. It is evident that during the last decade forest fires in this region have greatly diminished in extent and frequency, and those which have covered the largest area during this period burned in chaparral.

The only older burns which give any clue to their age are those which stretch in a line from northwest to southeast through the central district of the region. They are marked by the occurrence of large tracts covered with chaparral. Most of these areas are situated contiguous with placer camps, worked from the earliest times, and might be regarded as having been burned over by fires spreading from such camps. In some instances this most likely happened, but a large proportion of the chaparral tracts was denuded of forest so long ago that nearly all the stumps have decayed. Hence the fires which overran them probably date back to the early part of the last century.

(Ibid.) Regardless of the patterns of burning mapped during the previous 100 years, Leiberg concludes that the fires, in many cases, originated by human actions and not natural events such as lightning. At a minimum, the confounding of human and natural causes for the fires evaluated by Leiberg limits the utility of the that study in establishing the pace, scale, and intensity of fires under a natural disturbance regime.

If we set aside the confounding ignition sources for the fires mapped by Leiberg, any characterization of the acceptable or desired levels of high severity fire will need to take into account vegetation and geographic location. Hanson uses the Leiberg data to estimate fire rotations for high severity fire (Hanson 2007). His discussion tends to focus on high severity rotations of +/-300 years, but much of the Sierra Nevada bioregion is occupied by types with high severity fire rotations longer than 300 years and that would affect a much smaller portion of the landscape. Hanson (2007) identified fire rotations in pine dominated types (ponderosa pine...
(PP), Douglas-fir/pine (DF-P), and mixed conifer-pine (MC-P)) that range from 490 to 1230 years. These rotations would result in a much lower proportion of an area in high severity compared to rotations of 300 years. These forest types are a significant component of the Sierra Nevada. PP and MC-P cover about 45% of the area in the Sierra Nevada occupied by the seven vegetation types that Hanson examined (i.e., PP, DF-P, MC-P, mixed conifer-fir, Jeffrey pine, white fir, and red fir). In addition, significant area on the eastside of the Sierra Nevada is in pine type and would likely support longer rotations similar to the PP type. A rotation of +/-300 years for a fire rotation in the Sierra Nevada should not be universally applied and may not reflect a majority of the land base in the bioregion.

Lastly, the general statements used by Hanson to describe high severity fire effects do not take into account the highly variable nature of past fire patterns that ranged from no amount to significant amounts of severe fire even within a forest type.

FACT 6 (p. 17): The most recent projections indicate that, in most forested regions of the North America, reduced fire activity is likely to occur, due to vegetation changes that will result in less combustible fuel, and due to increased precipitation in many areas.

Comment

It is not clear to me how this “fact” relates specifically to the Sierra Nevada. On one hand, Hanson argues that fire is underrepresented, yet in this instance he argues that climate effects will not deliver more fire. This effort to reassure that there will not be an increase in fire confuses the thesis that we need more fire.

The predictions about future outcomes of climate change are highly variable and depend on the climate change assumptions (i.e., the model used) and the underlying geography (Westerling and Bryant 2008). For the Sierra Nevada bioregion in particular, there is a great deal of variability even within a given model on the changes in precipitation estimated for California (Cayan et al. 2008). We do know from climate records and historic fire patterns that there is a relationship between drought years and fire severity (Taylor et al. 2008, Westerling et al. 2006). But we also see that there are places were climate patterns do not seem to be related to the fire patterns (e.g., compare the two recent studies in Yosemite National Park, Scholl and Taylor (2010) and Collins and Stephens (2010) where we see the same regional climate, but different fire patterns).

It is also important to consider the form of precipitation. Under warming conditions, a reduce snow pack is expected. Combined with the reduced snow pack, an early onset of spring and an extension of the fire season have been observed in the Sierra Nevada (Westerling et al. 2006). Early onset of spring and extended fire seasons may contribute to increased fire activity in the Sierra Nevada.
FACT 7 (p. 19): There are far too few large dead trees to maintain ecologically healthy forests.

Comment

I generally agree with this statement. If there were extensive areas of dying trees, I think we would have something to be concerned about. The Forest Service is on record stating that pest and disease levels in Sierra Nevada are not at epidemic levels.

The effect of drought on large trees should be watched carefully. van Mantgem and Stephenson (2007) and van Mantgem et al. (2009) suggest that the incidence of drought induced tree mortality is increasing. These papers suggest that loss of larger trees has occurred even in settings where the fire regime has been less disturbed. They suggest that reduced numbers may reflect the increased stress of drought in these systems.

The focus, in my mind, should be on making clear statements about desired levels of mortality from a variety of disturbance processes to create the important habitat structures that Hanson mentions. We also need to keep in mind that as a general matter the density of large, live, old trees is substantially reduced across the landscape. Any provision for dying old trees needs to be kept in balance with the maintenance and development of live, relatively healthy large, old trees that will be capable of persisting their full life span.

FACT 8 (p. 20): High-intensity fire burns cleaner, and produces fewer particulate emissions.

Comment

I am not very familiar with this topic area. I read through the Reid et al. (2005) and Ward and Hardy (1991) which were cited by Hanson. I also reviewed additional papers on the topic (Andreae and Merlet 2001, McMeeking et al. 2009). After reading through these papers, the subject area seems to be more complicated than characterized by Hanson’s statement (p. 20) that “high intensity fire burns cleaner, and produces fewer particulate emissions.”

Reid et al. (2005, p. 813) found, as a general matter, “particle emission factors logically increasing with decreasing combustion efficiency (that is with increasing relative amounts of smoldering combustion). For example, the average particle EF for all flaming combustion measurements is [about] 18 g per kg C burned versus [about] 68 g per kg C burned for smoldering combustion, roughly a factor of three difference (or [about] 9 and 34 g kg$^{-1}$ dry matter burned for flaming and smoldering combustion, respectively).” This statement is relevant to relative trends among vegetation types. If one focuses on forest types in North America (see Reid et al. 2005, Table 6), the particle emission factor estimates for flaming fires versus smoldering fires vary by a factor of 0.33 to 0.9 in three cases and in one case by a factor of 4. This paper and others (e.g., McMeeking et al. 2009) stress that fires are not one type or the other, but have components of both smoldering and flaming. This is especially the case for forest fires that can continue for days with the mode of burning changing significantly over time.
McMeeking et al. (2009) also point out that others (Ward and Hardy 1991) have found that emissions for total particulate matter can increase as fire release rates increase (i.e., flaming occurs) likely due to turbulence generated by the larger fir size that lofted into the air larger sized particulate matter, including ash and soil. Emissions also include inorganic and other gas emissions and not just particulates. Hanson does not mention these other components. Some of the other compounds that can be released during fire events vary with combustion efficiency and others depend more on fuel type and composition (Andreae and Merlet 2001, McMeeking et al. 2009).

The discussion of emissions and their nature depending on fire type is more complicated than presented by Hanson.

FACT 9 (p. 20): Western U.S. conifer forests are major carbon sinks, where logging has been reduced.

Comment

The ecological point of this “myth” or “fact” is unclear to me. There is likely some “carbon” threshold around which the system would fluctuate in a natural disturbance regime. Keith et al. (2009) discuss the idea of a carbon carrying capacity – the amount of carbon that can be stored in a forest under prevailing climatic conditions and natural disturbance regimes. Over space and time, the carbon pool would fluctuate between source and sink. A more relevant point would be that if we establish a more natural fire regime, the Sierra Nevada bioregion will become resilient and not swing wildly over time as a carbon reserve. More frequent fires will allow the development of more and larger fire resistant trees, creating a more resilient carbon pool.

Two recent studies on carbon accumulation show differing results with respect to carbon storage and loss due to wildfire and treatments. Reinhardt and Holsinger (2010) found that “fuel treatments decreased fire severity and crown fire occurrence and reduced subsequent wildfire emissions, but did not increase post-wildfire carbon stored on-site. Conversely, untreated stands had greater wildfire emissions but stored more carbon.” This paper also found that some types took longer than 85 years to recover carbon loss to either emissions or logging. This contrasts, in part, with Hurteau and North (2010) who found that “Within our 7-year re-sample period, the burn only and understory thin treatments sequestered more carbon than had been removed or emitted during treatment” and that “Our results indicate that while there is an initial carbon stock reduction associated with fuels treatments, treated forests can quickly recover carbon stocks if treatments do not remove large, fire-resistant overstory trees.”

A recent study by Hurteau et al. (2011) conducted in southwest ponderosa pine found that current carbon stocks are much larger than the reconstructed carbon stock. They suggest that high crowning and torching indices indicate that the system has exceeded its carbon carrying capacity. These findings suggest that as a result of recent land management practices, carbon stocks accumulated above levels that would have occurred had the appropriate disturbance regime been functioning. Other studies also have examined carbon fluctuations following disturbance. Dore et al. (2008 and 2010) found that 10 years following a high severity wildfire the site continued to be a source of C, a trend likely to continue for a considerable period of time.
Meigs et al. (2009) had similar findings over a shorter time period in Oregon. These studies indicate that fire as a disturbance regime will result in source or sink conditions depending on the fire cycle and other factors.

To suggest that the forest ecosystem is a carbon sink overlooks the carbon fluctuations necessary to the function of these dynamic systems.

**FACT 10 (p. 20):** Commercial logging, including mechanical “thinning”, reduces forest carbon storage.

**Comment**

This seems to be the same point as made in FACT 9. Thinning does reduce carbon stocks for various periods of time and the magnitude of the reduction depends on the activities undertaken. Managed fire or wildfire also reduces carbon stores in a forest. Recent research in the Sierra Nevada indicates that carbon stocks following thinning or understory burning can be recovered in 7 years (Hurteau and North 2010). The most important consideration is not the total quantity of C, but rather the qualities of the structure in which it is stored. It must also be recognized that there is a carbon carrying capacity – the amount of carbon that can be stored in a forest under prevailing climatic conditions and natural disturbance regimes.

It would be more relevant to focus on the ecological processes appropriate to the system and not on the human commodification or valuing of “carbon.”

**MYTH 11 (p. 23):** “Biomass” thinning is benign or beneficial in our forests; such thinning can reduce fire intensity and only removes some of the small trees.

**FACT 11 (p. 23):** Further reducing snag forest habitat created by high-intensity fire patches – habitat that is already in short supply – would be ecologically devastating to the many wildlife species dependent upon that habitat. Biomass logging also: a) reduces carbon sequestration; b) increasingly seeks to remove old-growth trees; c) is generally tied to larger timber sales; and d) tends to remove all or nearly all of the smaller trees, regardless of species.

**Comment**

This particular myth/fact couplet seems to carry the weight of Hanson’s view of limiting management to the use of fire.

The discussion supporting this couplet seems weak. I don’t see the relationship between salvage logging (i.e., “reducing snags”) and “biomass” thinning. The mingling of pre-fire actions (thinning live material) with post-fire salvage (removal of mostly dead) confuses the issue.
Hanson makes four points against biomass thinning, three of which are weak:

“a) reduces carbon sequestration”

The removal of biomass or commercial timber does reduce the amount of carbon in a forest. However, as noted by Depro et al. (2008, p. 1133) “Forest and carbon management, however, is much more subtle than simply determining how much to harvest.” Hanson suggests that the total amount of carbon is the relevant metric to compare and does not address the structural arrangement of that carbon. Hanson states that “Though timber interests have promoted increased logging by describing current forests as “overstocked”, the scientific data indicates that, due to past logging, as well as exclusion of wildland fire, forests of today have much less biomass than historic forests (Bouldin 1999, Fellows and Goulden 2008).” A closer examination of Bouldin (1999, p. 63-64) indicates that he found on average for the forest types he examined in the northern Sierra Nevada that stocking (basal area per acre) in 1992 was much greater than in 1935 for trees less than 12” DBH, stocking was about the same in 1992 and 1935 for trees 12-24” in size and stocking was lower in 1992 compared to 1935 for trees >24” dbh. Bouldin concluded that logging of large trees since the early 1900s resulted in significant reductions in the numbers of large trees and that the lack of a natural fire regime has lead to high numbers of small trees that would have been otherwise killed by fire. Similar to Bouldin (1999), Fellows and Goulden (2008) concluded that “Large trees contain a disproportionate amount of carbon, and the loss of large trees accounts for the decline in biomass between surveys.”

Biomass removal focuses on reducing small diameter (<12” dbh) conifer trees with modest reductions in carbon. Much of the biomass targeted for removal would not have been apparent in these stands, if the periodic fire regime had not been disrupted. Hanson also neglects to factor in the likely carbon losses if the more frequent fire regime that he promotes is achieved.

“b) biomass logging “increasingly seeks to remove old-growth trees”

This does not make sense to me. I am not sure where this is occurring “increasingly” in the Sierra Nevada. From our project tracking, the number of projects that remove hardwoods up to 30” dbh is pretty limited.1 Hardwood and juniper were mentioned by Hanson as species subjected to removal of old growth. The removal of trees, as biomass, associated with pinyon-juniper woodlands has been proposed to restore grassland and savannah systems. Whether or not removal of pinyon-juniper is a desirable management action, this practice seems to be more prevalent in areas outside of the Sierra Nevada (i.e., Modoc National Forest).

1 Slapjack (Plumas National Forest) is the only recent project that I know of and the target species was tan oak; these were large trees, but probably not old growth) that said, the removal of these trees was objectionable.
“c) is generally tied to larger timber sales”

This isn’t an ecological reason to object to biomass removal. What if biomass removal is not tied to a larger timber sale? What if the larger timber sale is focused on the removal of surface and ladder fuels and the ladder fuels that just happen to have commercial value?

“d) tends to remove all or nearly all of the smaller trees, regardless of species”

This is the only relevant issue mentioned. This is an important point, but should not be used as a reason to unequivocally reject biomass projects. Biomass projects, like all management activities, need to be designed to support a restoration goal for the treated area that provides for structural diversity now and supports its development in the future. The key is to design projects in the right place and at the right pace and scale to meet the restoration need.

Hanson (p. 23) conflates the terms “biomass” and “old growth” by stating that “The living and dead plant material in a forest is called biomass. This includes everything from the small diameter branches, trees, and shrubs up to the old-growth trees.” Biomass generically is defined as living matter. In the context of forest management in the Sierra Nevada, “biomass” is defined as the wood fiber products to be removed that are not utilized for commercial timber products. Commercial timber products are defined by tree species and size. As a general matter, “biomass” as a product does not include commercial sized trees; an exception to this could be the occasional inclusion of cull logs in biomass piles. Individual old growth trees of commercially designated species generally would not be called biomass. The two examples of tree types Hanson used in association with the term old-growth were hardwood and juniper. These are generally not considered to be commercial timber species. Biomass removal in the Sierra Nevada largely has focused on small diameter material and shrubs.

Hanson claims that “biomass thinning not only reduces carbon sequestration in the short-term, it also diminishes the forest’s productive capacity, and carbon sequestration potential, in the longer-term.” This statement is in conflict with Hurteau and North (2010) which shows that carbon stocks can recover. Reinhardt and Holsinger (2010) also concluded that “fuel treatments reduce tree mortality from subsequent wildfire, enabling stand recovery and long term carbon uptake.” I have not been able to verify that Hanson’s citation of Schlesinger (1997) supports his claim that biomass removal as practiced in the Sierra Nevada diminishes the productive capacity of this region’s forests. This citation is for a reference book and lacks a page number citation.

Hanson refers to several papers in support of his thesis that logging and biomass removal reduces carbon stocks and sequestration. These papers (Turner et al. 2007, Depro et al. 2008, Keith et al. 2009) cover a variety of regions; Depro et al. (2008) is the only study that specifically includes the Sierra Nevada region. Hanson uses these studies to support the claim that:

Carbon sequestration is maximized where logging is absent and wildland fire is present (Turner et al. 2007, Depro et al. 2008, Keith et al. 2009).

(Hanson, p. 24). These studies do not support or only marginally support this claim for the following reasons.
Turner et al. (2007) examined productivity in Oregon and Washington. This study created a carbon budget for a heterogeneous region. Logging and fire, as disturbance processes, were accounted for in the modeling effort, but the logging was limited to clear-cut harvest. The researchers identified that thinning as a practice was not included as a disturbance. Turner et al. (2007, p. 609) specifically identify that the effects of thinning could be incorporated into future models. This paper does not make any claim about the effects of thinning on carbon sequestration and did not evaluate a condition where logging was absent and wildfire was present.

Depro et al. (2008) examined the sequestration potential of forests throughout the United States. The “no harvest” scenario assumed that nationwide 140,000 acres each year would be regenerated due the effects of natural mortality from wildfire, insects and pathogens. Annual estimates for Sierra Nevada forests in the last ten years average about 121,000 acres per year of fire with approximately 20% of that or 24,000 acres in high severity fire (Miller et al. 2009, Figures 2 and 4). Based on these regional estimates of fire effects for the Sierra Nevada, the estimate in Depro et al. (2008) seems very low and does not appear to take into account fire effects that do not result in “regeneration” (i.e., fire effects that “thin” a stand and reduce biomass, but do not result in a stand regenerating from seed). The modeled results do not take into account the effects from types of wildfire that we see today in addition to the increased levels of burning desired in the future. Depro et al. (2008) recognized that they provided a “rough estimate” of carbon sequestration and indicated that:

Of particular interest is the link between carbon management, fire management, and biofuel production, each of which can have a profound impact on the carbon balance, ecological integrity, and economic value of the forest. One research need is a better understanding of how such linkages are affected by the stochastic nature of certain disturbances such as fires.

This study provides a useful methodology and first estimates of carbon that takes into account various management practices, but does not adequately characterize (nor does it claim to do so) potential changes in carbon due to fire patterns that we experience today or were likely to have experienced in the past. Using the modeling tools described, the study (Depro et al. 2008, p. 1133) found that the scenario of no logging would result in maximum carbon sequestration and noted that such an approach would “have opportunity costs in terms of the economic and ecological value of the corresponding changes in market and nonmarket ecosystem services” and concluded, in part, that “Forest and carbon management, however, is much more subtle than simply determining how much to harvest.” Hanson’s statement that the study found that “carbon sequestration would be maximized by ending all logging on U.S. public lands nationwide (Depro et al. 2008)” is correct for the modeling assumptions that they made, but as noted by the authors it is a not the final answer to carbon management.

Keith et al. (2009, p. 11640) examined forests worldwide, including those in Oregon and Washington, but did not include data for forests in the Sierra Nevada. The data was taken from “sites that represent largely mature or primary forest with minimal human disturbance.” Study areas in Oregon and Washington are most comparable to characteristics in the Sierra Nevada.
The only type of fire noted for these sites was catastrophic and occurred anywhere from 40 years prior to the study (Keyes and Grier 1981), 150 or 450 years prior (Smithwick et al. 2002), or was vaguely specified as fire not having occurred for at least 25-30 years (Grier and Logan 1977). Keith et al. (2009) also did not compare unlogged with logged areas. This study does not support (or refute) Hanson’s statement that the carbon levels are greater in unlogged areas with fire, since the characterizations of fire history are limited and there was no comparison to logged areas.

Hanson also cites Keith et al. (2009) when referring to the effects of high intensity fire on carbon stocks:

Researchers recently found that the highest carbon sequestration levels were in forests that had previously experienced considerable occurrence of high-intensity fire (Keith et al. 2009).

Peak biomass levels have been found in areas that have experienced high-intensity wildland fire – the total biomass being comprised of the fire-killed trees and downed logs, as well as the regenerating post-fire stand of trees (Keith et al. 2009).

(Hanson, p. 24) Hanson’s implication appears to be that high-intensity fire results in peak biomass. Keith et al (2009, p. 11639) discuss the variety of factors that influence carbon stocks including “a combination and interaction of environmental conditions, life history attributes, morphological characteristics of tree species, disturbance regimes, and land-use history.” Their report included data on Eucalyptus regnans forests in Australia which have the highest known biomass density in the world. For this forest type, they found “the highest values were from areas experiencing past partial stand-replacing natural disturbances” (Ibid., p. 11536). However, there was no specific claim made in Keith et al. (2009) that as a general matter stand replacing fire was (or was not) a significant driver in the increased carbon storage. This is not surprising since the time since a catastrophic event was highly variable (25 to 450 years) for the sites in Washington and Oregon and not sufficiently characterized (e.g., area affected, quantification of non-stand replacing fire effects) to be evaluated in this meta-analysis completed by Keith et al. (2009). Catastrophic fire was identified as having occurred at some point during the stand history for several of the sites in the study, but no statement was made about the causal relationship between this high severity disturbance and peak biomass.

The general understanding of the dynamic between carbon sequestration and disturbance is still not fully understood and appears to be quite variable among vegetation associations.

Summary (p. 24): “Current forest management direction continues to be disconnected from the current scientific data, and remains heavily focused on mechanical thinning projects ostensibly to reduce future tree mortality from competition and wildland fire.”

Comment

I agree that current management projects are heavily focused on mechanical treatments to achieve fuel reduction. It is important to expand project planning and implementation to use significantly more managed fire to achieve resource goals. That said, I have not read anything in
the scientific literature to suggest that as a general matter there is an objection to mechanical thinning to reduce future tree mortality from competition and wildfire.

To the contrary, the management recommendations that emerge from recent papers focused on montane forest in the Sierra Nevada (e.g., Stephens and Moghaddas 2005, Hurteau and North 2010, North et al. 2009) support the judicious removal of wood fiber to improve ecosystem function. The focus tends to be on surface and ladder fuels to address fire concerns. In other regions (e.g., Pacific Northwest and northern Arizona), restoration objectives to thin near large individual trees are at times suggested to reduce stress on large, old trees (Kolb et al. 2007) and thinning has been shown to improve seasonal drought resistance and reduce carbon loss (Dore et al. 2010). Management recommendations in the literature also tend to directly address the need to increase the use of managed fire to restore disturbance processes to the system. The recommendations presented in the scientific literature do not support the idea of applying only managed fire to the Sierra Nevada landscape.

References


Hanson et al. 2009.


*Britting (7-26-11): Review of Hanson 2010*


*Britting (7-26-11): Review of Hanson 2010*


Appendix

Taken from Plumas Lassen Administrative Study, annual report 2009

Selected figures

Figure 9. Maps of fire severity in the: (a) Moonlight-Antelope Complex fire (88,000 acres) that burned in 2007, and (b) the Cub-Union Complex fire (21,000 acres) that burned in 2008 on the Plumas and Lassen National Forests, California.
(a)

(b)
Figure 13. Distribution of California spotted owls within the Moonlight-Antelope Complex fire area and a 1.6 km buffer during 2008 and 2009 on the Plumas and Lassen National Forests, California.
Figure 14. Distribution of California spotted owls detected in 2009 within the Cub-Onion Complex Fire Area and a 1.6 km buffer and wildfire burn severity classes on the Lassen National Forest, California.
calveg 2006

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Mixed Chaparral
Montane Hardwood
Sierran Mixed Conifer