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Regional Forester
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Dear Cal Joyner, M. Earl Stewart, and Michael R. Williams,

Much hard work and thought has gone into the Final EIS and DROD for the 4FRI project, but new science shows parts of the plan and Final EIS are not scientifically supported. I am thus writing to object to the 2014 Final Environmental Impact Statement and Draft Record of Decision for the Four-Forest Restoration Initiative, Coconino and Kaibab National Forests, Coconino County, Arizona (MB-R3-04-23).

My objection concerns issues that arose after the opportunities for formal comment were over. I did not comment on the draft EIS.

These issues are:
(1) New scientific evidence corroborates published findings that historical mixed- and high-severity fires significantly structured the dry-forest landscapes on the Coconino and Mogollon Plateau that are the focus of restoration in 4FRI Phase 1, thus the 4FRI goal of reducing these fires is unfortunately fire suppression, not ecological restoration.

(2) New scientific evidence shows that historical dry forests in the 4FRI project area were dominated by small trees. The 4FRI goal of removing most small trees would not be ecological restoration and would likely reduce the resilience of these forests to insect outbreaks and droughts that are the most serious disturbance threats to 4FRI forests.

(3) New scientific evidence shows that rates of historical low-severity fire were lower than previously thought, and 4FRI is proposing too much prescribed burning.

(4) New scientific evidence shows that Mexican spotted owls (MSOs) benefit from historical mixed- and high-severity fires, that the habitat of related spotted owls was created and maintained by mixed- and high-severity fires, that MSO PACs are being affected in some areas by human-set fires but not at high rates and actual effects on MSO habitat and occupancy are unknown, and proposed thinning in MSO habitat is likely to adversely affect future habitat of the MSO.

This new scientific evidence is documented in published peer-reviewed scientific papers that were not cited or used in the draft or final EIS or Record of Decision and were published in 2014-2015 after the comment period on the draft EIS had ended. Copies of the 2014-2015 publications that are the basis for this objection are included with this letter. To facilitate USFS review, I include selected pre-2014 papers that are cited for clarity. Fortunately, all these issues could be resolved with modest revision and modification of plans in the Final EIS and ROD.

Issue 1. New scientific evidence corroborates previously published findings that historical mixed- and high-severity fires significantly structured the dry-forest landscapes on the Coconino Plateau and Mogollon Plateau that are the focus of

restoration in 4FRI Phase 1.
For the Coconino Plateau, new evidence from tree-ring reconstructions (Dugan and Baker, in press) corroborates published General Land Office-survey reconstructions (Williams and Baker 2013), which showed that mixed-severity fire was a significant component of historical fires that structured the Coconino's dry-forest landscapes. Of total area burned historically, about 22% burned in mixed-severity fires on the South rim of Grand Canyon National park (Dugan and Baker, in press) and about 39% of the larger Coconino Plateau, including the South Rim, burned in mixed-severity fires (Williams and Baker 2013). Only about 3% of historical burned area on the Coconino Plateau was from high-severity fire.

For the Mogollon Plateau, Williams and Baker's (2012) reconstructions from General Land Office surveys showed that: (1) mean tree densities were 141.5 trees/ha, median = 124.3 trees/ha, s = 75.9 trees/ha, range = 22.2-534.1 trees/ha, (2) only about 33% of the Mogollon had open forests with < 100 trees/ha, while 17.7% of the Mogollon forests had > 200 trees/ha and 8.4% had > 250 trees/ha, (3) fire severity was 14.5% high-severity, 23.1% mixed-severity, and 62.4% low-severity, and (4) recent fires such as the 2002 Rodeo-Chediski and 2011 Wallow had similar to lower proportions of high-severity fire than occurred in nearby reconstructed landscapes, suggesting that the recent fraction of high-severity fire in these large fires is not unprecedented and has not increased relative to the historical record.

The Final EIS said that published findings of Williams and Baker (2012) were refuted by Fulé et al. (2014), but did not present these actual findings of Williams and Baker (2012) or cite or review the rebuttal of Fulé et al. (2014) by Williams and Baker (2014) published at the same time. This means explaining the central findings of Williams and Baker (2012) listed above, and what Williams and Baker (2014) say in rebuttal about: (1) serious problems with the Fulé et al. (2014) article itself, (2) the Fulé et al. critique that the Williams and Baker (2012) fire-severity reconstruction methods are not valid, and (3) the Fulé et al. critique that the Williams and Baker (2012) reconstructions are not corroborated by other scientific evidence.

First, regarding the Fulé et al. (2014) article itself, Williams and Baker (2014) showed that Fulé et al. (2014) "extensively misquote our article, mistake our methods and say it addressed topics and made conclusions that were not made...FE substantially misleads readers about W&B's findings." (Williams and Baker 2014 p. 831). Fulé et al. (2014) created three new false narratives that overlook and misuse other available scientific evidence about high-severity fire in and near the 4FRI project area, including misuse of Aldo Leopold.

Second, Williams and Baker (2014) explained that the fire-severity reconstruction methods that Fulé critiqued were also used by three authors of Fulé et al. (2014) in other published articles without any concerns when they used them. Also, unlike these earlier uses by authors of Fulé et al. (2014), the Williams and Baker (2012) fire-severity reconstructions were calibrated and validated against published tree-ring-based fire-severity reconstructions. The Williams and Baker (2012) fire-severity reconstructions were calibrated using 64 tree-ring reconstructions of fire severity, and the reconstructions correctly predicted fire severity for 63 of the 64 tree-ring reconstructions (Williams and Baker 2012). The 54 tree-ring reconstructions of fire severity in the Southwest used to calibrate the model were *all* correctly classified by the fire-severity reconstructions. The Final EIS implied that the fire-severity reconstructions do not match the extensive tree-ring research done in the past, when in fact the reconstructions do completely match them at the actual sites of those tree-ring reconstructions.

Third, in response to the Fulé et al. (2014) critique that other scientific corroboration (e.g., early scientific observation) is lacking for the fire-severity reconstructions, Williams and Baker (2014) explained that Fulé et al. (2014) completely missed Appendix S1 in Williams and Baker (2012), which presented this substantial corroborating evidence.

Also, Williams and Baker (2014) presented two new significant sources of corroboration for the original findings of Williams and Baker (2012) on the Mogollon Plateau. New corroboration has also appeared (Dugan and Baker, in press) since the Final EIS for the Williams and Baker (2013) reconstructions on the Coconino Plateau. And, a new source of corroboration for both the Mogollon and Coconino reconstructions was published in Odion et al. (2014) since the Final EIS. Here are the three new sources of corroboration:

1. Williams and Baker (2014) presented new evidence of early scientific observation of extensive high-severity fire on the Mogollon Plateau. John Leiberg (Leiberg et al. 1904) was a highly trained and experienced government forester who spent 2 years completing a timber cruise and making systematic scientific observations across the Mogollon Plateau. Leiberg et al. (1904 p. 23) said:

> "The light stands in many cases represent tracts which were burned clear, or nearly so, one hundred or one hundred and twenty years ago, and now are chiefly stocked with sapling growths, ranging in age from 35 to 90 years"

This is a direct early scientific observation of extensive high-severity fire in dry forests in the 4FRI project area on the Mogollon Plateau between about A.D. 1815 and 1865. The Leiberg et al. data suggest that these light stands that regenerated after high-severity fires covered about 17% of the ponderosa pine area in the San Francisco Mountains Forest Reserve (Table S2 in Williams and Baker 2014), representing a historical high-severity fire rotation of about 600-700 years (100-120 years/0.17). These are similar to Williams and Baker's (2014) estimates of 14.5% of area burned at high severity in an overlapping pre-1880 period, and a historical high-severity rotation of 828 years.

2. Paleoecological reconstruction also corroborates the rate and extent of high-severity fire (Jenkins *et al.*, 2011) found by Williams and Baker (2012) on the Mogollon Plateau. Fulé et al. (2014) acknowledged that this study on the Mogollon Plateau corroborates the historical <u>occurrence</u> of high-severity fire in the dry forests of the 4FRI study area, but they suggested that these fires were not as spatially extensive as found by the Williams and Baker (2012) reconstructions. However, the Final EIS should explain that this was speculation, as Fulé et al. (2014) presented no actual evidence about the spatial extent of historical high-severity fires.

In fact, Jenkins et al. (2011) found evidence of high-severity fires at roughly 200-400 year intervals over the last 1000 years, a higher rate of burning than the 828-year fire rotation found by Williams and Baker (2012) for the whole Mogollon Plateau. With a mean interval between high-severity fires of 200 years, about half the Plateau would, on average, be generally ≤100 years old, with corresponding dense, young forests across about half of the Plateau. Even with a mean interval of 400 years, about 25% of the Plateau would have been ≤100 years old. The Jenkins et al. high-severity rates suggest that the Plateau would have had extensive dense, young forests from high-severity fires, corroborating the findings of Williams and Baker (2012).

3. Odion et al. (2014) presented new and independent corroborating evidence of historical mixed- and high-severity fire in the 4FRI project area. The independent evidence is from a large dataset of tree ages collected by the Forest Inventory and Analysis (FIA) program from the 4FRI project area and similar nearby areas in unmanaged dry forests. For the Southwest, 319 plots representing 492,000 ha of FIA sampling were used, including substantial data from the

Mogollon Plateau, Coconino Plateau, and nearby parts of the Kaibab Plateau.

These data show that unmanaged dry forests in the 4FRI project area, and the Southwest as a whole, had dominant overstory trees that were not old as expected if low-severity fire had historically dominated fire regimes, but instead were young to intermediate in age, between 80-199 years old (Odion et al. Figure 2F), having originated between about 1815-1930 in mixed- and high-severity fires. The earliest date of about 1815 corresponds with the earliest date of stands burned in high-severity fires noted by Leiberg et al. (1904) on the Mogollon Plateau, cited above. Leiberg et al. observed extensive stands 35-90 years old in 1904 that originated from high-severity fires–the year 1904 minus 90 years is 1814, almost identical to the earliest date from the Odion et al. data. The Leiberg et al. (1904) observations thus strongly corroborate the finding of extensive historical mixed- and high-severity fire from FIA data for the 4FRI project area and the Southwest in general (Odion et al. 2014).

Summary and Suggested Remedies: I suggest that, to incorporate this new science, the Final EIS be revised to accurately present to the public all the now-extensive scientific evidence that supports the finding that mixed- and high-severity fires were a significant and spatially extensive natural feature of the historical fire regime in dry forests in the 4FRI project area. These six sources of evidence include: (1) Williams and Baker (2012, 2013) fire-severity reconstructions from General Land Office surveys, (2) Jenkins et al. (2011) fire-severity reconstructions from charcoal in sediments, (3) Odion et al. (2014) fire-severity reconstructions from Forest Inventory and Analysis data, (4) Dugan and Baker (in press) fire-severity reconstructions from tree rings, (5) early corroborating scientific evidence in Williams and Baker (2012 Table S1), (6) early scientific observations of extensive high-severity fire by Leopold et al. (1904). A revised Final EIS needs to present the details of the rebuttal of Fulé et al. (2014) by Williams and Baker (2014) and explain in detail the findings of these six sources of scientific evidence that together agree on the historical importance of mixed- and high-severity fire in the 4FRI project area.

References:

Dugan, A. J. and W. L. Baker (In press). Sequentially contingent fires, droughts and pluvials structured a historical dry forest landscape and suggest future contingencies. Journal of Vegetation Science, in press.

Fulé, P. Z. et al. 2014. Unsupported inferences of high severity fire in historical western United States dry forests: response to Williams and Baker. Global Ecology and Biogeography 23:825-830.

Jenkins, S. E., C. H. Sieg, D. E. Anderson, D. S. Kaufman, and P. A. Peartree. 2011. Late Holocene geomorphic record of fire in ponderosa pine and mixed-conifer forests, Kendrick Mountain, northern Arizona, USA. International Journal of Wildland Fire 20:125-141.

Leiberg, J. B., T. F. Rixon, and A. Dodwell. 1904. Forest conditions in the San Francisco Mountains Forest Reserve, Arizona. US Geological Survey Professional Paper No. 22. US Government Printing Office, Washington, D.C.

Odion, D. C., C.T. Hanson, A. Arsenault, W. L. Baker, D. A. DellaSala, R. L. Hutto, W. Klenner, M. A. Moritz, R. L. Sherriff, T. T. Veblen, and M. A. Williams. 2014. Examining historical and current mixed-severity fire regimes in ponderosa pine and mixed-conifer forests of western North America. PloS One 9(2), article e87852.

Williams, M. A. and W. L. Baker. 2012. Spatially extensive reconstructions show variable-severity fire and heterogeneous structure in historical western United States dry forests. Global Ecology and Biogeography 21:1042-1052.

Williams, M. A. and W. L. Baker. 2013. Variability of historical forest structure and fire across ponderosa pine landscapes of the Coconino Plateau and south rim of Grand Canyon National Park, Arizona. Landscape Ecology 28:297-310.

Williams, M. A. and W. L. Baker. 2014. High-severity fire corroborated in historical dry forests of the western United States: response to Fulé *et al.* Global Ecol. and Biogeogr. 23: 831-835.

Issue 2. New scientific evidence shows that historical forests in the 4FRI project area were dominated by small trees. The 4FRI goal of removing most small trees is thus not ecological restoration and would reduce the resilience of these forests to insect outbreaks and droughts that are the most serious disturbance threats to 4FRI forests.

Baker and Williams (2015) presented new evidence from seven study areas covering about 1.7 million ha of dry forests across the western USA, including much of the 4FRI project area, that dry forests were historically dominated by small trees, rather than just large trees in open park-like stands as had been widely thought in the past. This finding is based on direct measurements of 45,171 bearing trees and direct records along 22,206 km of section lines by General Land Office surveyors in the late-1800s. These data are not reconstructions, but instead direct systematic records made by highly trained surveyors. These direct records are from historical forests, as they were collected before widespread logging and other land-use changes that later substantially altered these forests.

Three of the seven study areas were in and near the 4FRI project area. The 41,214 ha Coconino Plateau study area, the 405,214 ha Mogollon Plateau study area, and the 151,080 ha Black Mesa study area together include evidence from 15,232 bearing trees and 6,084 km of section lines. Small trees, defined as < 40 cm (about 16 inches) diameter, made up 69.5%, 51.8%, and 81.1% of total trees in these three study areas, respectively. The Mogollon Plateau study area, where 4FRI Phase 1 is located, had a higher percentage of large trees than the other two study areas, but even on the Mogollon more than half the trees were small. The abundance of small trees likely was fostered by episodic mixed- and high-severity fires, insect outbreaks, droughts and other disturbances (Williams and Baker 2013, Dugan and Baker, in press).

The key role of small trees in providing resilience to these forests over the long-term is that they provide advance recruitment that differentially survives insect outbreaks and droughts. The Baker and Williams (2015) study also showed, using government fire and insect data, that rates of insect outbreaks over the period from 1999-2012 were 4.5 times the rates of mixed- and high-severity fires across ponderosa pine forests in the western USA. Droughts have also recently led to substantial tree mortality in dry forests. Large trees are especially susceptible to drought mortality, and small trees have a higher probability of surviving droughts.

Removing most small trees, as proposed in the Final EIS and ROD, across the 4FRI project area to reduce fire risk thus would not restore the historical structure of these forests and instead would substantially reduce the resilience of these forests to insect outbreaks and droughts that are currently the most significant disturbance threats to these forests.

Summary and Suggested Remedies: Forests in the 4FRI project area were shown in Baker and Williams (2015) to have been historically dominated by small trees (< 40 cm diameter) that particularly conferred resilience to insect outbreaks and droughts that today are shown to be a much more significant threats to 4FRI forests than are wildfires. The general proposed 4FRI goal of removing most small trees would not be ecological restoration, but could be modified to be restorative. Retaining and increasing large trees until they are again at historical levels, since they are definitely in deficit, is certainly restorative. Removing small trees to a lesser extent than proposed in the Final EIS and ROD, so that small trees remain numerically dominant across dry-forest landscapes would match the new evidence. Also compatible would be to restore the percentages found for the Mogollon and Coconino (52-81% of trees < 40 cm) study areas of Williams and Baker (2012, 2013), while retaining the goal of restoring historical heterogeneity in tree density, basal area, and other key features of historical forest structure.

References:
Baker, W. L. and M. A. Williams. 2015. Bet-hedging dry-forest resilience to climate-change threats in the western USA based on historical forest structure. Frontiers in Ecology and Evolution, in press.
Dugan, A. J. and W. L. Baker (In press). Sequentially contingent fires, droughts and pluvials structured a historical dry forest landscape and suggest future contingencies. Journal of Vegetation Science, in press.
Williams, M. A. and W. L. Baker. 2013. Variability of historical forest structure and fire across ponderosa pine landscapes of the Coconino Plateau and south rim of Grand Canyon National Park, Arizona. Landscape Ecology 28:297-310.

Issue 3. New scientific evidence shows that rates of historical low-severity fire were lower than previously thought, and 4FRI is consequently proposing too much prescribed burning during the 10-year project period.

New evidence in Dugan and Baker (2014, in press) showed that typical estimates of mean fire-return intervals in dry forests in and near the 4FRI project area that suggest historical fires burned at very short intervals substantially underestimate the length of historical fire intervals.

The traditional composite fire-interval (CFI) method used to estimate mean fire-return interval calculates mean intervals between fires in a pooled composite list of fires found anywhere in a sampling area. Mean CFI represents how often a fire was found on a scarred tree or a few scarred trees somewhere in the sampling area, not how often fire burned across the whole sampling area or across points. Thus, tradition estimates are not appropriate to use to guide prescribed burning programs, which generally blacken much of each burn unit.

Mean CFI also has multiple limitations documented by simulation analysis, analytical studies, empirical comparisons, and the new modern calibration at Grand Canyon (Dugan and Baker 2014). Mean CFI is typically strongly related to sample size and sample area, more than being a property of the fire regime (Baker and Ehle 2001, Dugan and Baker 2014). Mean CFI declines toward 1.0 years as sampling area increases, a highly undesirable property. Since most fires are small, burning only a few trees, mean CFI nearly always underestimates how long fire intervals were on average across the sampling area, which is the population mean fire interval (Baker and Ehle 2001). The population mean fire interval is the measure that is congruent with prescribed burning programs that generally blacken burn units.

The discrepancy between traditional CFI estimates and the population mean fire interval can be seen, for example, in the Grandview part of the Dugan and Baker (2014) study area on the South rim of Grand Canyon National Park. In this area, Fulé et al. (2003) found the historical mean CFI (25% scarred) to have been 9.5 years. In contrast, the fire rotation and population mean fire interval reconstructed using validated spatial methods (Farris et al. 2010) were 25.7 years (Dugan and Baker 2014), thus 2.7 times as long as estimated by the traditional mean CFI. Thus, 2.7 is an appropriate multiplier to correct mean CFI estimates so they roughly approximate the population mean fire interval in the 4FRI project area, which is the measure that is scaled appropriately for use in guiding prescribed burning programs.

Valid new scientific methods are available to accurately reconstruct population mean fire interval for use in prescribed burning programs, including a method for small plots (Dugan and Baker 2014) and for spatial reconstruction across landscapes (Farris et al. 2010, Dugan and Baker, in press). Until these new methods are widely applied, it is essential to use the available valid new estimates or correct known deficiencies of the CFI method by using multipliers (Baker and Ehle 2001). As an interim estimator of the population mean fire interval, traditional estimates of fire-return intervals in the 4FRI project area should be multiplied by 2.7, as this is the multiplier shown to be appropriate in the comparison, described above, by Dugan and Baker (2014) on the Coconino Plateau.

Summary and Suggested Remedies:
I suggest avoiding the use of traditional estimates of mean fire-return interval because of the documented problems with these measures. If they are used in some way in 4FRI, the significant deficiency in traditional estimates of historical rates of burning need to be fully discussed and disclosed to the public, as their use will likely lead to too much fire, which has significant adverse effects on the environment. Too much fire has known adverse impacts that include: (1) increasing the spread of invasive species, such as cheatgrass (*Bromus tectorum*), a known concern in the 4FRI project area, (2) adversely affecting native understory plants (Laughlin and Grace 2006), and (3) killing large trees that are already in deficit (van Mantgem et al. 2011). For example, the DROD reported on p. 31 that one prescribed fire "showed an 8 percent loss of trees greater than 18 inches d.b.h."

As currently proposed on Page 13 of the DROD the plan is: "Up to two prescribed fires will be conducted on all acres proposed for treatment over the 10-year period." The footnote on that page also indicates: "...with the expectation that desired conditions would require a fire return interval of about 10 years." The rationale for a 10-year interval and about 585,000 total acres of prescribed burning over the project period is that an initial fire needs to be followed by another fire before a maintenance fire interval can be put in place. However, it is not clear whether the project proposes to accomplish these sequential fires within the actual project period or simply within 10 years after each initial fire, which could extend beyond the project period.

Regardless, I suggest the proposed 10-year interval of burning and up to two fires during the 10-year project period is too much prescribed burning: (1) relative to historical fire rotations and population mean fire intervals, which likely were 25-30 years or more, based on the analysis by Dugan and Baker (2014) on the Coconino Plateau, and (2) is likely to lead to too much mortality of large trees, too much expansion of cheatgrass and other invasive plants, and adverse impacts on native plants. Since a major focus of the project is to restore large trees, and considerable effort has been made to devise a method to retain large trees during restoration, it is contrary to this effort to have potentially two successive losses of 8% of large trees (as in the example cited above) within the 10-year project period.

Certainly a single burn across the project area, to reduce activity fuels after mechanical treatments, during the project period of 10 years is likely to be generally restorative and an essential step, but I suggest that to minimize adverse impacts, another prescribed burn not be generally done until 25-30 years after the initial burn. Although this may not reduce fuels as much as two successive fires within 10 years, the goal of the 4FRI project is not fuel reduction, it is ecological restoration. A 25-30 year period would give damaged trees and native understory plants time to partially or fully recover before the next fire, and increase the chances that large trees will survive and native plants will be able to compete with invasives.

References:
Dugan, A. J. and W. L. Baker. 2014. Modern calibration and historical testing of small-area, fire-interval reconstruction methods. International Journal of Wildland Fire 23:58-68.
Dugan, A. J. and W. L. Baker (In press). Sequentially contingent fires, droughts and pluvials structured a historical dry forest landscape and suggest future contingencies. Journal of Vegetation Science, in press.
Farris, C. A., C. H. Baisan, D. A. Falk, S. R. Yool, and T. W. Swetnam. 2010. Spatial and temporal corroboration of a fire-scar-based fire history in a frequently burned ponderosa pine forest. Ecological Applications 20:1598-1614.
Fulé, P. Z., T. A. Heinlein, W. W. Covington, and M. M Moore. 2003. Assessing fire regimes on Grand Canyon landscapes with fire-scar and fire-record data. International Journal of Wildland Fire 12:129-145.
Laughlin, D. C. and J. B. Grace. 2006. A multivariate model of plant species richness in forested systems: old-growth montane forests with a long history of fire. Oikos 114:60-70.
van Mantgem, P. J., N. L. Stephenson, E. Knapp, J. Battles, and J. E. Keeley. 2011. Long-term effects of prescribed fire on mixed conifer forest structure in the Sierra Nevada, California. Forest Ecology and Management 261:989-994.

Issue 4. New scientific evidence shows that Mexican spotted owls (MSOs) benefit from historical mixed- and high-severity fires, that the habitat of related spotted owls was created and maintained by mixed- and high-severity fires, that MSO PACs are being affected in some areas by human-set fires but not at high rates and actual effects on MSO habitat and occupancy are unknown, and proposed thinning in MSO habitat is likely to adversely affect future habitat of the MSO.

First, a just-published study (Ganey et al. 2014) shows that wintering MSO moved to moderate- and high-severity burned areas, that provided greater prey biomass and prey diversity, rather than to lower-elevation areas with milder weather. This shows that the 4FRI goal of reducing mixed- and high-severity fire to protect MSO habitat would likely instead have adverse effects on the MSO by reducing favored habitat during the stressful winter season.

Second, a newly-published study (Baker, in press) shows that the main historical habitat components of the Northern spotted owl in the Eastern Cascades of Oregon were preferentially found in areas with preceding mixed-severity wildfires. These wildfires produced early-successional post-fire habitat favorable for spotted owl foraging and roosting and mid- to late-successional habitat favorable for nesting, which also can be created by high-severity fires. The study shows that a focus on reducing short-term loss of spotted owl nest sites to mixed- and high-severity fires by thinning and fuel reduction, if successful, will lead to reduced future spotted owl habitat.

Third, the 2012 MSO Recovery Plan and a new master's thesis (Normandin 2014) purport to show that the risk of high-severity fire to MSO is high and thinning is needed to reduce what Normandin calls uncharacteristic high-severity fires. However, the 2012 Recover Plan and the Normandin thesis actually both show that the rate of high-severity fire is not high and is confined almost entirely to arson/accidental fires. Here are the problems with the Recovery Plan and Normandin's findings and with the treatment of risk of high-severity fire to MSO habitat in the Final EIS:

1. Normandin did not cite or use the evidence presented with issue 1 above that shows that high-severity fires were a natural component of historical fire regimes in MSO habitat and that

spotted owl habitat in other areas was created and maintained by mixed- and high-severity fires (Baker, in press). In this latter case, the publication just came out, but it is germane. The 2012 Recovery Plan was developed before the appearance of Williams and Baker (2012), and thus perhaps had no reason to comprehensively review evidence about historical high-severity fire in MSO habitat, but this evidence is now available.

2. Normandin also did not cite or use new evidence that MSO winter habitat is favored in moderate and high-severity burned areas (Ganey et al. 2014), likely also because this paper was just published. This new information, however, is also germane to the analysis.

3. The 2012 Recovery Plan did not study or document an increasing trend in high-severity fire in NSO habitat. The increase in high-severity fire that Normandin showed is nearly all due to the 2002 Rodeo-Chediski fire and the 2011 Wallow fire (Normandin Figure 2 shows this). Both fires were accident/arson fires. If people had not set these fires, there almost certainly would be no increased high-severity fire in the 4FRI MSO habitat area. This shows that fuels and forest structure in MSO forests are not leading to increased high-severity fire. The causal problem is almost entirely arson/accidental ignitions by people.

4. Neither the 2012 Recovery Plan nor Normandin calculated fire rotation for recent high-severity fires, but this measure is essential to evaluate fire risk, as it estimates the expected time to burn across a study area and also the expected mean interval between fires at any point in the study area. The calculation of fire rotation is given by: Observation period / fraction of area burned (Baker 2009).

For the 2012 Recovery Plan, which studied about 89% of total PAC area, the observation period is 14 years (1995-2008). the cumulative PAC hectares burned by high-severity fire are given in Box B.2, Table 1, p. 198 as 12,675 ha across the total study area, and total hectares in designated PACs are given in this same table as 329,054 ha. Thus, the high-severity fire rotation from 1995-2008 is: 14 years / (12,675 ha / 329,054 ha) = 363.5 years. Similar calculations for individual EMUs show that the Upper Gila Mountains EMU had a high-severity fire rotation of 307.9 years during this same period.

For Normandin (2014), the observation period is 20 years (1992-2011), the cumulative PAC hectares burned by high-severity fire are given in Table 3, p. 30 in Normandin (2014) as 8,402.5 ha and total hectares in designated PACs are given as 101,380.2 ha in the same table. Thus, the high-severity fire rotation from 1992-2011 is: 20 years / (8,402.5 ha / 101,380.2 ha) = 241.3 years.

Fire rotation is also the expected mean interval between high-severity fires at any point in the landscape (Baker 2009). Thus, using Normandin's data, even if the two unprecedented human-set fires were to recur as they did between 1992-2011, it is expected that high-severity fires would not recur for 241 years on average in each MSO PAC, which is ample time for recovery and redevelopment of mature forests favored for MSO. Similarly, using the 2012 Recovery Plan data, the expected mean interval between high-severity fires in a PAC would be 363.5 years across all the PACs studied and 307.9 years across PACs in the Upper Gila Mountains. These also are ample periods for recovery and redevelopment of mature forests favored for MSO.

Normandin reports (his Figure 6) that the human-set 2011 Wallow fire alone added 3,830 ha of high-severity fire. If that fire had not occurred, the high-severity fire rotation would have been 443 years, not 241 years, showing that this human-set fire is the primary source of a somewhat reduced high-severity fire rotation. The 2012 Recovery Plan suggested that the 2011 Wallow fire might add concern, but comparing the fire rotation from the 2012 Recovery Plan to that of Normandin shows that the 2011 Wallow fire had only modest effect, reducing the fire rotation by about 22%, from 307.9 years to 241.3 years. This comparison illustrates the large buffering capacity of the PAC system, which is likely quite resistant and resilient to very significant rapid changes in high-severity fire.

Neither the 2012 Recovery Plan nor Normandin make projections of future fire risk to MSO that are grounded in published scientific projections of future climate and fire. The 2012 Recovery Plan uses arbitrary exponential rate increases that are not linked to any of the several published projections of increased fire that use global climate models and emissions scenarios. Normandin simply extrapolates from his study period, effectively assuming that events like the 2002 Rodeo-Chediski and 2011 Wallow fires will recur as they occurred during his study period. This is certainly not a testament to faith in our public fire services to be able to prevent future arson/accidental fires from spreading over such large areas.

5. Normandin does not consider, in his risk calculation for MSO, the rate at which forest succession is producing new MSO habitat, only the rate of loss to fire, even though it is also a fundamental component of analysis of fire risk to spotted owls to include both the rates of loss of habitat and the rates at which new habitat is being produced by forest succession (Hanson et al. 2009). The 2012 Recovery Plan says: “the amount of habitat affected by high severity burns was not offset by restored or newly developed habitat over this analysis period,” (p. 197), but presents no data (so far as I could find) showing the hectares of restored or newly developed habitat.

6. Finally and most fundamental, neither the 2012 Recovery Plan nor Normandin’s (2014) analysis gathered data on MSO occupancy and use of post-fire areas that were studied, but instead simply assumed that high-severity fire equates to lost habitat and no occupancy. It is now well know, from studies cited in the Final EIS (e.g., Bond et al. 2002, Lee et al. 2012) that this is not a valid assumption for spotted owls. Thus, neither analysis provides adequate evidence that there is any actual risk to MSO from high-severity fire.

Fourth, a new study in related spotted-owl habitat in the Pacific Northwest shows that thinning directly degrades and reduces spotted owl habitat much more than thinning reduces habitat loss to wildfire, leading to a net loss of spotted owl habitat from thinning (Odion et al. 2014). Thinning reduced 3.4 to 6.0 times more dense, late-successional forest than would be prevented from burning by a thinning approach, thus a no-thinning approach would provide much more future spotted owl habitat. Although the numbers would be slightly different if this analysis were completed for MSO habitat, the outcome would likely be similar.

In summary, Normandin’s study and the Final EIS do not correctly analyze the risks and benefits of high-severity fire to MSO habitat. No evidence was presented that showed that high-severity fire actually reduced MSO habitat or MSO occupancy. As I have shown above, if mature forest was reduced by high-severity fire, it would not be prevented from redeveloping before another high-severity fire even with future events like the 2011 Wallow fire, which is not likely to recur. The effects of the 2011 Wallow fire on the PAC network also were not very large, reducing fire rotation to PACs by only about 22%, demonstrating the large buffering capacity of the PAC network. Needed analyses include: (1) actual effects of high-severity fire on MSO habitat and occupancy, (2) comparison of rates of loss versus creation of MSO habitat, (3) potential treatment effects on future habitat (Odion et al. 2014), and (4) response of MSO to the spectrum of treatments. Proposed treatments have little scientific basis until these analyses are completed, and thus proposed treatments should be suspended until results are available.

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How could the 4FRI Final EIS and ROD be revised, given these new scientific findings?
I suggest that to meet the requirements of NEPA and the mandates of Omnibus Public Land Management Act of 2009, the Final EIS and ROD need to be revised to fully disclose the findings of the new studies presented above and included with this objection and to accommodate this new scientific evidence. Here are my suggestions:

1. Remove the sections in Chapter 3 of the Final EIS on “Opposing Science” and incorporate the six sources of evidence of historical high-severity fire, presented under issue 1 above, into the proposed plan. The 4FRI project plan can be modified to include mixed- and high-severity fire as a part of the historical fire regime that shaped the historical forests of the 4FRI project area, and that needs to be restored and maintained by the project.

Title IV of the Omnibus Public Land Management Act of 2009 established the Collaborative Landscape Forest Restoration Program and mandated “reestablishing natural fire regimes and reducing the risk of uncharacteristic wildfire.” The historical fire regime in the 4FRI project area included substantial mixed- and high-severity fire, as reviewed under issue 1, and a fire regime with nearly exclusive low-severity fire as proposed in the Final EIS would be uncharacteristic.

To meet the mandate of Title IV, I suggest the Final EIS be revised to present the details of all the scientific evidence, reviewed under issue 1 above, that show that mixed- and high-severity fires were major parts of the historical fire regime on the Mogollon and Coconino Plateaus.

The debate between Fule et al. (2014) and Williams and Baker (2014) is distracting and not very important, if the decision is made to incorporate restoration and maintenance of historical rates of mixed- and high-severity fire into the project goals, as should occur given the evidence. If the debate is retained in a revised Final EIS, I suggest it could either minimize and balance the presentation of the debate or continue to keep the details of Fule et al.’s concerns and add all the details of the rebuttal by Williams and Baker (2014) to Fule et al. (2014). If the latter, the revision should present all the counter-evidence that W&B (2014) presented to each of the points of Fule et al. (2014) that were given in the Final EIS. Pages 158-159 of the Final EIS summarized the critiques by Fulé et al. (2014) and page 188 provided more detail on their critiques. It would also be essential to correct Pages 158-159 regarding the extent of evidence that supports the Williams and Baker (2012) reconstructions. The Final EIS says “The bulk of the science relating to fire regimes in southwestern ponderosa pine does not agree with W&B." That is incorrect, as W&B (2012) used 54 published tree-ring reconstructions from low- and high-severity fire areas in the Southwest to calibrate their model and showed that the model agreed completely with all 54 of them. Also, it is essential to present all the new corroborating evidence for Williams and Baker (2012) that I reviewed above under issue 1. It is not worthwhile to argue that Fule et al. (2014) "has 18 co-authors, the majority of whom are well published in fire ecology." A count of the number of authors is a poor measure of the merit of scientific evidence, but if that is retained, then the revised Final EIS should also say that now 11 authors of Odion et al. (2014), who are even better published than the authors of Fule et al. (2014), support the findings of Williams and Baker (2012), using an independent dataset.

2. Corresponding with 1, it is essential to eliminate the 4FRI goal, in the Draft and Final EIS and ROD, of reducing naturally ignited mixed- and high-severity fires, as that would add more adverse fire-suppression effects to a landscape that is already suffering from fire suppression.

Odion et al. (2014) showed that since about 1930 there has been a deficiency in stand-initiation by high-severity fire relative to rates of stand-initiation prior to the onset of fire suppression. Fire suppression is not ecological restoration, thus the Final EIS and ROD need to be both revised to modify these goals to meet Title IV of the Omnibus Public Land Management Act of 2009.

An appropriate revised goal compatible with the historical fire regime and Title IV would be to restore and maintain historical rates and patterns of mixed- and high-severity fire, as well as low-severity fire, in the 4FRI project area and the forest structure that is congruent with these fire severities. For example, Table 71 p. 179 in the Fire Ecology Specialist Report would need to change to include maintenance of mixed- and high-severity fire at historical levels, but that should be an explicit goal in the ROD as well. This includes maintaining a general dominance across the project area by small trees (< 40 cm diameter), as reviewed under issue 2 above.

To match historical rates of low-severity fire across the project area as Title IV suggests, I indicated, under issue 3 above, that one initial prescribed fire to reduce activity fuels after mechanical treatments across the project area is scientifically sound, if the next prescribed fire does not occur until 25-30 years later.

I suggest restoring and managing mixed- and high-severity fire at historical levels, as mandated by Title IV, can be achieved outside wildland-urban interfaces using a combination of prescribed burning and wildland fire use, including managed multi-objective fires in which mixed- and high-severity fire becomes an accepted component. Indeed, this is happening by default now. P. 181 of Vol. 1 of the Final EIS says: "Wildfires from 2001 to 2014 effects (silviculture report, tables 94 and 95) have burned on approximately 255,067 acres in or adjacent to the project area. Of these acres, it is estimated that the overall average burn severity to the vegetation was 20 percent high severity, 30 percent mixed severity and 50 percent low severity." This is reasonably close to the historical fire-severity proportions reconstructed for the Mogollon Plateau, which were 14.5% high-severity, 23.1% mixed-severity and 62.4% low-severity (Williams and Baker 2012). Thus, current fire-severity proportions appear not much different now from historical fire-severity proportions. I suggest this outcome could be accomplished with more purpose. The Williams District of USFS and the National Park Service at Grand Canyon NP have recently demonstrated exemplary skill at managing complex multi-objective fires over thousands of acres, and could likely provide leadership and guidance in accomplishing goals that include maintaining mixed- and high-severity fire at historical levels. Of course, it would be essential to continue to protect people and their infrastructure while accomplishing these goals across the 4FRI project area.

3. Also, Title IV suggests restoring and maintaining forest structures compatible with historical fire regimes, which indicates that 15-18% of the project area should be maintained as dense forests with > 200 trees/ha. See Table 1 in Williams and Baker (2013) which shows that 15-18% of the Coconino and Mogollon study areas historically had dense forests with > 200 trees/ha. These dense-forest areas can offset lower-density and less dominance by small trees in more open forests with large trees that were found historically across 19% and 33%, respectively, of the Coconino and Mogollon study areas (Table 1 in Williams and Baker 2013). Since an estimated 14% already will be maintained in a closed-canopy condition (Appendix G Table 167 p. 890), I suggest that a revised Final EIS and ROD simply increase this protected dense forest area to 15-18% and make it explicit that this closed-canopy area will also be maintained with > 200 trees/ha and dominance by small trees explicitly to be congruent with historical conditions as well as to provide habitat for wildlife dependent on denser forests. This habitat should be permanently maintained, not just be “bridge” habitat.

4. Management goals for Mexican spotted owls (MSO) in the Final EIS and ROD also need revision, given the new science reviewed under issue 4 above. The analysis of fire risk to MSO by Normadin (2014) and in the Final EIS is incorrect and overstates the risk to MSO from high-severity fires. Since these analyses omit fundamental parts needed to accurately estimate fire risk, leading to incorrect conclusions, I suggest the Final EIS suspend proposed treatments in MSO habitat until adequate analysis is completed. USFWS and the scientific community need to undertake needed analyses to accurately estimate fire risk to MSO relative to benefits of mixed- and high-severity fire for MSO and rates at which new habitat is being produced by forest succession. During the suspension, it is important to conduct and complete small-scale experiments to determine the effects of thinning on MSO, since nothing is known about this. If the necessary full assessment shows there is significant risk to MSO from high-severity fire, which seems unlikely, then an analysis of tradeoffs between treatment approaches is needed, including thinning, no-thinning or other approaches, such as possible methods for direct reduction of arson/accidental fires in and near MSO habitat.

Summary:
I have suggested ways in which the new scientific evidence I have reviewed in this objection could be used to revise the Final EIS and ROD to produce a plan that would allow 4FRI to restore and manage the full range of historical fire severities that produced diverse habitats for plants and animals across the 4FRI area, as is the mandate of Title IV of the Omnibus Public Land Management Act of 2009. The Final EIS and ROD can be easily revised to incorporate the substantial evidence that mixed- and high-severity fires were part of the historical fire regime in 4FRI forests. Efforts can begin immediately to increase the use of multi-objective wildland fires away from people and their infrastructure to begin explicitly restoring and maintaining historical rates and patterns of mixed- and high-severity fires, along with a single low-severity fire after mechanical treatments during the 10-year project period. Restoring large trees as planned, while retaining the dominance of small trees, may somewhat reduce byproducts for industry, but would not be a difficult revision, and would much better prepare these forests for insect outbreaks and droughts that are the most significant threats to these forests in the next few decades. The plan already has interim protection for dense forests across about 14% of the area, that only needs to be increased to 15-18% and permanently designated for retention of > 200 trees/ha to be congruent with historical reconstructions. Reanalyzing risks to MSO habitat is essential since the current analysis is incorrect and incomplete, but 4FRI could simply suspend any treatments in MSO habitat. During this suspension, the most important action is to adequately study effects of high-severity fires on MSO habitat and occupancy and fully evaluate risks and benefits of high-severity fires both

immediately post-fire and over longer time frames. It would also be sensible to devise and implement plans for reducing unintended human-set fires.

I hope 4FRI will take the time to do the needed revision so that these beautiful forests can be effectively restored for both people and nature and have a better chance of persisting in the face of insect outbreaks, droughts, and fires likely to increase with forthcoming climate change.

Sincerely,

Dr. William L. Baker

I happen to be an Emeritus Professor in the Program in Ecology and Department of Geography at the University of Wyoming, but these comments are my own. I am the author of > 100 peer-reviewed scientific articles and books on fire ecology, ecological restoration, landscape ecology, invasive species, declining birds (e.g., spotted owls), and other ecological topics. These include several studies in 4FRI forests and nearby areas. I have been attending 4FRI stakeholder group meetings for > 9 months and have scientific research underway in and near the 4FRI project area. A publication list is at: scholar.google.com/citations?user=FZN8N04AAAAJ&hl=en&oi=ao.