CENTER *for* BIOLOGICAL DIVERSITY

THE JOHN MUIR PROJECT *of* EARTH ISLAND INSTITUTE

1 May 2013

Re: Draft USFS R5 Science Synthesis (2013)

To Whom It May Concern:

The Center for Biological Diversity and the John Muir Project offer the following comments regarding the Draft Science Synthesis.

High-Severity Fire Extent And Patch Size

While pages 2-5 of section 4.1 to some extent acknowledge the uncertainties and nuances of addressing fire, the report overall nonetheless presents a picture of a) too much high severity fire that must therefore be curtailed, and b) too large of high-severity patch sizes that must therefore be avoided. The report also refers to “uncharacteristically severe wildfire,” but without any meaningful context or basis for that characterization (e.g., page 3 of section 1.1) – the literature cited for this proposition does not actually establish that any recent wildfires in the Sierras/Cascades are “uncharacteristic.”

We recognize that although it is now well accepted that high-severity fire is a key component of the landscape and a disturbance that numerous wildlife species rely upon either directly or indirectly, there is debate as to what is the acceptable range of high-severity percentage in any given fire or fires, and there is still debate as to what is the appropriate size for high-severity patches within a fire. The Draft Synthesis, however, does not acknowledge this debate, nor does it acknowledge the considerable breadth of literature regarding this subject. High-severity fire, as well as large patches of high-severity fire, are an important component of not only fir and lodgepole pine forest, but also of mixed-conifer forests in the Sierra/Cascade region, and the available literature indicates that a wide range of high-severity fire (extent as well as patch size) is ecologically appropriate and acceptable (e.g., Beaty and Taylor 2001, Bekker and Taylor 2001, Bekker and Taylor 2010, Collins and Stephens 2010).

Contrary to assumptions (e.g., the 2004 Sierra Nevada Framework), considerable data and research exists that indicates that mixed-severity fire: a) is not limited to true fir and lodgepole pine and is instead also a natural condition in ponderosa-pine/Jeffrey-pine and mixed-conifer forest; b) generally dominated pre-fire suppression fire regimes in these forest types; and c) can include a significant proportion of high-severity fire including occasional large high-severity fire patches hundreds or thousands of acres in size (Baker 2006, Baker 2012, Baker et al. 2007, Beaty and Taylor 2001, Bekker and Taylor 2001, Bekker and Taylor 2010, Brown et al. 1999, Collins and Stephens 2010, Colombaroli and Gavin 2010, Hessburg et al. 2007, Iniguez et al. 2009, Klenner et al. 2008, Leiberg 1897, 1899a, 1899b, 1899c, 1900a, 1900b, 1900c, 1902, 1903, 1904a, 1904b, Nagel and Taylor 2005, Sherriff and Veblen 2007, Shinneman and Baker 1997, Show and Kotok, 1924, 1925, Stephenson et al. 1991, Taylor 2002, USFS 1910-1912, Whitlock et al. 2008, 2010, Williams and Baker 2010, 2011, 2012a, 2012b, Wills and Stuart 1994).

For example, Baker (2012) found that in dry mixed-conifer forests of the eastside of the southern Cascades in Oregon, historic fire was 24% low-severity, 50% mixed-severity, and 26% high-severity [Table 5]. The Baker (2012) paper, as well as the recent Williams and Baker studies (2012a, 2012b), have been criticized by the Forest Service for not being specific to the Sierras. However, no similar landscape level effort has been conducted for the Sierras – in other words, there is no other study or studies for the Sierra that can claim to have answered the questions that the Williams and Baker addressed using their methodology (see Williams and Baker 2011). Moreover, in the regions wherein the Baker and the Williams and Baker studies do exist, the same assumptions that prevail in the Sierras had prevailed in those areas as well – i.e., the assumption that low-severity fire heavily dominated and maintained forests that were mostly open and parklike (Williams and Baker 2010, Williams and Baker 2011, Williams and Baker 2012a, 2012b). Further, the Williams and Baker (2012) study was based on over 13,000 records from surveyors across about 4 million acres of land in three states and these records are as good or better than the kinds of data other studies reply upon, and the accuracy and validity of the survey data were validated in an extensive scientific trial (Williams and Baker 2011). Finally, the tree-ring data that others rely upon are very spatially limited and are generally from small, isolated studies totaling at most thousands of acres, not millions of acres. The Synthesis does not acknowledge or address this.

Even if the Forest Service continues to wrongly be dismissive of the studies just described, data that exist for the Sierra/southern Cascades region of California are telling as well. Beaty and Taylor (2001), in the western slope of the southern Cascades in California, found that historic fire severity in mixed-conifer forests was predominantly moderate- and high-severity, except in mesic canyon bottoms, where moderate- and high-severity fire comprised 40.4% of fire effects [Table 7]. Bekker and Taylor (2001), another study in the western slope of the southern Cascades in California, found historic fire severity to be predominantly high-severity in their study area [Fig. 2F]. Bekker and Taylor (2010), in mixed-conifer forests of the southern Cascades, found reconstructed fire severity to be dominated by high-severity fire effects, including high-severity fire patches over 2,000 acres in size [Tables I and II].

Outside of the Cascades, Leiberg (1902), which contains information from the central and northern Sierra Nevada, found high-severity fire patches over 5,000 acres in size in mixed-conifer forest that had not been logged previously during the 19th century, prior to fire suppression. Show and Kotok (1924), in ponderosa pine and mixed-conifer/pine forests of the Sierra Nevada, found that high-severity crown fires, though infrequent on any particular area, "may extend over a few hundred acres" in patches [p. 31; see also Plate V, Fig. 2, Plate VII, Fig. 2, Plate VIII, Plate IX, Figs. 1 and 2, and Plate X, Fig. 1], with some early-successional areas resulting from high-severity fire patches covering 5,000 acres in size or more [pp. 42-43]. Within unlogged areas, the authors noted many large early-successional habitat patches, dominated by montane chaparral and young, regenerating conifer forest, and explained that such areas were the result of past severe fire because: a) patches of mature/old forest and individual surviving trees were found interspersed within these areas, and were found adjacent to these areas, indicating past forest; b) snags and stumps of fallen snags, as well as downed logs from fallen snags, were abundant in these areas; c) the species of chaparral found growing in these areas are known to sprout abundantly following severe fire; and d) natural conifer regeneration was found on most of the area [p. 42], often growing through complete chaparral cover [p. 43]. Similarly, Show and Kotok (1925) found that within the ponderosa pine and mixed-conifer/pine belt of the Sierra Nevada, 1 acre out of every 7 on average was dominated by montane chaparral and young regenerating conifer forest following high-severity fire [Footnote 2, and Figs. 4 and 5]; and on one national forest 215,000 acres out of 660,000 was early-successional habitat from severe fire [p. 17]. Forest Service Timber Survey Field Notes from 1910-1912 show that surveys were conducted within primary forest to evaluate timber production potential in 16.2-ha (40-acre) plots within each 259.1-ha (640-acre) section in ponderosa pine and mixed-conifer forest on the westside of the Stanislaus National Forest, using one or more 1.62-ha transect per plot. The surveyors noted that surveys for individual tree size, density and species were not conducted in areas that had experienced high-severity fire sufficiently recently such that the regenerating areas did not yet contain significant merchantable sawtimber. Surveyors also noted that the dominant vegetation cover across the majority of many 259.1-ha sections was montane chaparral and young conifer regeneration following high-severity fire. For example (from a typical township in the data set): a) T1S, R18E, Section 9 ("Severe fire went through [this section] years ago and killed most of the trees and land was reverted to brush", noting "several large dense sapling stands" and noting that merchantable timber existed on only four of sixteen 16.2-ha plots in the section); b) T1S, R18E, Section 14 ("Fires have killed most of timber and most of section has reverted to brush"); c) T1S, R18E, Section 15 (same); d) T1S, R18E, Section 23 ("Most of timber on section has been killed by fires which occurred many years ago"); T1S, R18E, Section 21 ("Old fires killed most of timber on this section and most of area is now brushland".)

Although the Draft Synthesis argues that fire in the Sierras must be significantly different than fire in the southern Cascades, that argument may not in fact be true and therefore should not be presented as definitive. The draft mischaracterizes the findings from, e.g., Beaty and Taylor (2001) and Bekker and Taylor (2001) by claiming that the mixed-conifer forests of the southern Cascades are different from those of the Sierra Nevada because the topography of the southern Cascades is gentle, with unbroken forest, allowing long runs of wildland fire, despite the fact that both Beaty and Taylor (2001) [Fig. 1] and Bekker and Taylor (2001) [Fig. 1] include topographical maps which show that the study areas were mostly on slopes, not gentle topography, and were broken by peaks, meadows, and lava fields, contrary to the draft Science Synthesis' assertion about unbroken forest cover in the southern Cascades.

Furthermore, with regard to high-severity patch size, burned patches have been found to conform to a power law size distribution that is scale invariant and applies to any fire regime. Small patches are more numerous, but large patches cover much of the area. The implication is that large patches will be found in any analysis that evaluates a sufficiently large area and it is necessary to study a large area to adequately encompass large patches. As a result, studies done over large areas of the Sierra Nevada, such as Leiberg's, are most useful for documenting the large patches. Conversely, studies of relatively small areas or small fires, and/or a very small number of fires (e.g., Collins and Stephens 2010) may or may not intersect large patches depending on how and where they are located with respect to those patches. Thus, while there are studies that have evaluated relatively small areas within the Sierra landscape which found no large stand-replacing fire patches, this does not negate the occurrence of large patches outside the boundaries of these study areas.

Existing data and research also suggest that Sierra forests were historically structurally complex, with a high degree of heterogeneity from natural disturbance, in terms of chaparral patch extent, stand structure, density, and species composition—including stands dominated by fir and cedar with dense understories as a significant part of the mix in both ponderosa-pine/Jeffrey-pine and mixed-conifer forests. Baker (2012) found that historic mixed-conifer forests contained some open and park-like areas, but such areas were a minority. Rather, overall, the area was dominated by denser forests with substantial shrub cover and understory conifer density—small trees comprised over 50% of all trees on over 72% of the forest (see also Duren et al. 2012.) Leiberg (1902) found that, in mixed-conifer forests in the central and northern Sierra Nevada, while some of the areas were open and parklike stands dominated by ponderosa pine, Jeffrey pine, and sugar pine, the majority were dominated by white fir, incense-cedar, and Douglas-fir, especially on north-facing slopes and on lower slopes of subwatersheds; such areas were predominantly described as dense, often with "heavy underbrush" from past mixed-severity fire. Natural heterogeneity, resulting from fire, often involved dense stands of old forest adjacent to snag forest patches of standing fire-killed trees and montane chaparral with regenerating young conifers: "All the slopes of Duncan Canyon from its head down show the same marks of fire—dead timber, dense undergrowth, stretches of chaparral, thin lines of trees or small groups rising out of the brush, and heavy blocks of forest surrounded by chaparral." [p. 171] Similarly, the USDA 1910-1912 Timber Survey Field Notes found that historic ponderosa pine and mixed-conifer forests of the central/southern Sierra Nevada [western slope] varied widely in stand density and composition; open and park-like pine-dominated stands comprised a significant portion of the lower montane and foothill zones, but dense stands dominated by fir and cedar, and by small/medium-sized trees, dominated much of the middle montane zone (It should be noted that the old-growth forests chosen for study by Scholl and Taylor 2010 and Collins et al. 2011 comprised only a very small portion of the 1910-1912 Stanislaus data set). Nagel and Taylor (2005) noted that "[c]haparral has been replaced by forest and this vegetation change has reduced the heterogeneity of the mixed conifer forest landscapes in the Sierra Nevada. . . Our study suggests that maintenance of chaparral should be an integral part of ecosystem restoration plans for mixed conifer forest landscapes in the Lake Tahoe basin and northern Sierra Nevada."

Current rates of high-severity fire (rotation intervals) in the Sierra Nevada and southern Cascades are also likely far lower (longer rotation intervals) than historic rates, indicating less high-severity fire and therefore a high-severity fire deficit. Miller et al. (2012) found that the current high-severity fire rotation interval in the Sierra Nevada management region overall is over 800 years. The authors recommended increasing high-severity fire amounts [i.e., decreasing rotation intervals] in the Cascades-Modoc region and on the western slope of the Sierra Nevada, where the current high-severity fire rotation is 859 to 4650 years [Table 3]. The authors noted that "high-severity rotations may be too long in most Cascade-Modoc and westside NF locations, especially in comparison to Yosemite . . . ."

Due to the lack of fire (compared to historic levels) in the Sierra region, it is sometimes argued, such as in the Draft Synthesis, that when fire does finally enter an area again, that area will be more likely to burn at high-severity due to the missed intervals. However, research has found that forest areas that have missed the largest number of fire return intervals in California's forests are burning predominantly at low/moderate-severity levels, and are not experiencing higher fire severity than areas that have missed fewer fire return intervals (Miller et al. 2012b, Odion and Hanson 2008, Odion et al. 2010, van Wagtendonk et al. 2012). This is important because it means that missed fire return intervals are not a reliable indicator of how a forest will burn when fire does again enter a given area.

<u>High-Severity Fire From A Wildlife Perspective</u>

The Draft Synthesis fails to meaningfully acknowledge what wildlife biology tells us about the importance of high-severity fire. For example, while some recent fires have been characterized as too large or as containing too high a percentage of high-severity fire (e.g., McNally Fire, Moonlight Fire), these same fires can be characterized as ecologically beneficial (and necessary from an evolutionary perspective) in light of data regarding wildlife use of the post-fire landscape. In regard to the McNally Fire, one study (Buchalski et al. 2013) found that most phonic groups of bats showed higher activity in areas burned with moderate to high-severity. (See also Malison and Baxter 2010, finding greater bat activity was observed in high-severity burned riparian habitat within mixed-confer forest than at unburned areas of similar habitat in central Idaho). Similarly, in the McNally area, California spotted owls were found to be preferentially selecting high-severity fire areas for foraging (Bond et al. 2009). In the Moonlight Fire area, researchers explained that "[i]t is clear from our first year of monitoring three burned areas [Cub, Moonlight and Storrie Fires] that post-fire habitat, especially high severity areas, are an important component of the Sierra Nevada ecosystem." (Burnett et al. 2010). They also found that "[o]nce the amount of the plot that was high severity was over 60% the density of cavity nests increased substantially," and that "more total species were detected in the Moonlight fire which covers a much smaller geographic area and had far fewer sampling locations than the [unburned] green forest." (Burnett et al. 2010). Moreover, while the Forest Service has characterized the Moonlight Fire as detrimental to spotted owls, the impacts of the extensive salvage logging on private lands directly adjacent to the PACs were not accounted for. In general as well, it is important to keep in mind that post-fire areas that are manipulated by salvage logging and/or by reforestation efforts are, from an ecological perspective, no longer valuable as post-fire areas; rather, post-fire salvage logging and reforestation substantially reduce, and often locally eliminate, wildlife species strongly associated with the forest habitat created by high-severity fire patches (Hanson and North 2008, Hutto 2008, Burnett et al. 2011, 2012, Seavy et al. 2012, Siegel et al. 2012, 2013).

Time since fire provides important insights into the continuum of use of post-fire areas over time by different species. Black-backed woodpeckers, for example, are well known to require areas with very high snag densities immediately post-fire – e.g., mature forest that has very recently experienced higher-severity fire, and has not been salvage logged (Hanson and North 2008, Hutto 2008, Saab et al. 2009, Seavy et al. 2012, Siegel et al. 2010, 2011, 2012, 2013). However, "while some snag associated species (e.g. black-backed woodpecker) decline five or six years after a fire [and move on to find more recent fire areas], [species] associated with understory plant communities take [the woodpeckers'] place resulting in similar avian diversity three and eleven years after fire (e.g. Moonlight and Storrie)." (Burnett et al. 2012). Burnett et al. (2012)

also noted that “there is a five year lag before dense shrub habitats form that maximize densities of species such as Fox Sparrow, Dusky Flycatcher, and MacGillivray’s Warbler. These species have shown substantial increases in abundance in the Moonlight fire each year since 2009 but shrub nesting species are still more abundant in the eleven year post-burn Storrie fire. This suggests early successional shrub habitats in burned areas provide high quality habitat for shrub dependent species well beyond a decade after fire.” (Burnett et al. 2012). Raphael et al. (1987) found that at 25 years after high-severity fire, total bird abundance was slightly higher in snag forest than in unburned old forest in eastside mixed-conifer forest of the northern Sierra Nevada; and bird species richness was 40% higher in snag forest habitat. In earlier post-fire years, woodpeckers were more abundant in snag forest, but were similar to unburned by 25 years post-fire, while flycatchers and species associated with shrubs continued to increase to 25 years post-fire (Raphael et al. 1987). In ponderosa pine and Douglas-fir forests of Idaho at 5-10 years post-fire, levels of aquatic insects emerging from streams were two and a half times greater in high-severity fire areas than in unburned mature/old forest, and bats were nearly 5 times more abundant in riparian areas with high-severity fire than in unburned mature/old forest (Malison and Baxter 2010). Schieck and Song (2006) found that bird species richness increased up to 30 years after high-severity fire, then decreased in mid-successional forest [31-75 years old], and increased again in late-successional forest [>75 years]).

Even areas that burn at high-severity and then, shortly therafter, burn again at high-severity, are ecologically valuable. Donato et al. (2009) found that a high-severity re-burn [high-severity fire occurring 15 years after a previous high-severity fire] had the highest plant species richness and total plant cover, relative to high-severity fire alone [no re-burn] and unburned mature/old forest; and the high-severity fire re-burn area had over 1,000 seedlings/saplings per hectare of natural conifer regeneration. Fontaine et al. (2009) found that bird species richness was not significantly different between high-severity re-burn, high-severity burn alone, and unburned old-growth forest, but was numerically highest in areas burned once by high-severity fire 17-18 years earlier, and in high-severity re-burn areas. Total bird abundance was higher in the high-severity fire area, at 17-18 years post-fire, than in the unburned old-growth forest [Figs. 3a and 3b] (Fontaine et al. 2009).

Finally, when comparing the impacts of mechanical treatments to those of high-severity fire, it is critical to keep in mind that the comparison is between a definite outcome (i.e., the area will in fact be thinned/treated) and an indefinite outcome (i.e., the area may not burn at all if left untreated, and even if it does burn, it may not burn at high-severity). Moreover, even if an untreated area were to burn at high-severity, as just explained, that can be very beneficial to the ecosystem. Thus, when examining mechanical treatments in regard to wildlife impacts, it is crucial to acknowledge what is actually being compared as well as to acknowledge the uncertainties associated with those comparisons. Only then so the tradeoffs actually have any meaning to them.

Post-fire Management

The section of the Draft Synthesis regarding post-fire management fails to discuss the considerable research showing the harm to wildlife from a) salvage logging, and b) planting trees in post-fire areas. Both of these actions essentially negate the complex early seral forest that high-severity fire creates. While much of the conservation attention in the Sierra Nevada has focused on iconic conifers like giant sequoia (*Sequoiadendron giganteum*) and old-growth forests generally, complex early seral forests (CESFs) created by stand-replacing fire are underappreciated for their unique biodiversity (see, e.g., Swanson et al. 2010), and, as such, CESFs are not even included as a habitat type in any current vegetation mapping used by the Forest Service (e.g., California Wildlife Habitat Relations). Complex early seral forests occupy sites that occur in time and space between a stand-replacement disturbance and re-establishment of a closed-forest canopy. Young forests, if resulting from purposeful regeneration harvest or from fire salvage harvest, lack the features and characteristics of unmanaged forests naturally regenerating from high-severity fire. CESFs are rich in post-disturbance legacies (e.g., very high snag levels) and post-fire vegetation (e.g., native fire-following shrubs, flowers, natural conifer regeneration) that provide important habitat for countless species and differ from those created by logging (e.g., salvage or pre-fire thinning), which are deficient in biological legacies and many other key ecological attributes (see, e.g., Table 1 in Swanson et al. 2010, Table 1 in Donato et al. 2012). Thus, to distinguish early seral forests from logged early seral, the term "complex" is used in association with early seral produced by natural disturbances.

In the Sierra Nevada, CESFs provide habitat for dependent species like Black-backed Woodpeckers. Post-fire logging and tree planting destroys that habitat, even when only partial salvage logging occurs. In the fall of 2012, the U.S. Forest Service recognized that there is a significant concern regarding the conservation of the Black-backed Woodpecker population in California and released a Conservation Strategy for this species (Bond et al. 2012). Among the conservation measures were the following: a) identify the areas of the highest densities of the largest snags, and do not salvage log such areas; b) if the Forest Service decides to conduct post-fire logging in a particular area, logging units should not be bigger than 2.5 hectares, or 6.2 acres (page 10, Recommendation 1.3); and c) avoid post-fire logging during nesting season, May 1 through July 31 (page 10, Recommendation 1.5). The Conservation Strategy is not even mentioned in the Draft Synthesis.

Siegel et al. (2013) describe in detail the level of snag basal area associated with suitable Black-backed Woodpecker foraging habitat, concluding that, within the overall home ranges of an individual pair, a threshold of about 20 square meters/hectare of snag basal area (i.e., over 87 square feet/acre), or at least 17 square meters/hectare (at least 74 square feet/acre), represents suitable, viable foraging habitat for this species (Siegel et al. 2013, pp. 45, 68-70). Siegel et al. (2013) also found (p. 59) that Black-backed Woodpecker suitable nesting habitat averages 43 square meters/hectare of recent snag basal area, and ranges from 18 to 85 square meters/hectare.

Siegel et al. (2011) concluded that native fire-following shrubs are vitally important to biodiversity in complex early seral forest (CESF) created by high-intensity fire: "Many more species occur at high burn severity sites starting several years post-fire, however, and these include the majority of ground and shrub nesters as well as many cavity nesters. Secondary cavity nesters, such as swallows, bluebirds, and wrens, are particularly associated with severe burns, but only after nest cavities have been created, presumably by the pioneering cavity-excavating species such as the Black-backed Woodpecker. Consequently, fires that create preferred conditions for Black-backed Woodpeckers in the early post-fire years will likely result in increased nesting sites for secondary cavity nesters in successive years."

In addition, the following are some key studies regarding how post-fire logging/artificial-planting can harm wildlife—studies which should be discussed in the Draft Synthesis in order to meaningfully inform the public regarding the severe ecological impacts of post-fire logging and replanting: Hanson and North (2008); Hutto (2008); Burnett et al. (2011 [Fig. 11]); and Siegel et al. (2013 [Fig. 13) (see also detailed annotated references in the last section below).

Particular Concerns Regarding Several Misleading Aspects of the Draft Synthesis

In this section, we address four significant misleading aspects of the Draft Synthesis that do not fall neatly into either of the categories described in the section below (data missed, and key findings not mentioned).

First, the draft Science Synthesis contains a misleading discussion of recent U.S. Forest Service modeling reports and papers pertaining to the Pacific fisher, and the balance of risks between mechanical thinning and wildland fire, based upon citations to Spencer et al. (2008), Scheller et al. (2011), Spencer et al. (2011), Syphard et al. (2011), and Thompson et al. (2011) (see draft Science Synthesis pages 17-19 of Section 1.1, pages 10 and 21 of Section 4.1, and pages 18-20 and 24-27 of Section 7.1). The Spencer et al. (2008) report was a purely hypothetical modeling exercise, not an attempt to estimate and predict actual or likely effects of thinning versus wildland fire on fishers (and the Scheller et al. 2011, Spencer et al. 2011, and Syphard et al. 2011 studies are all simply the published versions of different chapters of Spencer et al. 2008). For their hypothetical "what if" scenario (and at the specific request of the U.S. Forest Service), Spencer et al. (2008) "modeled" a hypothetical "Baseline" fire regime and a "High" fire regime, for which fire severity levels of 3.5 and 4.5 were assigned, and fire "tolerance" levels of 3 to 4 were assigned for the conifer species dominating mixed-conifer forests of the Sierra Nevada, based upon Sturtevant et al. (2009). *See* Spencer et al. 2008 (p. xviii, Table 3.1, p. 54, and references section). Sturtevant et al. (2009), at page 3385, stated that these hypothetical fire severity categories were based upon He and Mladenoff (1999). According to the He and Mladenoff (1999) hypothetical system, a fire severity level of 3 kills all but the oldest two age classes (71-85% and 85-100% of longevity) of a species with a fire tolerance level of 3 (He and Mladenoff 1999, Fig. 3c and pp. 82-83). A fire severity level of 4 kills all but the oldest age class of trees (85-100% of longevity) of a species with a fire tolerance level of 3 or 4 (He and Mladenoff 1999, Fig. 3d and pp. 82-83). A fire severity level of 5 kills 100% of the trees at any fire tolerance level (He and Mladenoff 1999, Fig. 3e). Spencer et al. (2008) assigns longevities of 300-500 years for the conifer species in mixed-conifer forests (Spencer et al. 2008, Table 3.1). Therefore, under the Baseline scenario, a fire severity level of 3.5, with fire tolerances of 3 to 4, assumes that the only trees that survive fire are those in the oldest age class, and about half of those in the second oldest age class—i.e., trees 260 to 400 years old survive, and half of the trees approximately 220 to 330 years old (depending upon conifer species) survive, while all other trees are killed. This equates to about 90% tree mortality or more, given that most stands have no trees this old and, even in the old-growth stands, less than 5% of the trees are this old. At a fire severity level of 4.5 (High fire regime), mortality is almost total (95-100%). These assumptions do not coincide, however, with the biological reality of how forest stands are actually burning in the Sierra Nevada. In reality, fires are dominated by low- and moderate-severity effects and most trees survive (Odion and Hanson 2006, 2008, Collins et al. 2009, Collins and Stephens 2010). For this same reason, Thompson et al. (2011) does not reflect biological reality, since it is likewise based upon the modeling assumption of 90% tree mortality when wildland fire occurs (see Fig. 3, regarding canopy cover, in Thompson et al. 2011). Moreover, Spencer et al. (2008, Table 3.1) assumes that, when these fires burn and kill all or nearly all of the trees, stands will only naturally regenerate effectively within 30-150 meters from the edge of the fire, while the vast majority of the acreage of any given fire area (the interior) will not naturally regenerate, contrary to published data on natural post-fire conifer regeneration in large high-intensity fire patches (Shatford et al. 2007, Donato et al. 2009, PLAS 2011). These are the fire scenarios that Spencer et al. (2008) used to "balance" the risks of fire versus logging. When the effects of fire are so exaggerated, the only thing that would be "riskier" than modeled fire effects would be clearcutting.

The draft Science Synthesis does not candidly divulge that the so-called "benefits" of logging identified in Spencer et al. (2008) and the related modeling exercises were based upon unrealistic criteria, as well as upon the assumption (which those studies did not test) that higher-severity fire is categorically harmful to Pacific fishers. Hanson (in preparation, 2013), using scat-detecting dogs in burned (not salvage logged) and unburned areas of the northern Kern Plateau, is finding that: a) fishers select mature/old forest both when it is unburned and when it has experienced moderate/high-severity wildland fire; b) when near fire edges, fishers select the within-fire side of fire boundaries, rather than avoid fires; and c) fishers are using large mixed-severity fire areas (e.g., McNally fire of 2002) over 5-6 kilometers inside the fire (i.e., over 5-6 km from the nearest edge of the fire perimeter). While these data are as yet unpublished, they are the only data available that actually examine how fishers use a post-fire landscape.

Second, the draft Science Synthesis contains a misleading and inaccurate discussion of Pacific fisher habitat in the context of the Forest Service's claims that extensive logging will be necessary, ostensibly to restore fisher habitat. Specifically, the draft Science Synthesis claims that removal of trees less than 20 inches in diameter at breast height, particularly white fir and incense-cedar, will be necessary to restore and benefit fisher habitat (see page 18 of Section 7.1). However, the draft Science Synthesis provides no reference to any scientific source to support this assertion. Moreover, Zielinski et al. (2006) found that one of the two most important factors for fisher rest sites is a high density of trees under 20 inches in diameter, and Underwood et al. (2010 [Table 3 and Figure 3]) found that the areas selected by fishers contain the highest densities of small and medium-sized trees, and contain the highest proportions of white fir and incense-cedar, including in the small/medium tree size classes. The draft Science Synthesis fails to adequately address and incorporate this information. Moreover, Dr. Sweitzer has presented preliminary data showing that in his SNAMP study area, fishers are selecting incense cedar and white fir as den trees (see bottom left of May 1 2012 - Fisher Field Trip Poster at http://snamp.cnr.berkeley.edu/documents/446/).

Third, the draft Science Synthesis contains a misleading and inaccurate reference to a book chapter, Lawler et al. (2012), to promote the notion that "fuel reduction" logging will be necessary to protect fishers from wildland fire and climate change, suggesting that this chapter concluded: a) climate change will cause range contraction of Pacific fishers in the southern Sierra Nevada; b) fire will threaten the fisher; and c) "forest fuel treatment" should be applied to protect fisher habitat from fire, in addition to allowing more managed wildland fire (see page 24 of Section 7.1). However, the book chapter does not address overall spatial contraction of the range of the southern Sierra Nevada fisher population. Rather, it addresses whether the fisher is likely to be pushed out of portions of it *current* range in the southern Sierra Nevada due to climate change (Lawler et al. 2012, p. 384 and Fig. 16.5). They projected that the forest vegetation used most by the fisher would move upslope as a result of climate change, thus reducing the fisher's distribution within its current range. Lawler et al. (2012) did not quantitatively address the additional portions of the fisher's range that could be added as a result of the same process—i.e., lower/middle-montane conifer/hardwood forests used by fishers moving upslope into areas that are currently upper montane and subalpine (Lenihan et al. 2008). Further, Lawler et al. (2012) claim to use the factors found to be most important to fishers for rest sites in order to model effects of various hypothetical fire scenarios, citing Zielinski et al (2004a), Zielinski et al. (2004b), and Zielinski et al. (2006). Lawler et al. (2012) then assessed four variables on this basis: 1) number of trees per hectare 76 cm dbh or larger ("large trees")—i.e., trees over 30 inches in diameter at breast height; 2) canopy cover; 3) snags ≥76 cm dbh per hectare; and 4) downed logs ≥30 cm diameter. However, this does not correspond with the factors found to be most important by the Zielinski et al. studies. Zielinski et al. (2006), which is the more recent of the Zielinski resting habitat studies, and is particular to the southern Sierra Nevada, found that the most important stand structure factors are canopy cover, basal area of small/medium-sized trees (trees less than 51 cm dbh—i.e., less than about 20 inches in diameter), mean diameter of hardwoods, and diameters of the largest tree and largest snag (Zielinski et al. 2006, p. 1017 and Table 3). Moreover, Lawler et al. (2009) inexplicably did not use the findings of the most recent study on fisher resting habitat in the southern Sierra Nevada, Purcell et al. (2009), which found the most important factors to be canopy cover, medium/large snag basal area (basal area of snags over about 10 inches in diameter), and density of smaller trees (Purcell et al. 2009, p. 2700). Had Lawler et al. (2012) used the main factors associated with fisher habitat, their fire modeling conclusions would have been very different. For example, the hypothetical less-frequent higher-severity fire scenarios projected the highest canopy covers and highest snag densities (Lawler et al. 2012, Table 16.1), and the highest densities of "small- and medium-sized trees" (Lawler et al. 2012, p. 392), and these are all factors positively associated with fisher detections (Zielinski et al. 2006, Purcell et al. 2009).

Fourth, the draft Science Synthesis (page 26 of Section 7.1) cites to unpublished data from Thompson and Purcell which the draft Synthesis claims shows that up to 10 percent of a fisher home range of 5 square miles can be "disturbed", including being logged, in any three year period without harm to the fisher. However, these data are nowhere available to confirm this, and the draft Science Synthesis seems to imply that this could be done in successive three-year periods, but no data are available to support this either. Moreover, the disturbances mentioned include things as varied as prescribed burning, thinning, and salvage logging, which may have very different effects on fishers. Is the draft Science Synthesis suggesting that they all have the same impacts, and can be analyzed as a group? If so, once again, there are no data available to support this. This reference should be removed from the Science Synthesis.

Overall Concerns Regarding Use of Citations, and Citations Omitted, in the Draft Synthesis

In the February 5, 2013 email message to us from U.S. Forest Service coordinator for the Draft Synthesis, Jonathan Long, he mentioned that the Forest Service only wanted us to send citations from studies published in peer-reviewed scientific journals. However, our careful review of the sources relied upon in the draft Science Synthesis reveals dozens of citations to U.S. Forest Service technical reports, which undergo some internal agency vetting, but which cannot accurately be characterized as peer-reviewed scientific studies. There are also numerous citations to unpublished reports contracted by the Forest Service (see, e.g., reference to Spencer et al. 2008 on pages 10 and 21 of Section 4.1 of the draft Science Synthesis), unpublished documents on U.S. government agency websites (see, e.g., reference to NASA website on p. 6 of Section 1.3), citations to unpublished reports from non-governmental environmental organizations (see, e.g., reference to Aplet 2006 on p. 9 of Section 1.2), reliance on unpublished data that is nowhere publicly available as well as personal communications (see, e.g., references to unpublished data from Sweitzer and Barrett, Spencer, Facka, and Thompson and Purcell, as well as a reference to personal communications from Sweitzer and Barrett, Purcell, and others, on pages 20 and 26 of Section 7.1), and references to Congressional testimony to define important ecological concepts such as “resilience” (see, e.g., references to Tidwell 2012 on pages 6 and 10 of Section 1.0). Because of this, and in order to avoid an arbitrary double-standard, while the majority of the citations in the reference lists below are from peer-reviewed scientific journals, we also included other scientific sources where appropriate, consistent with the type of sources used in the draft Science Synthesis. A number of these are extensive, and highly relevant, scientific studies of post-fire habitat conducted by the U.S. Forest Service in the Sierra Nevada and southern Cascades in California within the past several years. While the Forest Service most likely has access to the majority of the citations mentioned below, we would be happy to send you any of these references in pdf format upon request, and please do not hesitate to contact us for such references, or if you have any questions or desire to clarify any technical material mentioned in this memorandum.

Most of the reference categories below pertain to key scientific information that is simply missing from the draft Science Synthesis. For instance, the draft Science Synthesis, in Sections 1 and 4.1, assert that fire severity is increasing in the Sierra Nevada management region, citing Miller et al. (2009) and Miller and Safford (2013), but fail to cite the many scientific studies that find no trend of increasing fire severity within the Sierra Nevada management region (as we discuss below in section #7 of the annotated reference list). Similarly, the draft Science Synthesis includes considerable discussion of the assumption that Condition Class, based upon Fire Regime Interval Departure (i.e., number of fire return intervals “missed”), meaningfully corresponds to fire severity, with higher Condition Class/FRID categories predicting high fire severity if fire occurs (see, e.g., pages 10-11 of Section 1.1, and pages 12-14 of Section 4.1), with no mention of the fact that every scientific study that has empirically investigated this concept has found that high Condition Class/FRID categories are burning mostly at low/moderate-severity, and do not have higher fire severity than areas that have missed fewer fire return intervals.

Below is the scientific reference list that we submit for inclusion in the Science Synthesis, which covers both studies not discussed in the draft Science Synthesis, as well as studies that were referenced, but for which a key conclusion or conclusions were not discussed. We have included annotations ***(in parentheses, in bold, italicized font following the citation)***, where necessary, to describe central findings that may not be immediately apparent.

Relevant Scientific Literature Reference List:

1) **Mixed-severity fire is not limited to true fir and lodgepole pine; mixed-severity fire, including a significant proportion of high-severity fire and occasional large high-severity fire patches hundreds or thousands of acres in size, is also a natural condition in ponderosa-pine/Jeffrey-pine and mixed-conifer forest, and generally dominated pre-fire suppression fire regimes in these forest types.**

Baker, W.L. 2006. Fire history in ponderosa pine landscapes of Grand Canyon National Park: is it reliable enough for management and restoration? International Journal of Wildland Fire 15: 433-437.

Baker, W.L. 2012. Implications of spatially extensive historical data from surveys for restoring dry forests of Oregon's eastern Cascades. Ecosphere 3(3): article 23. ***(In dry mixed-conifer forests of the eastside of the southern Cascades, historic fire was 24% low-severity, 50% mixed-severity, and 26% high-severity [Table 5].)***

Baker, W.L., T.T. Veblen, and Sherriff, R.L. 2007. Fire, fuels and restoration of ponderosa pine-Douglas-fir forests in the Rocky Mountains, USA. Journal of Biogeography, 34: 251-269.

Beaty, R.M., and A.H. Taylor. 2001. Spatial and temporal variation of fire regimes in a mixed conifer forest landscape, Southern Cascades, USA. Journal of Biogeography 28: 955–966. ***(On the western slope of the southern Cascades in California, historic fire severity in mixed-conifer forests was predominantly moderate- and high-severity, except in mesic canyon bottoms, where moderate- and high-severity fire comprised 40.4% of fire effects [Table 7]. Contrary to the occasionally stated assumption that the forests studied in the southern Cascades of California allowed more high-severity fire than the western slope of the central and southern Sierra Nevada due to gentle and unbroken topography that allowed large "runs" of fire, and due to different conifer forest types and precipitation levels, the study area was mostly on moderate to steep slopes, with forest frequently broken by peaks, rock outcroppings, and water bodies [Fig. 1], the annual precipitation is similar to the southern/central Sierra Nevada's western slope (134 cm/yr, mostly as snow), and the composition of conifers in mixed-conifer forest is the same as in the southern/central Sierra Nevada, comprised of ponderosa and Jeffrey pine, white fir, incense-cedar, sugar pine, and Douglas-fir.)***

Bekker, M. F. and Taylor, A. H. 2001. Gradient analysis of fire regimes in montane forests of the southern Cascade Range, Thousand Lakes Wilderness, California, USA. Plant Ecology 155: 15-28. ***(On the western slope of the southern Cascades in California, in mixed-conifer forests, fire severity was predominantly high-severity historically [Fig. 2F]. Contrary to the occasionally stated assumption that the forests studied in the southern Cascades of***

California allowed more high-severity fire than the western slope of the central and southern Sierra Nevada due to gentle and unbroken topography that allowed large "runs" of fire, and due to different conifer forest types and precipitation levels, the study area was mostly on moderate to steep slopes, with forest frequently broken by peaks, rock outcroppings, and water bodies [Fig. 1], the annual precipitation is similar to the southern/central Sierra Nevada's western slope (105 cm/yr, mostly as snow), and the composition of conifers in mixed-conifer forest is the same as in the southern/central Sierra Nevada, comprised of ponderosa and Jeffrey pine, white fir, incense-cedar, and sugar pine [Table 1].)

Bekker, M. F. and Taylor, A. H. 2010. Fire disturbance, forest structure, and stand dynamics in montane forest of the southern Cascades, Thousand Lakes Wilderness, California, USA. Ecoscience 17: 59-72. ***(In mixed-conifer forests of the southern Cascades, reconstructed fire severity was dominated by high-severity fire effects, including high-severity fire patches over 2,000 acres in size [Tables I and II]. Contrary to the occasionally stated assumption that the forests studied in the southern Cascades of California allowed more high-severity fire than the western slope of the central and southern Sierra Nevada due to gentle and unbroken topography that allowed large "runs" of fire, and due to different conifer forest types and precipitation levels, the study area was mostly on moderate to steep slopes, with forest frequently broken by peaks, rock outcroppings, and water bodies [Fig. 1], the annual precipitation is similar to the southern/central Sierra Nevada's western slope (105 cm/yr, mostly as snow), and the composition of conifers in mixed-conifer forest is the same as in the southern/central Sierra Nevada, comprised of ponderosa and Jeffrey pine, white fir, incense-cedar, and sugar pine [Fig. 2].)***

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.

Collins, B.M., and S.L. Stephens. 2010. Stand-replacing patches within a mixed severity fire regime: quantitative characterization using recent fires in a long-established natural fire area. Landscape Ecology 25: 927939. ***(In a modern "reference" forest condition within mixed-conifer/fir forests in Yosemite National Park, 15% of the area experienced high-severity fire over a 33-year period—a high-severity fire rotation interval of approximately 223 years.)***

Colombaroli, D. and D. G. Gavin 2010. Highly episodic fire and erosion regime over the past 2,000 y in the Siskiyou Mountains, Oregon. Proceedings of the National Academy of Sciences 107: 18909-18915.

Hessburg, P. F., R. B. Salter, and K. M. James. 2007. Re-examining fire severity relations in pre-management era mixed conifer forests: inferences from landscape patterns of forest structure. Landscape Ecology 22:5-24.

Iniguez, J. M., T. W. Swetnam, and C. H. Baisan. 2009. Spatially and temporally variable fire regime on Rincon Mountain, Arizona, USA. Fire Ecology 5:3-21.

Klenner, W., R. Walton, A. Arsenault, L. Kremsater. 2008. Dry forests in the Southern Interior of British Columbia: Historical disturbances and implications for restoration and management. Forest Ecology and Management 256: 1711-1722.

Leiberg, J.B. 1897. General report on a botanical survey of the Coeur d'Alene Mountains in Idaho during the summer of 1895. United States Division of Botany, Contributions from the U.S. National Herbarium Volume V, No. 1, pp. 41–85. US Government Printing Office, Washington, DC.

Leiberg, J.B. 1899a. Bitterroot Forest Reserve. USDI Geological Survey, Nineteenth Annual Report, Part V. Forest Reserves, pp. 253–282. US Government Printing Office, Washington, D.C.

Leiberg, J.B. 1899b. Present condition of the forested areas in northern Idaho outside the limits of the Priest River Forest Reserve and north of the Clearwater River. USDI Geological Survey, Nineteenth Annual Report, Part V. Forest Reserves, pp. 373–386. US Government Printing Office, Washington, DC.

Leiberg, J.B. 1899c. Priest River Forest Reserve. USDI Geological Survey, Nineteenth Annual Report, Part V. Forest Reserves, pp. 217–252. US Government Printing Office, Washington, DC.

Leiberg, J.B. 1900a. Bitterroot Forest Reserve. USDI Geological Survey, Twentieth Annual Report to the Secretary of the Interior, 1898–99, Part V. Forest Reserves, pp. 317–410. US Government Printing Office, Washington, DC.

Leiberg, J.B. 1900b. Sandpoint quadrangle, Idaho. USDI Geological Survey, Twenty-first Annual Report, Part V. Forest Reserves, pp. 583–595. US Government Printing Office, Washington, DC.

Leiberg, J. B. 1900c. Cascade Range Forest Reserve, Oregon, from township 28 south to township 37 south, inclusive; together with the Ashland Forest Reserve and adjacent forest regions from township 28 south to township 41 south, inclusive, and from range 2 west to range 14 east, Willamette Meridian, inclusive. U.S. Geological Survey Annual Report 21(V):209-498.

Leiberg, J. B. 1902. Forest conditions in the northern Sierra Nevada, California. USDI Geological Survey, Professional Paper No. 8. U.S. Government Printing Office, Washington, D.C. ***(High-severity fire patches over 5,000 acres in size mapped in mixed-conifer forest that had not been logged previously during the 19th century, prior to fire suppression.)***

Leiberg, J. B. 1903. Southern part of Cascade Range Forest Reserve. Pages 229–289 in H. D. Langille, F. G. Plummer, A. Dodwell, T. F. Rixon, and J. B. Leiberg, editors. Forest conditions in the Cascade Range Forest Reserve, Oregon. Professional Paper No. 9. U.S. Geological Survey, U.S. Government Printing Office, Washington, D.C., USA.

Leiberg, J.B. 1904a. Forest conditions in the Absaroka division of the Yellowstone Forest Reserve, Montana. USDI Geological Survey Professional Paper No. 29, US Government Printing Office, Washington, DC.

Leiberg, J.B. 1904b. Forest conditions in the Little Belt Mountains Forest Reserve, Montana, and the Little Belt Mountains quadrangle. USDI Geological Survey Professional Paper No. 30, US Government Printing Office, Washington, DC.

Minnich, R.A., M.G. Barbour, J.H. Burk and J. Sosa-Ramirez, 2000. Californian mixed-conifer forests under unmanaged fire regimes in the Sierra San Pedro Martir, Baja California, Mexico. Journal of Biogeography27: 105-129.

Nagel, T.A. and Taylor, A.H. 2005. Fire and persistence of montane chaparral in mixed conifer forest landscapes in the northern Sierra Nevada, Lake Tahoe Basin, California, USA. J. Torrey Bot. Soc.132: 442-457.

Russell, W. H., J. McBride, and R. Rowntree. Revegetation after four stand-replacing fires in the Tahoe Basin. Madrono 45: 40-46.

Sherriff, R. L., and T. T. Veblen. 2007. A spatially explicit reconstruction of historical fire occurrence in the Ponderosa pine zone of the Colorado Front Range. Ecosystems 9:1342-1347.

Shinneman D.J. and W.L. Baker, 1997. Nonequilibrium dynamics between catastrophic disturbances and old-growth forests in ponderosa pine landscapes of the Black Hills. Conservation Biology11: 1276-1288.

Show, S.B. and Kotok, E.I. 1924. The role of fire in California pine forests. United States Department of Agriculture Bulletin 1294, Washington, D.C. ***(Historically, within ponderosa pine and mixed-conifer/pine forests of the Sierra Nevada, high-severity crown fires, though infrequent on any particular area, "may extend over a few hundred acres" in patches [p. 31; see also Plate V, Fig. 2, Plate VII, Fig. 2, Plate VIII, Plate IX, Figs. 1 and 2, and Plate X, Fig. 1], with some early-successional areas, resulting from high-severity fire patches, covering 5,000 acres in size or more [pp. 42-43]. The authors distinguished high-severity fire patches of this size from more "extensive" patches occurring in the northern Rocky Mountains [p. 31], where high-severity fire patches occasionally reach tens of thousands, or hundreds of thousands, of acres in size, and noted that patches of such enormous size were "almost" unknown in Sierra Nevada ponderosa pine and mixed-conifer forests. Within unlogged areas, the authors noted many large early-successional habitat patches, dominated by montane chaparral and young, regenerating conifer forest, and explained that such areas were the result of past severe fire because: a) patches of mature/old forest and individual surviving trees were found interspersed within these areas, and were found adjacent to these areas, indicating past forest; b) snags and stumps of fallen snags, as well as downed logs from fallen snags, were abundant in these areas; c) the species of chaparral found growing in these areas are known to sprout abundantly***

following severe fire; and d) natural conifer regeneration was found on most of the area [p. 42], often growing through complete chaparral cover [p. 43].)

Show, S.B. and Kotok, E.I. 1925. Fire and the forest (California pine region). United States Department of Agriculture Department Circular 358, Washington, D.C. ***(Historically, within the ponderosa pine and mixed-conifer/pine belt of the Sierra Nevada, 1 acre out of every 7 on average was dominated by montane chaparral and young regenerating conifer forest following high-severity fire [Footnote 2, and Figs. 4 and 5]; on one national forest 215,000 acres out of 660,000 was early-successional habitat from severe fire [p. 17].)***

Stephenson, N. L.; Parsons, D,J.; Swetnam, T,W. 1991. Restoring natural fire to the sequoia - mixed conifer forest: should intense fire play a role? Proceedings of the Tall Timbers Fire Ecology Conference 17:321-337.

Taylor A.H. 2002. Evidence for pre-suppression high-severity fire on mixed conifer forests on the west shore of the Lake Tahoe Basin. Final report. South Lake Tahoe (CA): USDA Forest Service, Lake Tahoe Basin Management Unit.

USFS (United States Forest Service). 1910-1912. Timber Survey Field Notes, 1910-1912, U.S. Forest Service, Stanislaus National Forest. Record Number 095-93-045, National Archives and Records Administration—Pacific Region, San Bruno, California, USA. ***(Surveys were conducted within primary forest to evaluate timber production potential in 16.2-ha (40-acre) plots within each 259.1-ha (640-acre) section in ponderosa pine and mixed-conifer forest on the westside of the Stanislaus National Forest, using one or more 1.62-ha transect per plot. Surveyors noted that surveys for individual tree size, density and species were not conducted in areas that had experienced high-severity fire sufficiently recently such that the regenerating areas did not yet contain significant merchantable sawtimber. Surveyors noted that the dominant vegetation cover across the majority of many 259.1-ha sections was montane chaparral and young conifer regeneration following high-severity fire. For example (from a typical township in the data set): a) T1S, R18E, Section 9 ("Severe fire went through [this section] years ago and killed most of the trees and land was reverted to brush", noting "several large dense sapling stands" and noting that merchantable timber existed on only four of sixteen 16.2-ha plots in the section); b) T1S, R18E, Section 14 ("Fires have killed most of timber and most of section has reverted to brush"); c) T1S, R18E, Section 15 (same); d) T1S, R18E, Section 23 ("Most of timber on section has been killed by fires which occurred many years ago"); T1S, R18E, Section 21 ("Old fires killed most of timber on this section and most of area is now brushland".)***

Whitlock, C., J. Marlon, C. Briles, A. Brunelle, C. Long and P. Bartlein, 2008. Long-term relations among fire, fuel, and climate in the north-western US based on lake-sediment studies. International Journal of Wildland Fire17: 72-83.

Whitlock, C., P.E. Higuera, D.B. McWethy, and C.E. Briles. 2010. Paleoecological perspectives on fire ecology: revisiting the fire-regime concept. The Open Ecology Journal 3: 6-23.

Williams, M.A. & Baker, W.L. 2010. Bias and error in using survey records for ponderosa pine landscape restoration. *Journal of Biogeography*37, 707–721.

Williams, M.A. & Baker, W.L. 2011. Testing the accuracy of new methods for reconstructing historical structure of forest landscapes using GLO survey data. *EcologicalMonographs*, 81: 63–88.

Williams, M.A., W.L. Baker. 2012a. Spatially extensive reconstructions show variable-severity fire and heterogeneous structure in historical western United States dry forests. Global Ecology and Biogeography. DOI: 10.1111/j.1466-8238.2011.00750.

Williams, M.A., W.L. Baker. 2012b. Comparison of the higher-severity fire regime in historical (A.D. 1800s) and modern (A.D. 1984-2009) montane forests across 624,156 ha of the Colorado Front Range. Ecosystems DOI 10.1007/s10021-012-9549-8.

Wills, R. D. & Stuart, J. D. 1994. Fire history and stand development of a Douglas-fir/hardwood forest in northern California. Northwest Science68, 205-212.

2) Historic high-severity fire occurrence and extent cannot be addressed with fire-scar studies that sample individual large trees across the landscape, because such methods miss patches where no trees survive, and even sampled trees may have survived past high-severity fire; and fire return intervals based upon fire-scar data greatly underestimate the actual fire rotation interval in any given area.

Baker, W.L. and D.S. Ehle. 2001. Uncertainty in surface-fire history: the case of ponderosa pine forests in the western United States. Canadian Journal of Forest Research 31: 1205-1226. ***(Methodological flaws in fire-scar studies—including targeting multiple-scar trees, the often incorrect assumption that fire scars in the same year in trees hundreds of meters, or several kilometers, apart correspond to an entire area burning [as opposed to spot fires from multiple lightning strikes] and the failure to account for the time interval between tree origin and the first fire scar--lead to a substantial underestimation of mean fire return interval and the range of intervals [2-25 years versus 22-308 years]).***

Beaty, R.M., and A.H. Taylor. 2001. Spatial and temporal variation of fire regimes in a mixed conifer forest landscape, Southern Cascades, USA. Journal of Biogeography 28: 955–966. ***(Pre-fire suppression composite fire return intervals were less than 8 years while fire rotation intervals were 28 years in the same forests during the same time period in mixed conifer forests [Tables 5 and 6].)***

Bekker, M. F. and Taylor, A. H. 2001. Gradient analysis of fire regimes in montane forests of the southern Cascade Range, Thousand Lakes Wilderness, California, USA. Plant Ecology 155: 15-28. ***(Fire rotation intervals were 4 to 6 times longer than composite fire return intervals in pre-fire suppression mixed conifer forests. [Table 2].)***

Veblen, T.T. 2003. Key issues in fire regime research for fuels management and ecological restoration. Omi PN, Joyce LA, technical editors. Fire, fuel treatments and ecological restoration: conference proceedings. USDA Forest Service: Fort Collins, CO. Proceedings RMRS-P-29. p 259-276.

3) **<u>High-severity fire patches, including large patches, create very biodiverse, ecologically important, and unique habitat (often called "snag forest habitat"), which often has higher species richness and diversity than unburned old forest; many wildlife species use this forest habitat type more than any other, and old forest species select it for foraging, while some rare species, such as the Black-backed Woodpecker, depend upon it for both nesting and foraging.</u>**

Buchalski, M.R., J.B. Fontaine, P.A. Heady III, J.P. Hayes, and W.F. Frick. 2013. Bat response to differing fire severity in mixed-conifer forest, California, USA. PLOS ONE 8: e57884. ***(In mixed-conifer forests of the southern Sierra Nevada, rare myotis bats were found at greater levels in unmanaged high-severity fire areas of the McNally fire than in lower fire severity areas or unburned forest.)***

Burnett, R.D., P. Taillie, and N. Seavy. 2010. Plumas Lassen Study 2009 Annual Report. U.S. Forest Service, Pacific Southwest Region, Vallejo, CA. ***(Bird species richness was approximately the same between high-severity fire areas and unburned mature/old forest at 8 years post-fire in the Storrie fire, and total bird abundance was greatest in the high-severity fire areas of the Storrie fire [Figure 4]. Nest density of cavity-nesting species increased with higher proportions of high-severity fire, and was highest at 100% [Figure 8]. The authors noted that "[o]nce the amount of the plot that was high severity was over 60% the density of cavity nests increased substantially", and concluded that "more total species were detected in the Moonlight fire which covers a much smaller geographic area and had far fewer sampling locations than the [unburned] green forest.")***

Burnett, R.D., P. Taillie, and N. Seavy. 2011. Plumas Lassen Study 2010 Annual Report. U.S. Forest Service, Pacific Southwest Region, Vallejo, CA.

Donato, D.C., J.B. Fontaine, W.D. Robinson, J.B. Kauffman, and B.E. Law. 2009. Vegetation response to a short interval between high-severity wildfires in a mixed-evergreen forest. Journal of Ecology 97: 142-154. ***(The high-severity re-burn [high-severity fire occurring 15 years after a previous high-severity fire] had the highest plant species richness and total plant cover, relative to high-severity fire alone [no re-burn] and unburned mature/old forest; and the high-severity fire re-burn area had over 1,000 seedlings/saplings per hectare of natural conifer regeneration.)***

Fontaine, J.B., D.C. Donato, W.D. Robinson, B.E. Law, and J.B. Kauffman. 2009. Bird communities following high-severity fire: response to single and repeat fires in a mixed evergreen forest, Oregon, USA. Forest Ecology and Management 257: 1496-1504. ***(Bird species richness was not significantly different between high-severity re-burn, high-severity burn alone, and unburned old-growth forest, but was numerically highest in areas burned once by high-severity fire 17-18 years earlier, and in high-severity re-burn areas.***

Total bird abundance was higher in the high-severity fire area, at 17-18 years post-fire, than in the unburned old-growth forest [Figs. 3a and 3b].)

Haney, A., S. Apfelbaum, and J.M. Burris. 2008. Thirty years of post-fire succession in a southern boreal forest bird community. The American Midland Naturalist 159: 421-433. ***(By 30 years after high-severity fire, bird species richness increased 56% relative to pre-fire mature unburned forest.)***

Hanson, C. T. and M. P. North. 2008. Postfire woodpecker foraging in salvage-logged and unlogged forests of the Sierra Nevada. Condor 110: 777–782. ***(Black-backed woodpeckers depend upon dense, mature/old forest that has recently experienced higher-severity fire, and has not been salvage logged.)***

Hutto, R. L. 1995. Composition of bird communities following stand-replacement fires in Northern Rocky Mountain (U.S.A.) conifer forests. Conservation Biology 9: 1041–1058.

Hutto, R. L. 2008. The ecological importance of severe wildfires: Some like it hot. Ecological Applications 18:1827–1834.

Kotliar, N.B., S.J. Hejl, R.L. Hutto, V.A. Saab, C.P. Melcher, and M.E. McFadzen. 2002. Effects of fire and post-fire salvage logging on avian communities in conifer-dominated forests of the western United States. Studies in Avian Biology 25: 49-64.

Malison, R.L., and C.V. Baxter. 2010. The fire pulse: wildfire stimulates flux of aquatic prey to terrestrial habitats driving increases in riparian consumers. Canadian Journal of Fisheries and Aquatic Sciences 67: 570-579. ***(In ponderosa pine and Douglas-fir forests of Idaho at 5-10 years post-fire, levels of aquatic insects emerging from streams were two and a half times greater in high-severity fire areas than in unburned mature/old forest, and bats were nearly 5 times more abundant in riparian areas with high-severity fire than in unburned mature/old forest.)***

Raphael, M.G., M.L. Morrison, and M.P. Yoder-Williams. 1987. Breeding bird populations during twenty-five years of postfire succession in the Sierra Nevada. The Condor 89: 614-626. ***(At 25 years after high-severity fire, total bird abundance was slightly higher in snag forest than in unburned old forest in eastside mixed-conifer forest of the northern Sierra Nevada; and bird species richness was 40% higher in snag forest habitat. In earlier post-fire years, woodpeckers were more abundant in snag forest, but were similar to unburned by 25 years post-fire, while flycatchers and species associated with shrubs continued to increase to 25 years post-fire.)***

Roberts, S.L. 2008. The effects of fire on California spotted owls and their mammalian prey in the central Sierra Nevada, California. Ph.D. Dissertation, University of California at Davis. ***(California spotted owl reproduction was 60% higher in a mixed-severity fire area [no salvage logging] than in unburned mature/old forest.)***

Schieck, J., and S.J. Song. 2006. Changes in bird communities throughout succession following fire and harvest in boreal forests of western North America: literature review and meta-analyses. Canadian Journal of Forest Research 36: 1299-1318. ***(Bird species richness increased up to 30 years after high-severity fire, then decreased in mid-successional forest [31-75 years old], and increased again in late-successional forest [>75 years]).***

Sestrich, C.M., T.E. McMahon, and M.K. Young. 2011. Influence of fire on native and nonnative salmonid populations and habitat in a western Montana basin. Transactions of the American Fisheries Society 140: 136-146. ***(Native Bull and Cutthroat trout tended to increase with higher fire severity, particularly where debris flows occurred. Nonnative brook trout did not increase.)***

Siegel, R. B., R. L. Wilkerson, and D. L. Mauer. 2008. Black-backed Woodpecker (*Picoides arcticus*) surveys on Sierra Nevada national forests: 2008 pilot study. The Institute for Bird Populations, Point Reyes, CA.

Siegel, R.B., J.F. Saracco, and R.L. Wilkerson. 2010. Management Indicator Species (MIS) surveys on Sierra Nevada national forests: Black-backed Woodpecker. 2009 Annual Report. The Institute for Bird Populations, Point Reyes, CA.

4) <u>Black-backed Woodpeckers rely upon large patches (generally at least 200 acres per pair) of recently killed trees (typically less than 8 years post-mortality) with very high densities of medium and large snags (usually at least 80-100 per acre), and any significant level of post-fire salvage logging largely eliminates nesting and foraging potential.</u>

Burnett, R.D., P. Taillie, and N. Seavy. 2011. Plumas Lassen Study 2010 Annual Report. U.S. Forest Service, Pacific Southwest Region, Vallejo, CA. ***(Black-backed Woodpecker nesting was eliminated by post-fire salvage. See Figure 11 [showing nest density on national forest lands not yet subjected to salvage logging versus private lands that had been salvage logged.)***

Burnett, R.D., M. Preston, and N. Seavy. 2012. Plumas Lassen Study 2011 Annual Report. U.S. Forest Service, Pacific Southwest Region, Vallejo, CA. ***(Black-backed Woodpecker potential occupancy rapidly approaches zero when less than 40-80 snags per acre occur, or are retained (Burnett et al. 2012, Fig. 8 [occupancy dropping towards zero when there are fewer than 4-8 snags per 11.3-meter radius plot—i.e., less than 4-8 snags per 1/10th-acre, or less than 40-80 snags per acre.)***

Hanson, C. T. and M. P. North. 2008. Postfire woodpecker foraging in salvage-logged and unlogged forests of the Sierra Nevada. Condor 110:777–782. ***(Black-backed Woodpeckers selected dense, old forests that experienced high-severity fire, and avoided salvage logged areas [see Tables 1 and 2].)***

Hutto, R. L. 2008. The ecological importance of severe wildfires: Some like it hot. Ecological Applications 18:1827–1834. ***(Figure 4a, showing about 50% loss of Black-backed***

Woodpecker post-fire occupancy due to moderate pre-fire logging [consistent with mechanical thinning] in areas that later experienced wildland fire.)

Saab, V.A., R.E. Russell, and J.G. Dudley. 2009. Nest-site selection by cavity-nesting birds in relation to postfire salvage logging. Forest Ecology and Management 257:151–159. ***(Black-backed Woodpeckers select areas with about 325 medium and large snags per hectare [about 132 per acre], and nest-site occupancy potential dropped to near zero when snag density was below about 270 per hectare, or about 109 per acre [see Fig. 2A, showing 270 snags per hectare as the lower boundary of the 95% confidence interval].)***

Seavy, N.E., R.D. Burnett, and P.J. Taille. 2012. Black-backed woodpecker nest-tree preference in burned forests of the Sierra Nevada, California. Wildlife Society Bulletin 36: 722-728. ***(Black-backed Woodpeckers selected sites with an average of 13.3 snags per 11.3-meter radius plot [i.e., 0.1-acre plot], or about 133 snags per acre.)***

Siegel, R.B., M.W. Tingley, and R.L. Wilkerson. 2011. Black-backed Woodpecker MIS surveys on Sierra Nevada national forests: 2010 Annual Report. A report in fulfillment of U.S. Forest Service Agreement No. 08-CS-11052005-201, Modification #2; U.S. Forest Service Pacific Southwest Region, Vallejo, CA. ***(Black-backed woodpecker occupancy declines dramatically by 5-7 years post-fire relative to 1-2 years post-fire, and approaches zero by 10 years post-fire [Fig. 15a].)***

Siegel, R.B., M.W. Tingley, R.L. Wilkerson, M.L. Bond, and C.A. Howell. 2013. Assessing home range size and habitat needs of Black-backed Woodpeckers in California: Report for the 2011 and 2012 field seasons. Institute for Bird Populations. ***(Black-backed woodpeckers strongly select large patches of higher-severity fire with high densities of medium and large snags, generally at least 100 to 200 hectares (roughly 250 to 500 acres) per pair, and post-fire salvage logging eliminates Black-backed woodpecker foraging habitat [see Fig. 13, showing almost complete avoidance of salvage logged areas]. Suitable foraging habitat was found to have more than 17-20 square meters per hectare of recent snag basal area [pp. 45, 68-70], and suitable nesting habitat was found to average 43 square meters per hectare of recent snag basal area and range from 18 to 85 square meters to hectare [p. 59, Table 13]. Moreover, Appendix 2, Fig. 2 indicates that the Sierra Nevada population of Black-backed Woodpeckers is genetically distinct from the Oregon Cascades population, though additional work needs to be conducted to determine just how distinct the two populations are.)***

Tarbill, G.L. 2010. Nest site selection and influence of woodpeckers on recovery in a burned forest of the Sierra Nevada. Master's Thesis, California State University, Sacramento. ***(In post-fire eastside pine and mixed-conifer forests of the northern Sierra Nevada, Black-backed woodpeckers strongly selected stands with very high densities of medium and large snags, with well over 200 such snags per hectare on average at nest sites [Table 2], and nesting potential was optimized at 250 or more per hectare, dropping to very low levels below 100 to 200 per hectare [Fig. 5b].)***

5) **<u>California Spotted Owls preferentially select unmanaged high-severity fire areas for foraging, have higher reproduction in mixed-severity fire areas than in unburned forests, and do not have reduced occupancy in areas dominated by moderate- and high-severity fire.</u>**

Bond, M. L., D. E. Lee, R. B. Siegel, & J. P. Ward, Jr. 2009a. Habitat use and selection by California Spotted Owls in a postfire landscape. Journal of Wildlife Management 73: 1116-1124. ***(In a radiotelemetry study, California spotted owls preferentially selected high-severity fire areas, which had not been salvage logged, for foraging.)***

Franklin, A.B., D.R. Anderson, R.J. Gutierrez, and K.P. Burnham. 2000. Climate, habitat quality, and fitness in northern spotted owl populations in northwestern California. Ecological Monographs 70: 539-590. ***(The authors found that stable or increasing populations of spotted owls resulted from a mix of dense old forest and complex early seral habitat, and less than approximately 25% complex early seral habitat in the home range was associated with declining populations [Fig. 10]; the authors emphasized that the complex early seral habitat was consistent with high-severity fire effects, and inconsistent with clearcut logging).***

Lee, D.E., M.L. Bond, and R.B. Siegel. 2012. Dynamics of breeding-season site occupancy of the California spotted owl in burned forests. The Condor 114: 792-802. ***(Mixed-severity wildland fire, averaging 32% high-severity fire effects, did not decrease California spotted owl territory occupancy, but post-fire salvage logging appeared to adversely affect occupancy.)***

Roberts, S.L. 2008. The effects of fire on California spotted owls and their mammalian prey in the central Sierra Nevada, California. Ph.D. Dissertation, University of California at Davis. ***(California spotted owl reproduction was 60% higher in a mixed-severity fire area [no salvage logging] than in unburned mature/old forest.)***

Seamans, M.E., and R.J. Gutiérrez. 2007. Habitat selection in a changing environment: the relationship between habitat alteration and spotted owl territory occupancy and breeding dispersal. The Condor 109: 566-576. ***(The authors found that commercial logging of as little as 20 hectares, or about 50 acres, in spotted owl home ranges significantly reduced occupancy.)***

6) **<u>Emerging data are indicating that Pacific fishers benefit from forests dominated by fir and cedar, with dense understories and high snag levels, and fishers may benefit from some mixed-severity fire as well.</u>**

Hanson, C.T. (in preparation 2013). Pacific fisher habitat use of a heterogeneous post-fire and unburned landscape in the southern Sierra Nevada, California, USA. ***(Pacific fishers are using pre-fire mature/old forest that experienced moderate/high-severity fire more than expected based upon availability, just as fishers are selecting dense, mature/old forest in its unburned state as well. When fishers are near fire perimeters, they strongly select the burned side of the fire edge. Both males and female fishers are using large mixed-severity***

fire areas, such as the McNally fire, including several kilometers into the fire area.)

Hanson, C.T., and D.C. Odion. 2013. Is fire severity increasing in the Sierra Nevada mountains, California, USA? *In review* in International Journal of Wildland Fire. ***(All current modeling studies on relative risks to Pacific fishers of mechanical thinning versus wildland fire base assessments on the assumption of 90% to 100% tree mortality from fire, while actual mortality rates are far lower).***

Purcell, K.L., A.K. Mazzoni, S.R. Mori, and B.B. Boroski. 2009. Resting structures and resting habitat of fishers in the southern Sierra Nevada, California. Forest Ecology and Management 258: 2696-2706. ***(High snag density was one of the two most important factors for fisher rest site occupancy, with snag basal area at occupied sites averaging about 31 square feet per acre [converted from metric to English, and from plot scale to per-acre], which was about 2.5 times higher than random sites.)***

Sweitzer, R. (unpublished data). ***(Fishers are predominantly using incense cedar and white fir as den trees (see bottom left of May 1 2012 - Fisher Field Trip Poster at http://snamp.cnr.berkeley.edu/documents/446/).***

Underwood, E.C., J.H. Viers, J.F. Quinn, and M. North. 2010. Using topography to meet wildlife and fuels treatment objectives in fire-suppressed landscapes. Environmental Management 46: 809-819. ***(Fishers are selecting the densest forest, dominated by fir and cedar, with the highest densities of small and medium-sized trees, and the highest snag levels.)***

Zielinski, W.J., N.P. Duncan, E.C. Farmer, R.L. Truex, A.P. Cleavenger, and R.H. Barrett. 1999. Diet of fishers (*Martes pennanti*) at the southernmost extent of their range. Journal of Mammalogy 80: 961-971. ***(The majority of the prey taxa identified in the fisher's diet are species associated with complex early-successional habitat, consistent with higher-severity fire effects.)***

Zielinski, W.J., R.L. Truex, J.R. Dunk, and T. Gaman. 2006. Using forest inventory data to assess fisher resting habitat suitability in California. Ecological Applications 16: 1010-1025. ***(The two most important factors associated with fisher rest sites are high canopy cover and high densities of small and medium-sized trees less than 50 cm in diameter [Tables 1 and 3].)***

Zielinski, W.J., J.A. Baldwin, R.L. Truex, J.M. Tucker, and P.A. Flebbe. 2013. Estimating trend in occupancy for the southern Sierra fisher (*Martes pennanti*) population. Journal of Fish and Wildlife Management 4: 1-17. ***(The authors investigated fisher occupancy in three subpopulations of the southern Sierra Nevada fisher population: the western slope of Sierra National Forest; the Greenhorn mountains area of southwestern Sequoia National Forest; and the Kern Plateau of southeastern Sequoia National Forest area, using baited track-plate stations. The Kern Plateau area is predominantly post-fire habitat [mostly unaffected by salvage logging] from several large fires occurring since 2000, including the Manter fire of 2000 and the McNally fire of 2002. The baited track-plate stations used for***

the study included these fire areas [Fig. 2]. Mean annual fisher occupancy at detection stations was lower on Sierra National Forest than on the Kern Plateau. Occupancy was trending downward on Sierra National Forest, and upward on the Kern Plateau, though neither was statistically significant, possibly due to a small data set.)

7) **<u>Post-fire salvage logging substantially reduces, and often locally eliminates, wildlife species strongly associated with snag forest habitat created by high-severity fire patches.</u>**

Burnett, R.D., P. Taillie, and N. Seavy. 2011. Plumas Lassen Study 2010 Annual Report. U.S. Forest Service, Pacific Southwest Region, Vallejo, CA. ***(Black-backed Woodpecker nesting was eliminated by post-fire salvage. See Figure 11 [showing nest density on national forest lands not yet subjected to salvage logging versus private lands that had been salvage logged.)***

Burnett, R.D., M. Preston, and N. Seavy. 2012. Plumas Lassen Study 2011 Annual Report. U.S. Forest Service, Pacific Southwest Region, Vallejo, CA. ***(Overall bird diversity is substantially reduced by post-fire logging. See Figures 6 and 7.)***

Hanson, C. T. and M. P. North. 2008. Postfire woodpecker foraging in salvage-logged and unlogged forests of the Sierra Nevada. Condor 110:777–782. ***(See Tables 1 and 2.)***

Hutto, R. L. 1995. Composition of bird communities following stand-replacement fires in Northern Rocky Mountain (U.S.A.) conifer forests. Conservation Biology 9:1041–1058.

Hutto, R. L. 2008. The ecological importance of severe wildfires: Some like it hot. Ecological Applications 18:1827–1834.

Siegel, R.B., M.W. Tingley, R.L. Wilkerson, and M.L. Bond. 2012b. Assessing home range size and habitat needs of Black-backed Woodpeckers in California: 2011 Interim Report. Institute for Bird Populations. A report in fulfillment of U.S. Forest Service Agreement No. 08-CS-11052005-201, Modification 3; U.S. Forest Service, Pacific Southwest Region, Vallejo, CA. ***(See Figure 10, showing almost complete avoidance of salvage logged areas by Black-backed Woodpeckers in a radiotelemetry study in the southern Cascades in California.)***

8) **<u>Natural, historic forests (pre-fire suppression, pre-logging) in the Sierra Nevada and southern dry Cascades were structurally complex, with a high degree of heterogeneity from natural disturbance, in terms of chaparral patch extent, stand structure, density, species composition—including stands dominated by fir and cedar with dense understories as a significant part of the mix in both ponderosa-pine/Jeffrey-pine and mixed-conifer forests.</u>**

Baker, W.L. 2012. Implications of spatially extensive historical data from surveys for restoring dry forests of Oregon's eastern Cascades. Ecosphere 3(3): article 23. ***(Historic mixed-conifer forests contained some open and park-like areas, but such areas were a minority.***

The area was, overall, dominated by denser forests with substantial shrub cover and understory conifer density—small trees comprised over 50% of all trees on over 72% of the forest.)

Duren, O.C., P.S. Muir, and P.E. Hosten. 2012. Vegetation change from the Euro-American settlement era to the present in relation to environment and disturbance in southwest Oregon. Northwest Science 86: 310-328. ***(Historic mixed-conifer forests in the southern dry Cascades were predominantly closed, rather than open-canopy.)***

Hessburg, P. F., R. B. Salter, and K. M. James. 2007. Re-examining fire severity relations in pre-management era mixed conifer forests: inferences from landscape patterns of forest structure. Landscape Ecology 22:5-24. ***(Historic mixed-conifer forests of eastern Oregon Cascades were mainly mixed- and high-severity, and were dominated by dense, early- and mid-successional forests regenerating from past higher-severity fire, rather than by open and park-like old-growth forests.)***

Leiberg, J. B. 1902. Forest conditions in the northern Sierra Nevada, California. USDI Geological Survey, Professional Paper No. 8. U.S. Government Printing Office, Washington, D.C. ***(In the 19th century, prior to fire suppression, composition of mixed-conifer forests in the central and northern Sierra Nevada was quantified in unlogged areas for several watersheds, and in dozens of specific locations within watersheds. The study reported that, while some of these areas were open and parklike stands dominated by ponderosa pine, Jeffrey pine, and sugar pine, the majority were dominated by white fir, incense-cedar, and Douglas-fir, especially on north-facing slopes and on lower slopes of subwatersheds; such areas were predominantly described as dense, often with "heavy underbrush" from past mixed-severity fire. Natural heterogeneity, resulting from fire, often involved dense stands of old forest adjacent to snag forest patches of standing fire-killed trees and montane chaparral with regenerating young conifers: "All the slopes of Duncan Canyon from its head down show the same marks of fire—dead timber, dense undergrowth, stretches of chaparral, thin lines of trees or small groups rising out of the brush, and heavy blocks of forest surrounded by chaparral." [p. 171])***

Nagel, T.A. and Taylor, A.H. 2005. Fire and persistence of montane chaparral in mixed conifer forest landscapes in the northern Sierra Nevada, Lake Tahoe Basin, California, USA. J. Torrey Bot. Soc.132: 442-457.

USFS (United States Forest Service). 1910-1912. Timber Survey Field Notes, 1910-1912, U.S. Forest Service, Stanislaus National Forest. Record Number 095-93-045, National Archives and Records Administration—Pacific Region, San Bruno, California, USA. ***(Historic ponderosa pine and mixed-conifer forests of the central/southern Sierra Nevada [western slope] varied widely in stand density and composition; open and park-like pine-dominated stands comprised a significant portion of the lower montane and foothill zones, but dense stands dominated by fir and cedar, and by small/medium-sized trees, dominated much of the middle montane zone. It should be noted that the old-growth forests chosen for study by Scholl and Taylor 2010 and Collins et al. 2011b comprised only a very small portion of the 1910-1912 Stanislaus data set.)***

Williams, M.A., W.L. Baker. 2012a. Spatially extensive reconstructions show variable-severity fire and heterogeneous structure in historical western United States dry forests. Global Ecology and Biogeography. DOI: 10.1111/j.1466-8238.2011.00750.

9) <u>The scientific data indicate that current rates of high-severity fire (rotation intervals) in the Sierra Nevada and southern Cascades are likely lower (longer rotation intervals) than historic rates, indicating less high-severity fire overall.</u>

Baker, W.L. 2012. Implications of spatially extensive historical data from surveys for restoring dry forests of Oregon's eastern Cascades. Ecosphere 3(3): article 23. ***(In dry mixed-conifer forests of the southern Cascades, the historic high-severity fire rotation was 435 years, and the combined mixed/high-severity rotation was 165 years.)***

Bekker, M. F. and Taylor, A. H. 2001. Gradient analysis of fire regimes in montane forests of the southern Cascade Range, Thousand Lakes Wilderness, California, USA. Plant Ecology155: 15-28. ***(Approximately 50% to 60% of the mixed-conifer forest in an unlogged area of the southern Cascades in California experienced high-severity fire over a 76-year period prior to fire suppression, indicating a high-severity fire rotation interval of 150-200 years.)***

Collins, B.M., and S.L. Stephens. 2010. Stand-replacing patches within a mixed-severity fire regime: quantitative characterization using recent fires in a long-established natural fire area. Landscape Ecology 25: 927939. ***(In a modern "reference" forest condition within mixed-conifer/fir forests in Yosemite National Park, 15% of the area experienced high-severity fire over a 33-year period—a high-severity fire rotation interval of approximately 223 years.)***

Miller, J.D., B.M. Collins, J.A. Lutz, S.L. Stephens, J.W. van Wagtendonk, and D.A. Yasuda. 2012b. Differences in wildfires among ecoregions and land management agencies in the Sierra Nevada region, California, USA. Ecosphere 3: Article 80. ***(Current high-severity fire rotation interval in the Sierra Nevada management region overall is over 800 years. The authors recommended increasing high-severity fire amounts [i.e., decreasing rotation intervals] in the Cascades-Modoc region and on the western slope of the Sierra Nevada, where the current high-severity fire rotation is 859 to 4650 years [Table 3]. The authors noted that "high-severity rotations may be too long in most Cascade-Modoc and westside NF locations, especially in comparison to Yosemite…").***

Minnich, R.A., M.G. Barbour, J.H. Burk, and J. Sosa-Ramirez. 2000. Californian mixed-conifer forests under unmanaged fire regimes in the Sierra San Pedro Martir, Baja California, Mexico. Journal of Biogeography 27:105–129. ***(High-severity fire rotation interval in reference forests that had not been logged or fire-suppressed was 300 years.)***

Stephens, S.L., R.E. Martin, and N.E. Clinton. 2007. Prehistoric fire area and emissions from California's forests, woodlands, shrublands, and grasslands. Forest Ecology and Management 251:205–216. ***(Estimated high-severity fire proportion and frequency***

indicate historic high-severity fire rotation intervals of approximately 250 to 400 years in historic ponderosa pine and mixed-conifer forests in California.)

10) **<u>Contrary to widespread, popular assumptions, forest areas that have missed the largest number of fire return intervals in California's forests are burning predominantly at low/moderate-severity levels, and are not experiencing higher fire severity than areas that have missed fewer fire return intervals.</u>**

Miller JD, Skinner CN, Safford HD, Knapp EE, Ramirez CM (2012b) Trends and causes of severity, size, and number of fires in northwestern California, USA. Ecological Applications 22, 184-203.

van Wagtendonk, J.W., K.A. van Wagtendonk, and A.E. Thode. 2012. Factors associated with the severity of intersecting fires in Yosemite National Park, California, USA. Fire Ecology 8: 11-32. ***("The proportion burned in each fire severity class was not significantly associated with fire return interval departure class…[L]ow severity made up the greatest proportion within all three departure classes, while high severity was the least in each departure class (Figure 4).")***

Odion, D.C., E.J. Frost, J.R. Strittholt, H. Jiang, D.A. DellaSala, and M.A. Moritz. 2004. Patterns of ire severity and forest conditions in the Klamath Mountains, northwestern California. Conservation Biology 18: 927-936.

Odion, D.C., and C.T. Hanson. 2006. Fire severity in conifer forests of the Sierra Nevada, California. Ecosystems 9: 1177-1189.

Odion, D.C., and C.T. Hanson. 2008. Fire severity in the Sierra Nevada revisited: conclusions robust to further analysis. Ecosystems 11: 12-15.

Odion, D. C., M. A. Moritz, and D. A. DellaSala. 2010. Alternative community states maintained by fire in the Klamath Mountains, USA. Journal of Ecology, doi: 10.1111/j.1365-2745.2009.01597.x.

11) **<u>Most studies of current fire trends in California's forests have not found an increase in fire severity, and studies are mixed on whether fire will increase, or decrease, in future decades as a result of climate change, depending upon the modeling assumptions used (e.g., hotter and drier versus warmer and wetter).</u>**

Collins, B.M., J.D. Miller, A.E. Thode, M. Kelly, J.W. van Wagtendonk, and S.L. Stephens. 2009. Interactions among wildland fires in a long-established Sierra Nevada natural fire area. Ecosystems 12:114–128. ***(No increase in high-severity fire found.)***

Crimmins, S.L., et al. 2011. Changes in climatic water balance drive downhill shifts in plant species' optimum elevations. Science 331:324-327. ***(Precipitation, and summer precipitation, were found to be increasing.)***

Dillon, G.K., et al. 2011. Both topography and climate affected forest and woodland burn severity in two regions of the western US, 1984 to 2006. Ecosphere 2:Article 130. ***(No increase in fire severity was found in most forested regions of the western U.S., including no increasing trend of fire severity in forests of the Pacific Northwest and Inland Northwest, which extended into the northern portion of the Sierra Nevada management region.)***

Gonzalez, P., R.P. Neilson, J.M. Lenihan, and R.J. Drapek. 2010. Global patterns in the vulnerability of ecosystems to vegetation shifts due to climate change. Global Change and Biogeography 19:755-768. ***(Precipitation has been increasing in the western U.S. [Fig. 1b], and a decrease in fire is projected over the 21st century in California's forests due to climate change, while increases are projected in desert areas east of the Sierra Nevada [Fig. 3b].)***

Hamlet, A.F., P.W. Mote, M.P. Clark, D.P. Lettenmaier. 2007. Twentieth-century trends in runoff, evapotranspiration, and soil moisture in the western United States. Journal of Climate 20:1468-1486. ***(A trend of increasing precipitation was found in western U.S. forests.)***

Hanson, C.T. , D.C. Odion, D.A. DellaSala, and W.L. Baker. 2009. Overestimation of fire risk in the Northern Spotted Owl Recovery Plan. Conservation Biology 23:1314–1319. ***(Fire severity is not increasing in forests of the Klamath and southern Cascades or eastern Cascades.)***

Hanson, C.T., D.C. Odion, D.A. DellaSala, and W.L. Baker. 2010. More-comprehensive recovery actions for Northern Spotted Owls in dry forests: Reply to Spies et al. Conservation Biology 24:334–337.

Hanson, C.T., and D.C. Odion. 2013. Is fire severity increasing in the Sierra Nevada mountains, California, USA? *In review* in International Journal of Wildland Fire. ***(Hanson and Odion (revision in review 2013) conducted the first comprehensive assessment of fire intensity since 1984 in the Sierra Nevada using 100% of available fire intensity data, and, using Mann-Kendall trend tests (a common approach for environmental time series data—one which has similar or greater statistical power than parametric analyses when using non-parametric data sets, such as fire data), found no increasing trend in terms of high-intensity fire proportion, area, mean patch size, or maximum patch size. Hanson and Odion (revision in review 2013) checked for serial autocorrelation in the data, and found none, and used pre-1984 vegetation data (1977 Cal-Veg) in order to completely include any conifer forest experiencing high-intensity fire in all time periods since 1984 (the accuracy of this data at the forest strata scale used in the analysis was 85-88%). Hanson and Odion (revision in review 2013) also checked the results of Miller et al. (2009) and Miller and Safford (2012) for bias, due to the use of vegetation layers that post-date the fires being analyzed in those studies. Hanson and Odion (revision in review 2013) found that there is a statistically significant bias in both studies (p = 0.032 and p = 0.021, respectively), the effect of which is to exclude relatively more conifer forest experiencing high-intensity fire in the earlier years of the time series, thus creating the false appearance of an increasing trend in fire severity. Interestingly, Miller et al. (2012a), acknowledged the potential bias***

that can result from using a vegetation classification data set that post-dates the time series. In that study, conducted in the Klamath region of California, Miller et al. used a vegetation layer that preceded the time series, and found no trend of increasing fire severity. Miller et al. (2009) and Miller and Safford (2012) did not, however, follow this same approach. Hanson and Odion (revision in review 2013) also found that the regional fire severity data set used by Miller et al. (2009) and Miller and Safford (2012) disproportionately excluded fires in the earlier years of the time series, relative to the standard national fire severity data set (www.mtbs.gov) used in other fire severity trend studies, resulting in an additional bias which created, once again, the inaccurate appearance of relatively less high-severity fire in the earlier years, and relatively more in more recent years. The results of Hanson and Odion (revision in review 2013) are consistent with all other recent studies of fire intensity trends in California's forests that have used all available fire intensity data, including Collins et al. (2009) in a portion of Yosemite National Park, Schwind (2008) regarding all vegetation in California, Hanson et al. (2009) and Miller et al. (2012a) regarding conifer forests in the Klamath and southern Cascades regions of California, and Dillon et al. (2011) regarding forests of the Pacific (south to the northernmost portion of California) and Northwest.)

Krawchuk, M.A., M.A. Moritz, M. Parisien, J. Van Dorn, and K. Hayhoe. 2009. Global pyrogeography: the current and future distribution of wildfire. PloS ONE 4: e5102. ***(Fire is projected to decrease in the Sierra Nevada management region over the next several decades due to climate change [Fig. 3].)***

Lenihan, J.M., D. Bachelet, R.P. Neilson, and R. Drapek. 2008. Response of vegetation distribution, ecosystem productivity, and fire to climate change scenarios for California. Climatic Change 87:S215-S230. *(**Fire would increase moderately in California's forests in the coming decades if there are hotter and drier conditions [i.e., models analyzed assumed hotter/drier conditions]**.)*

Liu, Y., J. Stanturf, and S. Goodrick. 2010. Trends in global wildfire potential in a changing climate. Forest Ecology and Management 259:685-697. ***(A decrease in fire is projected in California's forested regions over the 21st century due to climate change [Fig. 1].)***

McKenzie, et al. 2004. Z. Gedalof, D.L. Peterson, and P. Mote. 2004. Climatic change, wildfire, and conservation. Conservation Biology 18: 890-902. *(**Fire was projected to decrease in California's forests in the coming decades from climate change, despite warming, due to increasing summer precipitation**.)*

Miller, J.D., C.N. Skinner, H.D. Safford, E.E. Knapp, and C.M. Ramirez. 2012a. Trends and causes of severity, size, and number of fires in northwestern California, USA. Ecological Applications 22:184-203. ***(No increase in fire severity was found in the Klamath region of California, which partially overlaps the Sierra Nevada management region.)***

Mote, P.W. 2003. Trends in temperature and precipitation in the Pacific Northwest during the twentieth century. Northwest Science 77:271–282. ***(Steady increases in summer precipitation were found in the Pacific Northwest and Inland Northwest.)***

Schwind, B. compiler. 2008. Monitoring trends in burn severity: report on the Pacific Northwest and Pacific Southwest fires (1984 to 2005). U.S. Geological Survey Center for Earth Resources Observation and Science, Sioux Falls, South Dakota. Available from http://www.mtbs.gov/reports/projectreports.htm (accessed October 2008). ***(No increase in fire severity was found in California, with all vegetation combined.)***

12) **<u>Ecological resilience is enhanced by natural disturbance processes, and the heterogeneous habitat structures (e.g., snags, downed logs, montane chaparral patches, and patches of natural conifer regeneration following higher-severity fire and/or patches of beetle mortality) and natural successional stages resulting from such natural disturbance; the goal of consistently maintaining mature forest cover in a fire-adapted ecosystem is not ecological resilience but, rather, precisely the opposite: engineering resilience.</u>**

Thompson, I., B. Mackey, S. McNulty, and A. Mosseler. 2009. Forest resilience, biodiversity, and climate change. United Nations Environment Programme (UNEP), Secretariat of the Convention on Biological Diversity, Montreal, Canada. Technical Series No. 43. 67 pp. ***(The authors contrast ecological resilience, which pertains to the maintenance of the full complement of native biodiversity by maintaining active natural disturbance regimes, with engineering resilience, which pertains to the suppression of natural disturbance and the habitat structures and complex early-successional habitat created by such disturbance.)***

13) **<u>Natural conifer regeneration is considerable following large, high-severity fire patches in mixed-conifer forests, indicating substantial natural resilience in these forests, including in the very rare circumstances in which a high-severity fire "reburn" occurs within a short timeframe.</u>**

Collins, B.M., G. Roller, and S.L. Stephens. 2011. Fire and fuels at the landscape scale. Plumas Lassen Study: 2010 Annual Report. U.S. Forest Service, Pacific Southwest Research Station, Davis, CA. ***(See pages 15-23, including Tables 5 and 6.)***

Donato, D.C., et al. 2009. Vegetation response to a short interval between high-severity wildfires in a mixed-evergreen forest. Journal of Ecology 97: 142-154.

Haire, S.L. and K. McGarigal. 2008. Inhabitants of landscape scars: succession of woody plants after large, severe forest fires in Arizona and New Mexico. The Southwestern Naturalist 53: 146-161. ***(A high diversity of tree and shrub species naturally regenerates after severe fire [Table 1].)***

Haire, S.L. and K. McGarigal. 2010. Effects of landscape patterns of fire severity on regenerating ponderosa pine forests (*Pinus ponderosa*) in New Mexico and Arizona, USA. Landscape Ecology 25: 1055-1069. ***(Natural post-fire conifer regeneration, within the same fire areas analyzed in Haire and McGarigal 2008, occurs in 100% mortality patches even 200 or more meters from the nearest live tree, and regeneration nearer to the live-tree edge occurs vigorously within a few years post-fire, increasing rapidly after 10-15 years***

post-fire [Fig. 5]. The proportion of the total high-severity fire area that is more than 200 meters from the nearest live-tree edge was relatively small [Fig.2].)

Shatford, J.P.A., D.E. Hibbs, and K.J. Puettmann. 2007. Conifer regeneration after forest fire in the Klamath-Siskiyous: how much, how soon? Journal of Forestry April/May 2007, pp. 139-146.

14) <u>High-severity fire rotation intervals of 200 years, or somewhat less, still retain large proportions of late-successional/old-growth forest on the landscape, unlike even-aged logging rotations.</u>

Cyr, D., S. Gauthier, Y. Bergeron, and C. Carcaillet. 2009. Forest management is driving the eastern North American boreal forest outside its natural range of variability. Frontiers in Ecology and Environment 7: 519-524. ***(With a high-severity fire rotation of 200 years, approximately 27% of the forest is 100-200 years old, and approximately 34% of the forest is over 200 years old; and, even with a 100-year rotation for high-severity fire, approximately 25% of the forest is 100-200 years old, and approximately 14% is over 200 years old [Fig. 1]).***

15) <u>Areas with higher tree mortality from native beetle species do not burn more severely when wildland fire occurs.</u>

Bond, M.L., D.E. Lee, C.M. Bradley, and C.T. Hanson. 2009b. Influence of pre-fire tree mortality on fire severity in conifer forests of the San Bernardino Mountains, California. The Open Forest Science Journal 2: 41-47.

Donato, D.C., B.J. Harvey, W.H. Romme, M. Simard, and M.G. Turner. 2013. Bark beetle effects on fuel profiles across a range of stand structures in Douglas-fir forests of Greater Yellowstone. Ecological Applications 23: 3-20.

Simard, M., W.H. Romme, J.M. Griffin, and M.G. Turner. 2011. Do mountain pine beetle outbreaks change the probability of active crown fire in lodgepole pine forests? Ecological Monographs 81:3-24.

16) <u>Selective logging and mechanical thinning operations substantially harm some of the rarest and most imperiled bird species, and can create an “ecological trap”.</u>

Hutto, R. L. 2008. The ecological importance of severe wildfires: Some like it hot. Ecological Applications 18:1827–1834. ***(Mechanical thinning and selective logging operations reduced Black-backed Woodpecker occupancy by about 50% in areas that subsequently experienced wildland fire, and even heavier pre-fire logging reduced post-fire occupancy by about 90% [Fig. 4a].)***

Manning, T., J.C. Hagar, and B.C. McComb. 2012. Thinning of young Douglas-fir forests decreases density of northern flying squirrels in the Oregon Cascades. Forest Ecology and Management 264: 115-124. ***(Mechanical thinning harms a key prey species of the Northern***

Spotted Owl.)

Meyer M.D., M.P. North, and D.A. Kelt. 2005. Short-term effects of fire and forest thinning on truffle abundance and consumption by *Neotamias speciosus* in the Sierra Nevada of California. Canadian Journal of Forest Research 35: 1061-1070. ***(Mechanical thinning harms a key prey species of the California Spotted Owl.)***

Robertson, B.A., and R.L. Hutto. 2007. Is selectively harvested forest an ecological trap for Olive-sided Flycatchers? The Condor 109: 109-121. ***(Selective logging, consistent with a moderate mechanical thinning operation, created conditions that superficially appeared similar to the open conditions associated with high-severity post-fire habitat upon which this species depends, but nest success in the logged areas was only about one-half of what it was in the naturally burned areas, indicating ecological trap conditions that threaten population viability in the logged areas.)***

Seamans, M.E., and R.J. Gutiérrez. 2007. Habitat selection in a changing environment: the relationship between habitat alteration and spotted owl territory occupancy and breeding dispersal. The Condor 109: 566-576. ***(As little as 20 hectares of logging, including mechanical thinning, within the 400-hectare home range core area significantly reduced territory occupancy.)***

17) <u>The combination of snags and downed logs, along with post-fire regenerating shrubs and conifers, results in maximal levels of total biomass and carbon sequestration in high-severity fire areas.</u>

Keith, H., B.G. Mackey, and D.B. Lindenmayer. 2009. Re-evaluation of forest biomass carbon stocks and lessons from the world's most carbon-dense forests. Proceedings of the National Academy of Sciences 106: 11635-11640. ***(The highest biomass and carbon sequestration is found in eucalypt forests of Australia that naturally experience periodic high-severity fire.)***

Powers, E.M., J.D. Marshall, J. Zhang, and L. Wei. 2013. Post-fire management regimes affect carbon sequestration and storage in a Sierra Nevada mixed conifer forest. Forest Ecology and Management 291: 268-277. ***(In Sierra Nevada mixed conifer forests, the highest total aboveground carbon storage was found to occur in mature/old forest that experienced 100% tree mortality in wildland fire, and was not salvage logged or artificially replanted, relative to lightly burned old forest and salvage logged areas [Fig. 1b]).***

18) <u>Vegetation management designed to protect homes from fire is ineffective and unnecessary beyond approximately 40 meters from individual homes.</u>

Cohen, J.D. 2000. Preventing disaster: home ignitability in the Wildland-Urban Interface. Journal of Forestry 98: 15-21.

Cohen, J.D., and R.D. Stratton. 2008. Home destruction examination: Grass Valley Fire. U.S. Forest Service Technical Paper R5-TP-026b. U.S. Forest Service, Region 5, Vallejo, CA.

Sincerely,

Chad Hanson, Ph.D., Director
John Muir Project of Earth Island Institute
P.O. Box 697
Cedar Ridge, CA 95924
530-273-9290
cthanson1@gmail.com

Justin Augustine, Staff Attorney
Center for Biological Diversity
351 California St., Suite 600
San Francisco, CA 94104
415-436-9682, ext. 302
jaugustine@biologicaldiversity.org