July 8, 2019
Hannah Bergemann, Fireshed Coordinator
Española and Pecos/Las Vegas Ranger Districts
Santa Fe National Forest
Santa Fe County and San Miguel County, New Mexico
Submitted via: Hannah.Bergemann@usda.gov
Submitted by: Dominick A. DellaSala, Ph. D, Conservation Scientist

Re: **Santa Fe Mountains Landscape Resiliency Project Scoping Comments**

Please accept these detailed scoping comments for the public record regarding the Santa Fe Landscape Mountains Resilience Project (SFLMRP). I am a conservation scientist with over 30 years-experience in forest ecosystems, including fire-dependent forests (DellaSala and Hanson 2015[1]). My relevant expertise includes developing conservation science approaches to accommodate wildfires for ecosystem benefits while reducing fire risks to communities. I have published extensively on how logging has increased fire severity in western forests (Bradley et al. 2016, pdf provided), limitations of forest thinning in a changing climate[2], livestock grazing impacts to fire regimes (Beschta et al. 2012), increases in fire ignitions associated with road access (Ibisch et al. 2017), and climate change effects on altered fire regimes (DellaSala and Hanson 2015; also see Abatzoglou and Williams 2017) among other relevant works.

In general, the SFLMRP will not achieve its stated intent to protect communities from wildfire, is based on faulty fire reconstruction sampling resulting in over-reliance on inappropriate levels of thinning and road improvements, will harm important wildlife habitat and water quality, and may elevate fire risks from increased road access. For these reasons, I am requesting that the Santa Fe National Forest publish a full environmental impact statement pursuant to NEPA.

My detailed comments and supporting pdfs follow this signature page.

Sincerely,

Dominick A. DellaSala, Ph. D
Independent Conservation Scientist

[1] https://www.elsevier.com/books/the-ecological-importance-of-mixed-severity-fires/dellasala/978-0-12-802749-3
[2] https://www.forestlegacies.org/programs/fire-ecology/1410-everything-you-wanted-to-know-about-wildland-fires-in-forests-but-were-afraid-to-ask

SUMMARY OF MAJOR DEFICIENCIES IN PROJECT SCOPING & EIS REQUEST

While I generally support the SFLMRP need to improve watershed conditions and wildlife habitat, I am greatly concerned that aggressive thinning and road improvements will not protect communities. A tendency to rely on fire-scars to reconstruct historic fire regimes as baseline conditions underlines excessive use of thinning that will remove an undisclosed quantity of mid-size trees which, in fact, may degrade mature and old-growth characteristics that the Santa Fe National Forest plan (1987) purports to maintain. Over-reliance on fire scar sampling is apparent in project scoping which, in part, tiers to GTR-310 (Restoring Composition and Structure in Southwest Frequent Fire Forests). Notably, the GTR-310 does not even align with the geographic scope of the project area, as the SFLMRP is within the Colorado Rockies Forest Ecoregion yet GTR-310 is predominately within the Arizona Mountain Forest Ecoregion, which has a different climate, soil types, historical conditions, and fire regime. Extrapolating from one region to another is clearly inappropriate (Moritz et al. 2018) and thus GTR-310 cannot be relied on for project-specific descriptions or actions.

Importantly, the SFLMRP is in an area of high conservation importance to the Santa Fe watershed and the surrounding communities, including:

- Presence of large inventoried roadless and low density roaded areas.
- Undisturbed forests and wildlife habitat that have not been logged or roaded in many decades.
- Nesting territories and critical habitat for the threatened Mexican Spotted Owl (MSO).
- Intact (unroaded, low road densities) habitat for many large carnivores.

The SFLMRP proposes to improve 94 miles of roads and this may harm water quality, introduce undesirable non-native plants that can alter fire regimes, fragment wildlife habitat and increase unintentional human-caused wildfire ignitions (associated with greater access along roads). This cascade of ecological impacts is clearly significant and thus issuing a finding of no significant impact (FONSI) is ill-advised. The Forest Service scoping document provides insufficient information for the public to properly assess the numerous impacts to cultural and ecological resources or to assess the efficacy of fuel treatments as claimed. In particular, the delineation, extent and impacts to inventoried roadless areas in the SFLMRP are not even disclosed. Given the expansive ecological footprint of the project (e.g., thousands of acres cleared and 94 miles of road improvements), and the lack of sufficient project details provided in scoping, the Forest Service must prepare a full environmental impact statement (EIS) pursuant to the National Environmental Policy Act (NEPA). A range of alternatives is required to minimize direct, indirect, and cumulative impacts from significant project actions. The SFLMRP also presents highly controversial and highly uncertain effects involving unique and unknown risks that need sufficient analysis pursuant to an EIS and not an EA (Environmental Assessment).

The EIS should evaluate the following project-related **issues**:

1. **Prioritize community wildfire safety and fire-risk reduction, including home-hardening, defensible space, additional road closures/decommissioning to reduce ignitions, and identification/maintenance of community evacuation routes:** The most prudent means of community fire protection is to *work from the home-out* rather than the *wildlands-in* (emphasis added) according to retired Forest Service researcher Jack Cohen (2000; also see Youtube interviews[3]) and related home fire-risk reduction work (Syphard et al. 2013, 2014). Defensible space is not even mentioned in scoping despite claims of making Santa Fe and surrounding communities more resilient and adapted to fire (p. 2). Community and fire-fighter safety actions should be directed at home protection and anthropogenic fire-ignitions along highways and high-use roads (especially ingress/egress). Importantly, recent research demonstrates that there is a very low (<1%) probability of thinned areas encountering a fire when fuels are lowest (see below). Therefore, it is imperative that the Forest Service strategically direct limited resources at protecting homes rather than thinning in the backcountry which does nothing for home protection.
2. **Reduce human-caused wildfire ignitions (see Balch et al. 2017) associated with road access:** 94 miles of road improvements are proposed with only 1.5 miles of seasonal road closures and 20 miles of road decommissioning (p. 15, Table 7). The Forest Service needs to conduct a project-specific transportation plan to determine the probability of human-caused fire ignitions in relation to road densities, road improvements, and increased human access along improved roads. This plan should address a broad scope of road-related impacts and choose an alternative based on minimal road access (see below).
3. **Protect high value conservation areas from logging/thinning/road improvements:** The SFLMRP needs to fully disclose impacts of road improvements and thinning on low-density (<1 mi/sq mile) and inventoried roadless areas (see below) and make clear how late-successional forests within the project area will be protected from logging or restored. In particular, total acreage and distribution of late-successional forests in relation to reference landscapes/conditions need full disclosure. According to the SFLMRP, late-seral forests will be maintained at the minimum 20% level, based on arbitrary old growth standards in the Forest Plan (p. 8). The Plan, however, provides no historical or reference condition on whether the minimum 20% is sufficient to sustain this unique habitat nor discloses the cumulative effects of multiple project stressors (e.g., grazing, roads, livestock, past-current logging) on late-seral maintenance and restoration. If the project area is truly predominately a low-severity fire regime, then historically late-successional forests would theoretically have been much more widespread than 20%. Additionally, project scoping states "there is a need to improve riparian vegetation where

[3] National Fire Protection Association presentations by Jack Cohen - https://www.youtube.com/watch?v=vL_syp1ZScM; https://www.youtube.com/watch?v=RqKFDDBGd5o

conditions are departed and conifers are encroaching" (p. 10). Little information is provided – other than fencing may be used – on how livestock impact riparian conditions. Despite the emphasis on water quality (p. 10), there is no disclosure of the cumulative impacts of livestock nor sediment delivery from roads on this unique habitat type. There is an extensive literature that must be considered on livestock impacts to ecosystems in a changing climate (reviewed in Beschta et al. 2012). At a minimum, this includes livestock impacts to stream channel morphology, stream flow, bank erosion, and soil compaction in association with climate change impacts.

4. **Greatly limit thinning of mid-size tree cohorts:** The scoping document notes "thinning would *primarily* (emphasis added) target small diameter trees and medium diameter trees (up to 12 inches dbh) and no trees above 24 inches dbh would be cut"(p. 12). The Forest Service needs to fully disclose how much tree removal will occur in the mid-size class rather than relying on "*what we find on the ground*" (emphasis added) (p. 11). Disclosure should include tree diameter distributions from stand inventories in reference sites (see GTR-310 Fig. 10 as an example of diameter distribution plots) and how thinning may affect mid-size class (12-24 inch dbh) in relation to reference conditions and recruitment of large-trees over time. As it stands, it is impossible for the public to assess project impacts when ambiguous statements are used such as "*primarily*" and "*what we find on the ground*. This is particularly important as, depending on site conditions, mid-size trees may already possess mature/old-growth characteristics in the project area. For instance, "The Minimum Criteria for the Structural Attributes Used to Determine Old-Growth" in the Santa Fe Forest Management Plan of 1987 includes the same mid-tree size category that would qualify as old growth under the standards definition. Therefore, logging trees *up to 24* in dbh (12-24 in) is inconsistent with the Forest Plan that strives ". . . *to create or sustain as much old growth compositional, structural, and functional flow as possible over time at multiple-area scales*" (emphasis added).
5. **Discuss limitations and uncertainties of fire-scar sampling, importance of fire-free periods to shrub and tree recruitment, and include more robust fire occurrence/severity estimators that account for variability in fire-free and frequent-fire intervals:** The SFLMRP primarily relies on fire-scar sampling to determine the dominant fire regime present yet provides no discussion of uncertainties and limitations in sampling approaches (i.e., confidence levels). Notably, paleo-ecology studies conducted over longer timelines (millennia) than fire scar sampling show high variability in fire regimes related primarily to regional and local microclimatic factors (slope, aspect, elevation) over time (Meyer 2010). Large fires historically included portions of high severity patches during alternating cycles of wet followed by droughts (Margolis et al. 2011). This is particularly important as extreme fire-weather (top-down driver) is known to over-ride bottom up influences (fuels) on fire behavior in the Rockies (Bessie and Johnson 1995, Schoennagel et al. 2004) and elsewhere (Abatzoglou and Williams 2017). The effect of global heating and increased likelihood of regional droughts may (Margolis

et al. 2011) or may not (i.e., sufficient biomass is consumed initially leading to lower severities later; Parks et al. 2016, Margolis et al. 2017) increase fire severity. This uncertainty is most significant and must be analyzed in an EIS to determine the need for and limitations of extensive fuels treatments based predominately on limited assumptions regarding frequent-fire regimes that may become increasingly equivocal in a rapidly changing climate. Additionally, variability in fire return (point/plot scale) and fire rotation (landscape scale) intervals accounts for longer fire-free periods that allow for shrub and small tree recruitment, including both dense and open forest conditions (see below). Thus, the SFLMRP needs to clearly define what it means by a low-severity fire regime with respect to this variability and in relation to tree canopy mortality, shrub and small tree densities. Notably, even low severity systems have occasional fire-flare ups that kill dominant overstory trees and that allow for sufficient shrub and small tree recruitment (see Baker 2017).

6. **Remove thinning treatments in pinyon-juniper (4,000 ac) and spruce-fir (3,000 ac) as they are not ecologically appropriate:** There is no ecological justification for thinning treatments in these forest types and doing so may result in ecosystem type shifts and novel conditions. The SFLMRP inappropriately targets them without providing vegetation-specific fuel loads, fire regimes, and stand density diameter distributions characteristic of reference conditions. Fuel loads are only disclosed for ponderosa pine and mixed conifer (p. 9). There is no citation or link back to reference conditions for fuel targets in pinyon-juniper and spruce-fir (extrapolating conditions from one forest type to another is clearly inappropriate if that is what is going on here). Notably, upper elevation spruce-fir stands and lower elevation pinyon-juniper stands are on longer (than dry pine/mixed conifer) and more varied (with high severity predominant) fire return intervals (35-100 years and >300-400 years in places depending on elevation, slope, and other site conditions) allowing for recruitment of older forest conditions and fuels overtime (Huffman et al. 2008, Romme et al. 2008, Margolis et al. 2011). In particular, Romme et al. (2008) notes that “Recent large, severe (stand-replacing) fires in persistent piñon-juniper woodlands are normal kinds of fires, for the most part, because similar fires occurred historically. However, the frequency and size of severe fires appears to have increased throughout much of the West since the mid-1980s, in piñon-juniper and also in other vegetation types. The causes of this recent increase in large piñon-juniper fires are uncertain, and it is unclear whether the very large sizes of some recent fires are exceptional or represent infrequent but nevertheless natural events.” They further note “the fuel structure in wooded shrublands typically is not conducive to a spreading, low-severity fire that would consume fine fuels without killing the dominant trees or shrubs, because the fine fuels are usually discontinuous.”
7. **Reduce livestock grazing impacts in riparian areas and high value conservation areas:** Project scoping repeatedly mentions the contribution of livestock grazing to altered fire regimes and poorly functioning riparian areas yet provides no information on

livestock AUMs and whether they will be removed or curtailed other than "fencing may be installed to protect restored areas" (p. 11). There must be full disclosure of AUMs in relation to riparian and water quality conditions, including cumulative effects of livestock grazing, invasive species (particularly flammable vegetation like cheat grass) and climate change (Beschta et al. 2012).

8. **Disclose and avoid impacts to imperiled species like the Mexican Spotted Owl (MSO):** The SFLMRP provides no detail on whether thinning and road improvements will be conducted within MSO PACs or critical habitat. There is no discussion of importance of mixed-severity wildfires in maintaining foraging habitat for spotted owls (Lee 2018, pdf enclosed). Instead, the SFLMRP (p. 9) incorrectly assumes, without site-specific data on owl occupancy, that "the current risk for large, high-severity fire also poses a substantial threat to MSO habitats across the Project Area." However, Lee (2018) conducted a meta-analysis of fire effects on all three owl subspecies concluding that mixed-severity fire, including patches of large severity, was not the main cause of owl nest abandonment; pre- and post-fire logging was the predominant factor. Also, full disclosure of incidental take under the Endangered Species Act is required.
9. **Reduce emissions from logging and roads:** A stated intent of the SFLMRP is to provide for resilience to climate change yet there is no analysis of project-related emissions from tree clearing and road improvements. Notably, emissions from wildfires are typically much lower than landscape-level logging projects aimed at reducing wildfires (e.g., see Mitchell et al. 2009, Campbell et al. 2016, Law et al. 2018 as examples of appropriate methodologies). Actions that minimize emissions should be compared in CO_2 equivalents, including the social cost of carbon[4]. Project alternatives should then be selected with the lowest emissions.
10. **Provide a cost-benefits analysis of managing wildfires for ecosystem benefits by working with fire under safe conditions:** The SFLMRP must disclose project-related costs of thinning, prescribed fire, and road improvements in comparison to managing fire for ecosystem benefits as a viable alternative under safe conditions (e.g., refer to the Cohesive Wildland Fire Management Strategy for wildfire ecosystem benefits[5] and 2012 forest planning rule regarding ecosystem integrity, vegetation diversity, and wildfire maintenance). Thus, it must be disclosed under what conditions will wildfires be managed for ecosystem benefits vs. suppressed so that when fires do eventually occur appropriate actions are taken based on pre-fire response planning.

UNCERTAINTIES OF FIRE SCAR METHODOLOGY AND NEED FOR MULTIPLE LINES OF EVIDENCE

While local sampling is important for estimating fire return intervals at the stand level, there are significant uncertainties with extrapolating fire scar point data over large landscapes to

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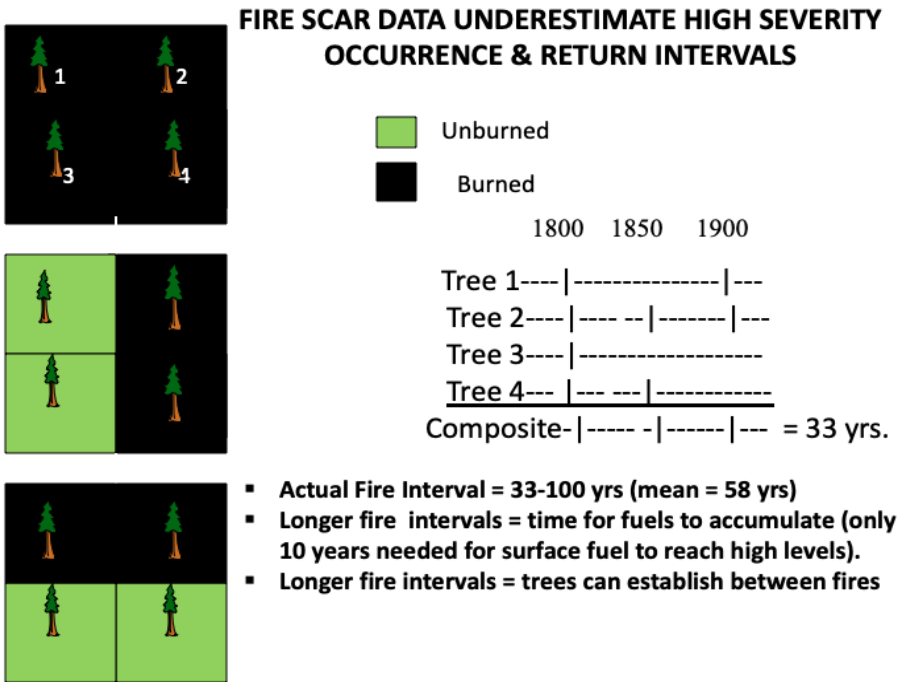
[4]See https://19january2017snapshot.epa.gov/climatechange/social-cost-carbon_.html
[5] See https://www.forestsandrangelands.gov/strategy/

reconstruct historic fire regimes as comparisons to contemporary conditions (Baker 2017). They include sample-site selection bias, lack of tree scars in fire-killed trees (thereby grossly underestimating high severity occurrence), and the fundamental uncertainties of site-specific data to draw landscape-level conclusions (Baker 2017). The hypothetical figure below illustrates the inherent sampling bias of grouping individual fire scar data to construct composite fire interval (mean CFI).



In sum, the variability in CFI estimates is masked whenever the scope of inference is inappropriately extrapolated over large areas and measures of central tendency (rather than the range) are used. This results in a bias toward very short fire return intervals and overly aggressive management to open stand conditions. The best estimator of fire intervals at landscape scales is fire rotation (Baker 2017).

Baker (2017) notes that fire rotations at the landscape scale can be derived from:

1. Areas burned in recent fires from agency fire records or records from remotely sensed data.
2. Historical areas burned reconstructed from scarred trees or plot locations.
3. Historical areas burned reconstructed using a ratio method and scarred-tree or plot records, or comparable data in a table or graph.

The Forest Service must provide information on the fire rotations using methodologies in Baker (2017) and the paleo-ecology literature that can be used to reduce sampling bias associated with fire scar extrapolations. For instance, Baker (2017) goes through each source of bias in tree-ring reconstructions and shows that using corrected estimators actually yields longer fire rotation periods for dry pine/mixed conifer areas. Note that Figure 3 and Figure 4 in Baker (2017) show the diversity of fire rotations (longer intervals) in the Santa Fe area and the S2 Table has individual estimates for New Mexico. The sampling bias in fire-scar data must be disclosed as the entire project is based mainly on fire-scar interpolation from plots to landscapes thereby compounding errors.

To correct for sampling bias, the Forest Service must account for variability in fire-free intervals using more robust methodologies, disclose whether there are historic accounts of fires in the project area beyond just fire-scars, and include paleo-ecology studies from nearby sites to illustrate variability in fire regimes over longer time intervals. Significant discrepancies and debate among researchers about fire scar sampling must be disclosed (e.g., see Odion et al. 2016 response to Stephens et al. 2016 and Moritz et al. 2018).

A key fire-history study for the nearby Santa Fe watershed is Margolis and Balmat (2009). These researchers indicate that the historical low-severity fire rotation in the Santa Fe watershed for dry pine forests was estimated at 39.80 years. They define frequent fire as < 25 years. Using their definition means that the Santa Fe watershed would not qualify as a frequent-fire regime, as this is a sufficient mean number of years between surface fires to allow understory fuels including shrubs and small trees to accumulate levels that would certainly enable the occurrence of some mixed and high-severity fires overtime. Moreover, this longer period corresponds with the paleo-record from charcoal sediments showing that when wet periods are followed by successive droughts, large fires, including patches of high severity, do indeed occur (Meyer 2010).

It is important to accommodate this variability in fire return intervals as heterogeneity in the ensuing burn severity patches at the landscape scale results in high levels of biodiversity (i.e., pyrodiversity of fire severity patches begets biodiversity, DellaSala and Hanson 2015). Notably, even slight differences in fire-return intervals are consequential. Baker (2017) reports that understory fuels in dry forests recover after fires in 7-25 years. If mean fire-return intervals were <25 years, understory fuels would be limited. However, if the interval was >25 years, as reported by Margolis and Balmart (2009), then shrubs and small trees would recover across the landscape and excessive thinning to shift forest to more open-canopy forests with minimal shrub cover would be inappropriate at large spatial scales.

The role of shrubs and understory vegetation is also a key ecosystem component in dry forests allowing for nutrient cycling and below-ground processes, water absorption and retention, provision of wildlife habitat, pollination and other ecosystem services. Spatial heterogeneity in fire-return intervals at landscape scales is a key indicator of resilience as it allows for both fire refugia (longer return intervals) and fire-mediated biodiversity (short return intervals). It is essential to manage for this variability to accommodate wildlife that require low, moderate and high fire severity classes. In other words, when it comes to fire, nature is complex while management tends for uniformity typically at the expense of fire-mediated biodiversity.

The following Baker (2017) observations about fire interval estimators need to be addressed in the SFLMRP:

> "Dry-forest landscapes until recently were thought to have historically been primarily old growth forests, with a history of frequent low-severity fire, across their extent (e.g. [72]), but this has been refuted by GLO reconstructions and early aerial photographs (Table 6), paleoecological evidence [24], and early forest-reserve reports and other evidence [63 , 73]. Even in Arizona, which had abundant old forests with frequent fire (Fig 3), denser forests and high severity fire were extensive at certain times and in certain places, as on Black Mesa and parts of the Mogollon Plateau [60 , 73]. It is sensible to restore low-severity fire to its former dominance in the parts of dry-forest landscapes with a history of primarily low-severity fire, historically averaging about 34% of western dry-forest landscapes (Table 6). Estimated mean PMFI/FRs [population mean fire interval/fire rotation] here provide a guide for restoration and management of low-severity fire in extant old-forest parts of landscapes. For most dry-forests today, which are not old, using frequent fire (PMFI/FR < 25 years) in restoration is not supported, and fuels do not need to be substantially reduced, because historical PMFI/FRs naturally allowed historical shrubs and small trees to fully recover after fires. Restoration of low-severity fire is still needed. The most appropriate approach, given likely long but uncertain mean rates of historical low-severity fire, is for most dry forests today to receive at most one prescribed fire, followed by managed fire for resource benefit, with the goal of mimicking mean historical PMFI/FRs and variability in fire (fire-size distributions, unburned area) as forests reach old age."

Thus, based on Baker (2017) and the problems noted in estimating fire return intervals, the SFLMRP needs to greatly scale back thinning and road improvements except where thinning of small trees (<12 in dbh) is needed to introduce fire nearest homes.

ROAD IMPACTS AND ROADLESS AREA IMPORTANCE

Roads – Given the extensive and cumulative impacts of roads on ecosystem processes, wildlife, water quality, and fire ignitions (see below), a **minimum road density analysis** needs to be conducted to assure the public that there are no redundant roads and that more roads can and should be decommissioned and obliterated rather than improving 94 miles of roads. The SFLMRP needs to provide a transportation plan analysis to fully assess road-related fire ignitions associated with improved access and to come up with an alternative that reduces them.

Simply improving culverts and surfacing primitive dirt roads with poor drainage also may not be enough to improve water quality. Notably, the SFLMRP provides no information on Clean

Water Act 303d water-quality limited streams and how project-related impacts will be minimized to comply with state and federal water quality standards[6]. Water quality must be assessed in relation to road improvements, greater road access, thinning impacts, and road-stream intersections.

In sum, the project needs to fully disclose road-related impacts as follows:

- Roads and thinning contributions to soil erosion and sediment inputs affecting water-quality even when roads are improved.
- Probability of human-caused wildfire ignitions associated with improved road access (see Balch et al. 2017 for human-caused ignitions, pdf enclosed).
- Fragmentation and degradation of wildlife habitat at road densities > 1 mi/sq mi, particularly impacts to large carnivores and aquatics.
- Spread of invasive species and their effects on fire regimes.
- Likelihood of mass-wasting events on steep erosive slopes along the road prism.

Ibisch et al. (2017) provide a global synthesis of road-related impacts including: wildlife mortality (vehicle collisions); poaching pressure; sediment increases (runoff); chemical contamination; carbon emissions; spread of invasives; fire ignitions; and habitat fragmentation among others. These impacts can extend out to 1 km on either side of the road prism. Thus, the enclosed road impacts need to be fully addressed and properly mitigated to assess planned extensive road upgrades and access.

Roadless Areas - The ecological importance of roadless and lightly roaded areas, and their relatively lower priority in fuels reduction projects compared to heavily roaded areas, is well-documented in the literature (DellaSala and Frost 2000, Strittholt and DellaSala 2001, Loucks et al. 2003, Crist et al. 2005, Selva et al. 2011, Ibisch et al. 2017) and emphasized in landmark Forest Service policies such as the Roadless Conservation Rule[7] and Interior Columbia River Basin strategy[8]. At a minimum, the SFLMRP needs to disclose any treatments proposed in inventoried roadless areas and low density roaded areas (<1 mi/sq mi) and must avoid thinning in these areas because of their high conservation value, particularly as relatively unfragmented

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[6] Particularly in relation to EPA standards see https://nepis.epa.gov/Exe/ZyNET.exe/00001O9W.TXT?ZyActionD=ZyDocument&Client=EPA&Index=1986+Thru+1990&Docs=&Query=&Time=&EndTime=&SearchMethod=1&TocRestrict=n&Toc=&TocEntry=&QField=&QFieldYear=&QFieldMonth=&QFieldDay=&IntQFieldOp=0&ExtQFieldOp=0&XmlQuery=&File=D%3A%5Czyfiles%5CIndex%20Data%5C86thru90%5CTxt%5C00000001%5C00001O9W.txt&User=ANONYMOUS&Password=anonymous&SortMethod=h%7C-&MaximumDocuments=1&FuzzyDegree=0&ImageQuality=r75g8/r75g8/x150y150g16/i425&Display=hpfr&DefSeekPage=x&SearchBack=ZyActionL&Back=ZyActionS&BackDesc=Results%20page&MaximumPages=1&ZyEntry=1&SeekPage=x&ZyPURL

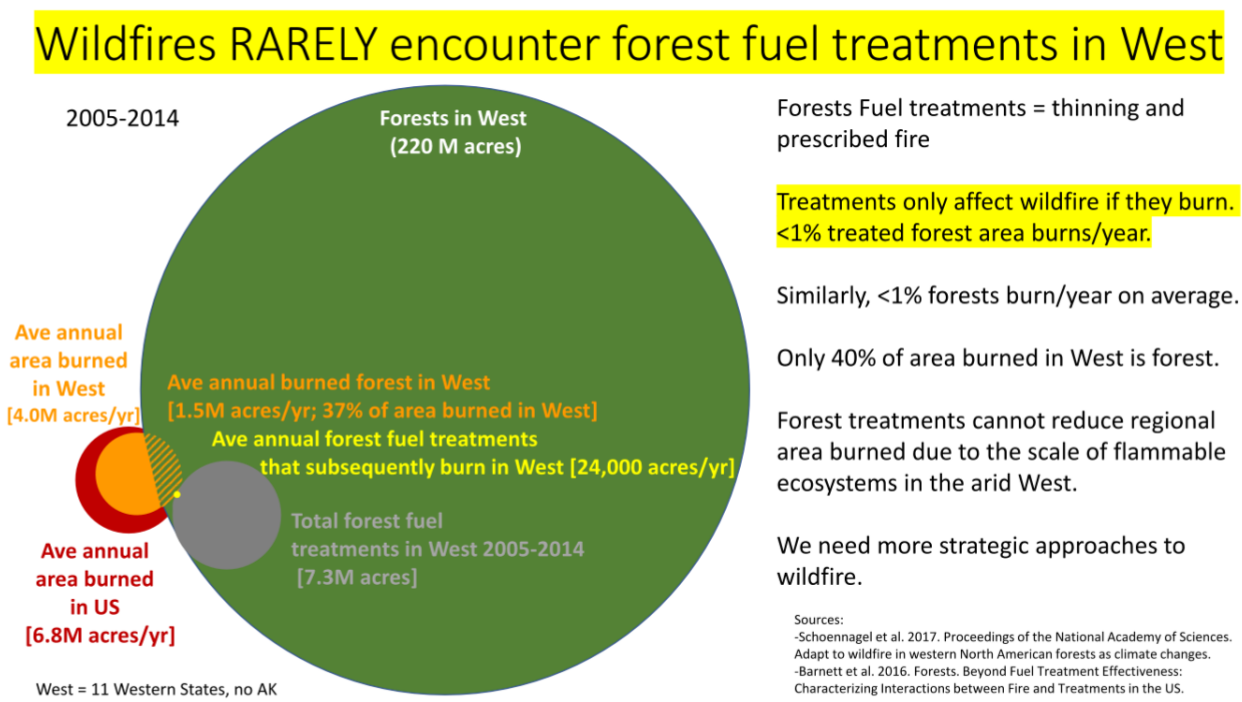
[7] https://www.fs.usda.gov/roadmain/roadless/2001roadlessrule

[8] https://www.fs.fed.us/r6/icbemp/html/ICBEMP_Frameworkmemorandum-and-strategy_2014.pdf

blocks of wildlife habitat. Roadless areas and low-density roaded areas are of considerable importance to ecosystem integrity (as defined by the 2012 planning rule) as they are often at the headwaters of watersheds essential in maintaining water quality and terrestrial and aquatic ecosystem integrity (DellaSala and Olson 2011). Roadless areas also tend to be of much lower priority for fuels reduction given their fire regimes are less altered by suppression and they lack the ignition problems associated with roaded areas (e.g., Roadless Conservation Rule, Columbia River Basin strategy, DellaSala and Frost 2001).

THINNING HAS LIMITED EFFECT ON FIRE BEHAVIOR IN A CHANGING CLIMATE AND SLASH PILE BURNING CAN CAUSE EXTENSIVE SOIL DAMAGE

The figure below summarizes uncertainties of relying on thinning to reduce fire intensity given that the period of when fuels are lowest is generally short lived and fires rarely encounter thinned sites when fuels are lowest (Schoennagel et al. 2017). The extremely low probability of fire and thinned site co-occurrence greatly reduces the project's assumptions about lowering fire intensity. Simply increasing the area thinned does not change these odds appreciably given one cannot accurately predict when and where a fire will occur and many areas are inaccessible (Schoennagel et al. 2017).



Moreover, the SFLMRP needs to disclose the difference between prescribed fire that is applied at the stand level (where impacts to soils can be dispersed and limited) vs. pile burning to consume slash that can cause localized extreme soil damage (excessive soil heating) facilitating the spread of invasive plants and delayed forest succession (especially if livestock grazing also occurs, Besctha et. al 2012).

Excessive opening of the tree canopy can also lead to an increase in shrub growth (even after prescribed fire), higher wind penetrance, and rapid fire spread, particularly if thinning is conducted on steep slopes and in remote areas with limited access. In a warming climate where more extreme fire weather is likely (Abatzoglou and Williams 2017), thinning is even less likely to alter fire behavior (Abatzoglou and Williams 2017, Schoennagel et al. 2017).

AVOIDING BIASED APPROACHES, AREAS OF AGREEMENT & DISAGREEMENT

Bias: The SFLMRP needs to avoid disputed approaches and biased perspectives on fire as generally noted by Iftekhar and Pannell (2015) and Moritz et al. 2018 (below). The following biased perspectives are inherent in the SFLMRP scoping documents:

- Action bias – tendency to take actions even when it is better to delay action (in this case the impacts of aggressive clearing and roads may be more significant than effects of fire on ecosystems given uncertainties of treatment effectiveness as noted).
- Framing effect – tendency to respond differently to alternatively worded but objectively equivalent descriptions of the same item (use of catastrophic fire terminology that fails to account for ecosystem benefits of mixed-severity fires, including periodic flare-ups of high severity patches).
- Reference-point bias – tendency to overemphasize a pre-determined benchmark for a variable when estimating the level of that variably (i.e., over-reliance on fire scar sampling rather than presenting more robust and multiple lines of evidence).
- Satisficing rule – tendency to stop searching for a better decision (i.e., a NEPA based range of alternatives) once a decision that seems sufficiently good is identified.
- Loss aversion – tendency to value losses more highly than similar gains (i.e., managing wildfire of moderate-high intensity for ecosystem benefits instead of avoiding it by mechanical thinning and fire suppression).
- Limited reliance on systematic learning – tendency to use information from past successful efforts rather than using information from both successful and failed efforts via extensive and well-funded ecosystem monitoring (adaptive management and learning is not possible without well-funded monitoring; there is no mention of monitoring in scoping).

The best way to avoid these biases is to use multiple lines of evidence in re-constructing fire regimes, not rely mainly on fire scars, and conduct well-funded monitoring studies that fully assess project effects on species of conservation concern and ecological and cultural values. Multiple lines of evidence and monitoring are discussed in Odion et al. 2016 and Moritz et al. (2018) in the Common Ground Report (see below).

Areas of Agreement/Disagreement (Common Ground): I participated as one of the respondents in the so-called "Common Ground" report and am thoroughly familiar with the report's findings. The SFLMRP should pay particular attention to the following key findings in relation to areas of agreement, uncertainty, and disagreement and adjust project actions accordingly.

Areas of Agreement (high certainty):

- The role of changing climatic conditions is increasingly important in influencing fires.
- Multiple fire ecology and fire history research can be useful.
- Heterogeneity of fire effects, including patterns of patches created by fires of all severities, is important to forest resilience to future fires.
- Generalized models of historical fire regimes vary by ecoregion and forest type.
- Even within the same ecoregion and forest type, there is variation in historical fire regimes among differing environmental gradients.
- Historically, some degree of low-, moderate-, and high-severity fire has occurred in all forest types, but in substantially different proportions and patch size distributions at different locations.
- Classification of historical fire regimes according to forest types can be coarse; thus, failure to recognize variation of historical fire regimes *within* forest types can lead to overgeneralization and oversimplification of landscape conditions.
- Presence of roads, road density and railways, livestock grazing, invasives, and mining can alter fire regimes. Even a single one of these influences can have profound effects on vegetation and fire behavior conditions. When present in combinations, cumulative effects will arise that may push ecosystems past tipping points (Paine et al. 1999, Lindenmayer et al. 2011).
- Knowledge of historical range of variability (HRV) is useful but does not dictate land management goals. HRV findings from one area may or may not have relevance elsewhere.
- Recent trends in many western forest regions of more large fires and more area burned are linked to recent climatic trends of hotter droughts and longer, more severe fire seasons.
- Respondents who emphasized the longer time scales of charcoal records noted that most areas of predominantly low-severity fires showed some incidence of moderate- or high-severity fire over longer time frames.
- It is desirable to use multiple methods to reconstruct historical fire regimes. More can be learned using multiple approaches and considering data from diverse temporal and spatial scales.

- Importance of local context in management of fire-prone landscapes underscores the need to move away from oversimplified narratives that encourage application of fire research beyond its original scope of inference. Note: the scope of inference is of particular concern here as over reliance on fire scar sampling for landscape scale interpolation has inherent biases and uncertainties.

Areas of Disagreement (high uncertainty):

- Fire regime inferences from historical and modern tree inventory data, simulation models, and other approaches have levels of uncertainty.
- Whether large, high-severity fires have increased to a significant and measurable degree in all forest types *in comparison to historical fire regimes* (i.e., prior to modern fire suppression) remains debatable.
- Fuel treatments are urgently needed across nearly all forests remains debatable.
- Fuel treatments should be focused around communities and plantations; but hazard fuel reduction elsewhere remains debatable.
- There is high uncertainty about where and when fuel treatments are beneficial.
- Commonly used vegetation classification schemes as a suitable basis for generalizing about fire regimes remains debatable. Known geographic variation in fire regimes within forest types argues for improved forest and fire regime classifications.
- Tree-ring evidence sometimes supports conclusions that contrast with those derived from landscape-scale inventory and monitoring data using different sampling frames creates uncertainty.
- General applicability of “thinning and prescribed burning remedies” to offset human influences is debatable.
- Human impacts on forest successional conditions in moist and cold forests remains debatable.
- Extent to which landscape tipping points have been reached as a result of high-severity fires is debatable.
- Effectiveness of fuel treatments under projected climate futures and associated more extreme fire weather is uncertain.
- Interpretation of any research evidence and the scope of related inferences is limited by scaling (uncertainty) and sampling concerns associated with the methods, and these limitations apply to all research methods.
- All methods for reconstructing historical fire regimes are necessarily indirect and have degrees of uncertainty. They may include, but are not limited to, interpreting evidence of past fires or the extent of fire-dependent ecosystems from historical documents, land surveys, aerial photographic reconstructions, fire-scar and growth-release data from tree rings, tree age and death dates from tree-ring data, climatic data linked with past fires,

charcoal and pollen deposits, current characteristics of stands (i.e., structure, species, and stand age distribution), fire perimeter mapping, historical timber survey data, and use of statistical distributions for modeling stand-replacing fire.

CONCLUSIONS

I am very concerned that the SFLMRP will result in adverse and unnecessary impacts to inventoried roadless areas and low-road density areas, fragment and degrade important wildlife habitat and water quality, impact mature forests and riparian areas (along with wildlife and cultural values), and uses methodologies inappropriate to the sampling scope of inference. There is a heavy reliance on fire-scar sampling without disclosure of biases and uncertainties, thinning of mid-size trees that already may possess old growth characteristics, including inappropriate thinning within pinyon-juniper and spruce-fir stands, and road improvements that may increase fire ignitions and undermine the integrity of the watershed. The effectiveness of proposed treatments is highly uncertain because of the likelihood that the region's fire regimes will increasingly shift to large and more intense burns due primarily to climate change (Abatzoglou and Williams 2017) and the extremely low odds that thinned sites will encounter a fire when fuels are lowest (Schoennagel et al. 2017). At a minimum, the agency should do the following:

- Provide an EIS that analyzes the ten major issues noted in my comments (p. 1), includes a range of alternatives focused on community protection (defensible space), and a wildfire management plan that clearly determines the conditions under which fire is to be suppressed vs. managed for ecosystem benefits.
- Compartmentalize the project area into fire management units to determine when to suppress fire for community safety vs. working with fire for ecosystem benefits.[9]
- Make strategic (rather than broad-scale) use of thinning by concentrating on a narrow buffer around heavily used highways and ingress/egress routes for community safety.
- Conduct a minimum road access analysis that decommissions and obliterates more roads to limit impacts to water quality, wildlife habitat and the likelihood of human-caused fire ignitions.
- Protect areas of high conservation and cultural values by conducting only (not *primarily*) small tree thinning (<12 in dbh) and prescribed fire (if ecologically appropriate).
- Avoid thinning within MSO PACs and owl critical habitat, and within pinyon-juniper and spruce-fir stands.

Importantly, contrary to what is often claimed, insect and disease outbreaks are not associated with increased fire intensity. Insect-fire studies, including a meta-analysis of outbreaks and fire

[9] see https://www.fs.fed.us/rmrs/publications/framework-developing-safe-and-effective-large-fire-response-new-fire-management; https://www.fs.fed.us/rmrs/publications/spatial-optimization-operationally-relevant-large-fire-confine-and-point-protection

intensity in the Rockies and elsewhere (Romme et al. 2006, Six et al. 2014, Hart et al. 2015, Meigs et al. 2016), have shown that there is no coupling of fire intensity with outbreaks and, in fact, outbreaks may actually lower fire intensity once the needles of dead trees fall to the ground (within 1-3 years) as canopy fuels and therefore crown fires become highly unlikely. Dead trees also do not contribute to fire spread as they do not fall all at once nor result in accumulation of fine fuels (fine fuel accumulation is associated with logging). Dead trees are keystone elements – i.e., biological legacies – that provide essential habitat for cavity nesting birds, denning mammals, and numerous other wildlife. Their role in forest ecosystems needs to be disclosed.

In closing, while wildfire clearly can be devastating to human communities, it is not an ecological catastrophe as often claimed. Thus, at a minimum, the agency needs to define exactly what it means by "catastrophic wildfire" as this view does not comport with the literature on large fires that typically result in pyrodiverse landscapes in dry mixed conifer and dry pine forests. The SFLMRP needs to develop alternatives that focus first and foremost on community protection where there is strong scientific agreement (see Moritz et al. 2014, Schoennagel et al. 2017, Moritz et al. 2018).

I close with a plea that the Santa Fe National Forest protect the amazing cultural and ecologically values inherent to these headwater forests that you have been entrusted to maintain by the public.

PDF enclosures

Bradley et al. 2016; Beschta et al. 2012; Ibisch et al. 2017; Abatzoglou and Williams 2017; Moritz et al. 2018; Cohen 2000; Syphard et al. 2013, 2014; Balch et al. 2017; Meyer 2010; Bessie and Johnson 1995 (abstract only); Margolis et al. 2011, 2017; Parks et al 2016; Baker 2017; Huffman et al. 2008; Romme et al. 2008; Lee 2018; Mitchell et al. 2009; Law et al 2018; Odion et al. 2016; Moritz et al. 2014, 2018; Schoennagel et al. 2004, 2017; Margolis and Balmart 2009; Strittholt and DellaSala 2000; DellaSala and Olson 2011; DellaSala and Frost 2000; Iftekhar and Pannell 2015; Paine et al. 1999; Lindenmayer et al. 2011; Hart et al. 2015; Meigs et al. 2016; Six et al. 2014; Loucks et al. 2003; Selva et al. 2011; Crist et al. 2005

Date submitted (Mountain Standard Time): 8/8/2019 12:00:00 AM
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Organization:
Title:
Comments:
July 8, 2019
Hannah Bergemann, Fireshed Coordinator
Espa[ntilde]ola and Pecos/Las Vegas Ranger Districts
Santa Fe National Forest
Santa Fe County and San Miguel County, New Mexico
Submitted via: Hannah.Bergemann@usda.gov
Submitted by: Dominick A. DellaSala, Ph. D, Conservation Scientist

Re: Santa Fe Mountains Landscape Resiliency Project Scoping Comments
Please accept these detailed scoping comments for the public record regarding the Santa Fe Landscape Mountains Resilience Project (SFLMRP). I am a conservation scientist with over 30 years-experience in forest ecosystems, including fire-dependent forests (DellaSala and Hanson 2015 [1 https://www.elsevier.com/books/the-ecological-importance-of-mixed-severity-fires/dellasala/978-0-12-802749-3]). My relevant expertise includes developing conservation science approaches to accommodate wildfires for ecosystem benefits while reducing fire risks to communities. I have published extensively on how logging has increased fire severity in western forests (Bradley et al. 2016, pdf provided), limitations of forest thinning in a changing climate (2 https://www.forestlegacies.org/programs/fire-ecology/1410-everything-you-wanted-to-know-about-wildland-fires-in-forests-but-were-afraid-to-ask), livestock grazing impacts to fire regimes (Beschta et al. 2012), increases in fire ignitions associated with road access (Ibisch et al. 2017), and climate change effects on altered fire regimes (DellaSala and Hanson 2015; also see Abatzoglou and Williams 2017) among other relevant works.
In general, the SFLMRP will not achieve its stated intent to protect communities from wildfire, is based on faulty fire reconstruction sampling resulting in over-reliance on inappropriate levels of thinning and road improvements, will harm important wildlife habitat and water quality, and may elevate fire risks from increased road access. For these reasons, I am requesting that the Santa Fe National Forest publish a full environmental impact statement pursuant to NEPA.
My detailed comments and supporting pdfs follow this signature page.

SUMMARY OF MAJOR DEFICIENCIES IN PROJECT SCOPING & EIS REQUEST While I generally support the SFLMRP need to improve watershed conditions and wildlife habitat, I am greatly concerned that aggressive thinning and road improvements will not protect communities. A tendency to rely on fire-scars to reconstruct historic fire regimes as baseline conditions underlines excessive use of thinning that will remove an undisclosed quantity of mid-size trees which, in fact, may degrade mature and old-growth characteristics that the Santa Fe National Forest plan (1987) purports to maintain. Over-reliance on fire scar sampling is apparent in project scoping which, in part, tiers to GTR-310 (Restoring Composition and Structure in Southwest Frequent Fire Forests). Notably, the GTR-310 does not even align with the geographic scope of the project area, as the SFLMRP is within the Colorado Rockies Forest Ecoregion yet GTR-310 is predominately within the Arizona Mountain Forest Ecoregion, which has a different climate, soil types, historical conditions, and fire regime. Extrapolating from one region to another is clearly inappropriate (Moritz et al. 2018) and thus GTR-310 cannot be relied on for project-specific descriptions or actions.
Importantly, the SFLMRP is in an area of high conservation importance to the Santa Fe watershed and the surrounding communities, including:

? Presence of large inventoried roadless and low density roaded areas.
? Undisturbed forests and wildlife habitat that have not been logged or roaded in many decades.
? Nesting territories and critical habitat for the threatened Mexican Spotted Owl (MSO).
? Intact (unroaded, low road densities) habitat for many large carnivores.

The SFLMRP proposes to improve 94 miles of roads and this may harm water quality, introduce undesirable non-native plants that can alter fire regimes, fragment wildlife habitat and increase unintentional human-caused wildfire ignitions (associated with greater access along roads). This cascade of ecological impacts is clearly significant and thus issuing a finding of no significant impact (FONSI) is ill-advised. The Forest Service scoping document provides insufficient information for the public to properly assess the numerous impacts to cultural and ecological resources or to assess the efficacy of fuel treatments as claimed. In particular, the delineation, extent and impacts to inventoried roadless areas in the SFLMRP are not even disclosed. Given the expansive ecological footprint of the project (e.g., thousands of acres cleared and 94 miles of road improvements), and the lack of sufficient project details provided in scoping, the Forest Service must prepare a full environmental impact statement (EIS) pursuant to the National Environmental Policy Act (NEPA). A range of alternatives is required to minimize direct, indirect, and cumulative impacts from significant project actions. The SFLMRP also presents highly controversial and highly uncertain effects involving unique and unknown risks that need sufficient analysis pursuant to an EIS and not an EA (Environmental Assessment).

The EIS should evaluate the following project-related issues:

1. Prioritize community wildfire safety and fire-risk reduction, including home-hardening, defensible space, additional road closures/decommissioning to reduce ignitions, and identification/maintenance of community evacuation routes: The most prudent means of community fire protection is to work from the home-out rather than the wildlands-in (emphasis added) according to retired Forest Service researcher Jack Cohen (2000; also see Youtube interviews [3 National Fire Protection Association presentations by Jack Cohen - https://www.youtube.com/watch?v=vL_syp1ZScM;https://www.youtube.com/watch?v=RqKFDDBGd5o]) and related home fire-risk reduction work (Syphard et al. 2013, 2014). Defensible space is not even mentioned in scoping despite claims of making Santa Fe and surrounding communities more resilient and adapted to fire (p. 2). Community and fire-fighter safety actions should be directed at home protection and anthropogenic fire-ignitions along highways and high-use roads (especially ingress/egress). Importantly, recent research demonstrates that there is a very low (<1%) probability of thinned areas encountering a fire when fuels are lowest (see below). Therefore, it is imperative that the Forest Service strategically direct limited resources at protecting homes rather than thinning in the backcountry which does nothing for home protection.

2. Reduce human-caused wildfire ignitions (see Balch et al. 2017) associated with road access: 94 miles of road improvements are proposed with only 1.5 miles of seasonal road closures and 20 miles of road decommissioning (p. 15, Table 7). The Forest Service needs to conduct a project-specific transportation plan to determine the probability of human-caused fire ignitions in relation to road densities, road improvements, and increased human access along improved roads. This plan should address a broad scope of road-related impacts and choose an alternative based on minimal road access (see below).

3. Protect high value conservation areas from logging/thinning/road improvements: The SFLMRP needs to fully disclose impacts of road improvements and thinning on low-density (<1 mi/sq mile) and inventoried roadless areas (see below) and make clear how late-successional forests within the project area will be protected from logging or restored. In particular, total acreage and distribution of late-successional forests in relation to reference landscapes/conditions need full disclosure. According to the SFLMRP, late-seral forests will be maintained at the minimum 20% level, based on arbitrary old growth standards in the Forest Plan (p. 8). The Plan, however, provides no historical or reference condition on whether the minimum 20% is sufficient to sustain this unique habitat nor discloses the cumulative effects of multiple project stressors (e.g., grazing, roads, livestock, past-current logging) on late-seral maintenance and restoration. If the project area is truly predominately a low-severity fire regime, then historically late-successional forests would theoretically have been much more widespread than 20%. Additionally, project scoping states "there is a need to improve riparian vegetation where conditions are departed and conifers are encroaching" (p. 10). Little information is provided - other than fencing may be used - on how livestock impact riparian conditions. Despite the emphasis on water quality (p. 10), there is no disclosure of the cumulative impacts of livestock nor sediment delivery from roads on this unique habitat type. There is an extensive literature that must be considered on livestock impacts to ecosystems in a changing climate (reviewed in Beschta et al. 2012). At a minimum, this includes livestock impacts to stream channel morphology, stream flow, bank erosion, and soil compaction in association with climate change impacts.

4. Greatly limit thinning of mid-size tree cohorts: The scoping document notes "thinning would primarily (emphasis added) target small diameter trees and medium diameter trees (up to 12 inches dbh) and no trees above 24 inches dbh would be cut"(p. 12). The Forest Service needs to fully disclose how much tree removal will occur in the mid-size class rather than relying on "what we find on the ground" (emphasis added) (p. 11). Disclosure should include tree diameter distributions from stand inventories in reference sites (see GTR-310 Fig. 10 as an example of diameter distribution plots) and how thinning may affect mid-size class (12-24 inch dbh) in relation to reference conditions and recruitment of large-trees over time. As it stands, it is impossible for the public to assess project impacts when ambiguous statements are used such as "primarily" and "what we

find on the ground. This is particularly important as, depending on site conditions, mid-size trees may already possess mature/old-growth characteristics in the project area. For instance, "The Minimum Criteria for the Structural Attributes Used to Determine Old-Growth" in the Santa Fe Forest Management Plan of 1987 includes the same mid-tree size category that would qualify as old growth under the standards definition. Therefore, logging trees up to 24 in dbh (12-24 in) is inconsistent with the Forest Plan that strives ". . . to create or sustain as much old growth compositional, structural, and functional flow as possible over time at multiple-area scales" (emphasis added).

5. Discuss limitations and uncertainties of fire-scar sampling, importance of fire-free periods to shrub and tree recruitment, and include more robust fire
occurrence/severity estimators that account for variability in fire-free and frequent-fire intervals: The SFLMRP primarily relies on fire-scar sampling to determine the dominant fire regime present yet provides no discussion of uncertainties and limitations in sampling approaches (i.e., confidence levels). Notably, paleo-ecology studies conducted over longer timelines (millennia) than fire scar sampling show high variability in fire regimes related primarily to regional and local microclimatic factors (slope, aspect, elevation) over time (Meyer 2010). Large fires historically included portions of high severity patches during alternating cycles of wet followed by droughts (Margolis et al. 2011). This is particularly important as extreme fire-weather (top-down driver) is known to over-ride bottom up influences (fuels) on fire behavior in the Rockies (Bessie and Johnson 1995, Schoennagel et al. 2004) and elsewhere (Abatzoglou and Williams 2017). The effect of global heating and increased likelihood of regional droughts may (Margolis et al. 2011) or may not (i.e., sufficient biomass is consumed initially leading to lower severities later; Parks et al. 2016, Margolis et al. 2017) increase fire severity. This uncertainty is most significant and must be analyzed in an EIS to determine the need for and limitations of extensive fuels treatments based predominately on limited assumptions regarding frequent-fire regimes that may become increasingly equivocal in a rapidly changing climate. Additionally, variability in fire return (point/plot scale) and fire rotation (landscape scale) intervals accounts for longer fire-free periods that allow for shrub and small tree recruitment, including both dense and open forest conditions (see below). Thus, the SFLMRP needs to clearly define what it means by a low-severity fire regime with respect to this variability and in relation to tree canopy mortality, shrub and small tree densities. Notably, even low severity systems have occasional fire-flare ups that kill dominant overstory trees and that allow for sufficient shrub and small tree recruitment (see Baker 2017).

6. Remove thinning treatments in pinyon-juniper (4,000 ac) and spruce-fir (3,000 ac) as they are not ecologically appropriate: There is no ecological justification for thinning treatments in these forest types and doing so may result in ecosystem type shifts and novel conditions. The SFLMRP inappropriately targets them without providing vegetation-specific fuel loads, fire regimes, and stand density diameter distributions characteristic of reference conditions. Fuel loads are only disclosed for ponderosa pine and mixed conifer (p. 9). There is no citation or link back to reference conditions for fuel targets in pinyon-juniper and spruce-fir (extrapolating conditions from one forest type to another is clearly inappropriate if that is what is going on here). Notably, upper elevation spruce-fir stands and lower elevation pinyon-juniper stands are on longer (than dry pine/mixed conifer) and more varied (with high severity predominant) fire return intervals (35-100 years and >300-400 years in places depending on elevation, slope, and other site conditions) allowing for recruitment of older forest conditions and fuels overtime (Huffman et al. 2008, Romme et al. 2008, Margolis et al. 2011). In particular, Romme et al. (2008) notes that "Recent large, severe (stand-replacing) fires in persistent pi[ntilde]on-juniper woodlands are normal kinds of fires, for the most part, because similar fires occurred historically. However, the frequency and size of severe fires appears to have increased throughout much of the West since the mid-1980s, in pi[ntilde]on-juniper and also in other vegetation types. The causes of this recent increase in large pi[ntilde]on-juniper fires are uncertain, and it is unclear whether the very large sizes of some recent fires are exceptional or represent infrequent but nevertheless natural events." They further note "the fuel structure in wooded shrublands typically is not conducive to a spreading, low-severity fire that would consume fine fuels without killing the dominant trees or shrubs, because the fine fuels are usually discontinuous."

7. Reduce livestock grazing impacts in riparian areas and high value conservation areas: Project scoping repeatedly mentions the contribution of livestock grazing to altered fire regimes and poorly functioning riparian areas yet provides no information on livestock AUMs and whether they will be removed or curtailed other than "fencing may be installed to protect restored areas" (p. 11). There must be full disclosure of AUMs in relation to riparian and water quality conditions, including cumulative effects of livestock grazing, invasive species (particularly flammable vegetation like cheat grass) and climate change (Beschta et al. 2012).

8. Disclose and avoid impacts to imperiled species like the Mexican Spotted Owl

(MSO): The SFLMRP provides no detail on whether thinning and road improvements will be conducted within MSO PACs or critical habitat. There is no discussion of importance of mixed-severity wildfires in maintaining foraging habitat for spotted owls (Lee 2018, pdf enclosed). Instead, the SFLMRP (p. 9) incorrectly assumes, without site-specific data on owl occupancy, that "the current risk for large, high-severity fire also poses a substantial threat to MSO habitats across the Project Area." However, Lee (2018) conducted a meta-analysis of fire effects on all three owl subspecies concluding that mixed-severity fire, including patches of large severity, was not the main cause of owl nest abandonment; pre- and post-fire logging was the predominant factor. Also, full disclosure of incidental take under the Endangered Species Act is required.

9. Reduce emissions from logging and roads: A stated intent of the SFLMRP is to provide for resilience to climate change yet there is no analysis of project-related emissions from tree clearing and road improvements. Notably, emissions from wildfires are typically much lower than landscape-level logging projects aimed at reducing wildfires (e.g., see Mitchell et al. 2009, Campbell et al. 2016, Law et al. 2018 as examples of appropriate methodologies). Actions that minimize emissions should be compared in CO_2 equivalents, including the social cost of carbon (4 See https://19january2017snapshot.epa.gov/climatechange/social-cost-carbon_.html). Project alternatives should then be selected with the lowest emissions.

10. Provide a cost-benefits analysis of managing wildfires for ecosystem benefits by working with fire under safe conditions: The SFLMRP must disclose project-related costs of thinning, prescribed fire, and road improvements in comparison to managing fire for ecosystem benefits as a viable alternative under safe conditions (e.g., refer to the Cohesive Wildland Fire Management Strategy for wildfire ecosystem benefits (5 See https://www.forestsandrangelands.gov/strategy/) and 2012 forest planning rule regarding ecosystem integrity, vegetation diversity, and wildfire maintenance). Thus, it must be disclosed under what conditions will wildfires be managed for ecosystem benefits vs. suppressed so that when fires do eventually occur appropriate actions are taken based on pre-fire response planning.

UNCERTAINTIES OF FIRE SCAR METHODOLOGY AND NEED FOR MULTIPLE LINES OF EVIDENCE
While local sampling is important for estimating fire return intervals at the stand level, there are significant uncertainties with extrapolating fire scar point data over large landscapes to reconstruct historic fire regimes as comparisons to contemporary conditions (Baker 2017). They include sample-site selection bias, lack of tree scars in fire-killed trees (thereby grossly underestimating high severity occurrence), and the fundamental uncertainties of site-specific data to draw landscape-level conclusions (Baker 2017). The hypothetical figure below illustrates the inherent sampling bias of grouping individual fire scar data to construct composite fire interval (mean CFI).

In sum, the variability in CFI estimates is masked whenever the scope of inference is inappropriately extrapolated over large areas and measures of central tendency (rather than the range) are used. This results in a bias toward very short fire return intervals and overly aggressive management to open stand conditions. The best estimator of fire intervals at landscape scales is fire rotation (Baker 2017).
Baker (2017) notes that fire rotations at the landscape scale can be derived from:

1. Areas burned in recent fires from agency fire records or records from remotely sensed data.
2. Historical areas burned reconstructed from scarred trees or plot locations.
3. Historical areas burned reconstructed using a ratio method and scarred-tree or plot records, or comparable data in a table or graph.

The Forest Service must provide information on the fire rotations using methodologies in Baker (2017) and the paleo-ecology literature that can be used to reduce sampling bias associated with fire scar extrapolations. For instance, Baker (2017) goes through each source of bias in tree-ring reconstructions and shows that using corrected estimators actually yields longer fire rotation periods for dry pine/mixed conifer areas. Note that Figure 3 and Figure 4 in Baker (2017) show the diversity of fire rotations (longer intervals) in the Santa Fe area and the S2 Table has individual estimates for New Mexico. The sampling bias in fire-scar data must be disclosed as the entire project is based mainly on fire-scar interpolation from plots to landscapes thereby compounding errors.
To correct for sampling bias, the Forest Service must account for variability in fire-free intervals using more robust methodologies, disclose whether there are historic accounts of fires in the project area beyond just fire-scars, and include paleo-ecology studies from nearby sites to illustrate variability in fire regimes over longer

time intervals. Significant discrepancies and debate among researchers about fire scar sampling must be disclosed (e.g., see Odion et al. 2016 response to Stephens et al. 2016 and Moritz et al. 2018).

A key fire-history study for the nearby Santa Fe watershed is Margolis and Balmat (2009). These researchers indicate that the historical low-severity fire rotation in the Santa Fe watershed for dry pine forests was estimated at 39.80 years. They define frequent fire as < 25 years. Using their definition means that the Santa Fe watershed would not qualify as a frequent-fire regime, as this is a sufficient mean number of years between surface fires to allow understory fuels including shrubs and small trees to accumulate levels that would certainly enable the occurrence of some mixed and high-severity fires overtime. Moreover, this longer period corresponds with the paleo-record from charcoal sediments showing that when wet periods are followed by successive droughts, large fires, including patches of high severity, do indeed occur (Meyer 2010).

It is important to accommodate this variability in fire return intervals as heterogeneity in the ensuing burn severity patches at the landscape scale results in high levels of biodiversity (i.e., pyrodiversity of fire severity patches begets biodiversity, DellaSala and Hanson 2015). Notably, even slight differences in fire-return intervals are consequential. Baker (2017) reports that understory fuels in dry forests recover after fires in 7-25 years. If mean fire-return intervals were <25 years, understory fuels would be limited. However, if the interval was >25 years, as reported by Margolis and Balmart (2009), then shrubs and small trees would recover across the landscape and excessive thinning to shift forest to more open-canopy forests with minimal shrub cover would be inappropriate at large spatial scales.

The role of shrubs and understory vegetation is also a key ecosystem component in dry forests allowing for nutrient cycling and below-ground processes, water absorption and retention, provision of wildlife habitat, pollination and other ecosystem services. Spatial heterogeneity in fire-return intervals at landscape scales is a key indicator of resilience as it allows for both fire refugia (longer return intervals) and fire-mediated biodiversity (short return intervals). It is essential to manage for this variability to accommodate wildlife that require low, moderate and high fire severity classes. In other words, when it comes to fire, nature is complex while management tends for uniformity typically at the expense of fire-mediated biodiversity.

The following Baker (2017) observations about fire interval estimators need to be addressed in the SFLMRP:

"Dry-forest landscapes until recently were thought to have historically been primarily old growth forests, with a history of frequent low-severity fire, across their extent (e.g. [72]), but this has been refuted by GLO reconstructions and early aerial photographs (Table 6), paleoecological evidence [24], and early forest-reserve reports and other evidence [63 , 73]. Even in Arizona, which had abundant old forests with frequent fire (Fig 3), denser forests and high severity fire were extensive at certain times and in certain places, as on Black Mesa and parts of the Mogollon Plateau [60 , 73]. It is sensible to restore low-severity fire to its former dominance in the parts of dry-forest landscapes with a history of primarily low-severity fire, historically averaging about 34% of western dry-forest landscapes (Table 6). Estimated mean PMFI/FRs [population mean fire interval/fire rotation] here provide a guide for restoration and management of low-severity fire in extant old-forest parts of landscapes. For most dry-forests today, which are not old, using frequent fire (PMFI/FR < 25 years) in restoration is not supported, and fuels do not need to be substantially reduced, because historical PMFI/FRs naturally allowed historical shrubs and small trees to fully recover after fires. Restoration of low-severity fire is still needed. The most appropriate approach, given likely long but uncertain mean rates of historical low-severity fire, is for most dry forests today to receive at most one prescribed fire, followed by managed fire for resource benefit, with the goal of mimicking mean historical PMFI/FRs and variability in fire (fire-size distributions, unburned area) as forests reach old age."

Thus, based on Baker (2017) and the problems noted in estimating fire return intervals, the SFLMRP needs to greatly scale back thinning and road improvements except where thinning of small trees (<12 in dbh) is needed to introduce fire nearest homes.

ROAD IMPACTS AND ROADLESS AREA IMPORTANCE

Roads - Given the extensive and cumulative impacts of roads on ecosystem processes, wildlife, water quality, and fire ignitions (see below), a minimum road density analysis needs to be conducted to assure the public that there are no redundant roads and that more roads can and should be decommissioned and obliterated rather than improving 94 miles of roads. The SFLMRP needs to provide a transportation plan analysis to fully assess road-related fire ignitions associated with improved access and to come up with an alternative that reduces them.

Simply improving culverts and surfacing primitive dirt roads with poor drainage also may not be enough to improve water quality. Notably, the SFLMRP provides no information on Clean Water Act 303d water-quality limited streams and how project-related impacts will be minimized to comply with state and federal water quality standards (6 Particularly in relation to EPA standards are https://nepis.epa.gov/Exe/ZyNET.exe/00001O9W.TXT?ZyActionD=ZyDocument&Client=EPA&Index=1986+Thru+1990&Docs=&Query=&Time=&EndTime=&SearchMethod=1&TocRestrict=n&Toc=&TocEntry=&QField=&QFieldYear=&QFieldMonth=&QFieldDay=&IntQFieldOp=0&ExtQFieldOp=0&XmlQuery=&File=D%3A%5Czyfiles%5CIndex%20Data%5C86thru90%5CTxt5C00000001%5C00001O9W.txt&User=ANONYMOUS&Password= anonymous&SortMethod=h%7C-&MaximumDocuments=1&FuzzyDegree=0&ImageQuality=r75g8/r75g8/x150y150g16/i425&Display=hpfr&DefSe ekPage=x&SearchBack=ZyActionL&Back=ZyActionS&BackDesc=Results%20page&MaximumPages=1&ZyEntr y=1&SeekPage=x&ZyPURL) . Water quality must be assessed in relation to road improvements, greater road access, thinning impacts, and road-stream intersections.

In sum, the project needs to fully disclose road-related impacts as follows:

? Roads and thinning contributions to soil erosion and sediment inputs affecting water-quality even when roads are improved.
? Probability of human-caused wildfire ignitions associated with improved road access (see Balch et al. 2017 for human-caused ignitions, pdf enclosed).
? Fragmentation and degradation of wildlife habitat at road densities > 1 mi/sq mi, particularly impacts to large carnivores and aquatics.
? Spread of invasive species and their effects on fire regimes.
? Likelihood of mass-wasting events on steep erosive slopes along the road prism.

Ibisch et al. (2017) provide a global synthesis of road-related impacts including: wildlife mortality (vehicle collisions); poaching pressure; sediment increases (runoff); chemical contamination; carbon emissions; spread of invasives; fire ignitions; and habitat fragmentation among others. These impacts can extend out to 1 km on either side of the road prism. Thus, the enclosed road impacts need to be fully addressed and properly mitigated to assess planned extensive road upgrades and access.
Roadless Areas - The ecological importance of roadless and lightly roaded areas, and their relatively lower priority in fuels reduction projects compared to heavily roaded areas, is well-documented in the literature (DellaSala and Frost 2000, Strittholt and DellaSala 2001, Loucks et al. 2003, Crist et al. 2005, Selva et al. 2011, Ibisch et al. 2017) and emphasized in landmark Forest Service policies such as the Roadless Conservation Rule (7https://www.fs.usda.gov/roadmain/roadless/2001roadlessrule) and Interior Columbia River Basin strategy (8https://www.fs.fed.us/r6/icbemp/html/ICBEMP_Frameworkmemorandum-and-strategy_2014.pdf). At a minimum, the SFLMRP needs to disclose any treatments proposed in inventoried roadless areas and low density roaded areas (<1 mi/sq mi) and must avoid thinning in these areas because of their high conservation value, particularly as relatively unfragmented blocks of wildlife habitat. Roadless areas and low-density roaded areas are of considerable importance to ecosystem integrity (as defined by the 2012 planning rule) as they are often at the headwaters of watersheds essential in maintaining water quality and terrestrial and aquatic ecosystem integrity (DellaSala and Olson 2011). Roadless areas also tend to be of much lower priority for fuels reduction given their fire regimes are less altered by suppression and they lack the ignition problems associated with roaded areas (e.g., Roadless Conservation Rule, Columbia River Basin strategy, DellaSala and Frost 2001).

THINNING HAS LIMITED EFFECT ON FIRE BEHAVIOR IN A CHANGING CLIMATE AND SLASH PILE BURNING CAN CAUSE EXTENSIVE SOIL DAMAGE The figure below summarizes uncertainties of relying on thinning to reduce fire intensity given that the period of when fuels are lowest is generally short lived and fires rarely encounter thinned sites when fuels are lowest (Schoennagel et al. 2017). The extremely low probability of fire and thinned site co-occurrence greatly reduces the project's assumptions about lowering fire intensity. Simply increasing the area thinned does not change these odds appreciably given one cannot accurately predict when and where a fire will occur and many areas are inaccessible (Schoennagel et al. 2017).

Moreover, the SFLMRP needs to disclose the difference between prescribed fire that is applied at the stand level (where impacts to soils can be dispersed and limited) vs. pile burning to consume slash that can cause

localized extreme soil damage (excessive soil heating) facilitating the spread of invasive plants and delayed forest succession (especially if livestock grazing also occurs, Besctha et. al 2012).
Excessive opening of the tree canopy can also lead to an increase in shrub growth (even after prescribed fire), higher wind penetrance, and rapid fire spread, particularly if thinning is conducted on steep slopes and in remote areas with limited access. In a warming climate where more extreme fire weather is likely (Abatzoglou and Williams 2017), thinning is even less likely to alter fire behavior (Abatzoglou and Williams 2017, Schoennagel et al. 2017).
AVOIDING BIASED APPROACHES, AREAS OF AGREEMENT & DISAGREEMENT Bias: The SFLMRP needs to avoid disputed approaches and biased perspectives on fire as generally noted by Iftekhar and Pannell (2015) and Moritz et al. 2018 (below). The following biased perspectives are inherent in the SFLMRP scoping documents:

? Action bias - tendency to take actions even when it is better to delay action (in this case the impacts of aggressive clearing and roads may be more significant than effects of fire on ecosystems given uncertainties of treatment effectiveness as noted).
? Framing effect - tendency to respond differently to alternatively worded but objectively equivalent descriptions of the same item (use of catastrophic fire terminology that fails to account for ecosystem benefits of mixed-severity fires, including periodic flare-ups of high severity patches).
? Reference-point bias - tendency to overemphasize a pre-determined benchmark for a variable when estimating the level of that variably (i.e., over-reliance on fire scar sampling rather than presenting more robust and multiple lines of evidence).
? Satisficing rule - tendency to stop searching for a better decision (i.e., a NEPA based range of alternatives) once a decision that seems sufficiently good is identified.
? Loss aversion - tendency to value losses more highly than similar gains (i.e., managing wildfire of moderate-high intensity for ecosystem benefits instead of avoiding it by mechanical thinning and fire suppression).
? Limited reliance on systematic learning - tendency to use information from past successful efforts rather than using information from both successful and failed efforts via extensive and well-funded ecosystem monitoring (adaptive management and learning is not possible without well-funded monitoring; there is no mention of monitoring in scoping).

The best way to avoid these biases is to use multiple lines of evidence in re-constructing fire regimes, not rely mainly on fire scars, and conduct well-funded monitoring studies that fully assess project effects on species of conservation concern and ecological and cultural values. Multiple lines of evidence and monitoring are discussed in Odion et al. 2016 and Moritz et al. (2018) in the Common Ground Report (see below).

Areas of Agreement/Disagreement (Common Ground): I participated as one of the respondents in the so-called "Common Ground" report and am thoroughly familiar with the report's findings. The SFLMRP should pay particular attention to the following key findings in relation to areas of agreement, uncertainty, and disagreement and adjust project actions accordingly.

Areas of Agreement (high certainty):

? The role of changing climatic conditions is increasingly important in influencing fires.
? Multiple fire ecology and fire history research can be useful.
? Heterogeneity of fire effects, including patterns of patches created by fires of all severities, is important to forest resilience to future fires.
? Generalized models of historical fire regimes vary by ecoregion and forest type.
? Even within the same ecoregion and forest type, there is variation in historical fire regimes among differing environmental gradients.
? Historically, some degree of low-, moderate-, and high-severity fire has occurred in all forest types, but in substantially different proportions and patch size distributions at different locations.
? Classification of historical fire regimes according to forest types can be coarse; thus, failure to recognize variation of historical fire regimes within forest types can lead to overgeneralization and oversimplification of landscape conditions.
? Presence of roads, road density and railways, livestock grazing, invasives, and mining can alter fire regimes. Even a single one of these influences can have profound effects on vegetation and fire behavior conditions. When present in combinations, cumulative effects will arise that may push ecosystems past tipping points (Paine et al. 1999, Lindenmayer et al. 2011).

? Knowledge of historical range of variability (HRV) is useful but does not dictate land management goals. HRV findings from one area may or may not have relevance elsewhere.
? Recent trends in many western forest regions of more large fires and more area burned are linked to recent climatic trends of hotter droughts and longer, more severe fire seasons.
? Respondents who emphasized the longer time scales of charcoal records noted that most areas of predominantly low-severity fires showed some incidence of moderate- or high-severity fire over longer time frames.
? It is desirable to use multiple methods to reconstruct historical fire regimes. More can be learned using multiple approaches and considering data from diverse temporal and spatial scales.

* Importance of local context in management of fire-prone landscapes underscores the need to move away from oversimplified narratives that encourage application of fire research beyond its original scope of inference. Note: the scope of inference is of particular concern here as over reliance on fire scar sampling for landscape scale interpolation has inherent biases and uncertainties.

Areas of Disagreement (high uncertainty):

? Fire regime inferences from historical and modern tree inventory data, simulation models, and other approaches have levels of uncertainty.
? Whether large, high-severity fires have increased to a significant and measurable degree in all forest types in comparison to historical fire regimes (i.e., prior to modern fire suppression) remains debatable.
? Fuel treatments are urgently needed across nearly all forests remains debatable.
? Fuel treatments should be focused around communities and plantations; but hazard fuel reduction elsewhere remains debatable.
? There is high uncertainty about where and when fuel treatments are beneficial.
? Commonly used vegetation classification schemes as a suitable basis for generalizing about fire regimes remains debatable. Known geographic variation in fire regimes within forest types argues for improved forest and fire regime classifications.
? Tree-ring evidence sometimes supports conclusions that contrast with those derived from landscape-scale inventory and monitoring data using different sampling frames creates uncertainty.
? General applicability of "thinning and prescribed burning remedies" to offset human influences is debatable.
? Human impacts on forest successional conditions in moist and cold forests remains debatable.
? Extent to which landscape tipping points have been reached as a result of high-severity fires is debatable.
? Effectiveness of fuel treatments under projected climate futures and associated more extreme fire weather is uncertain.
? Interpretation of any research evidence and the scope of related inferences is limited by scaling (uncertainty) and sampling concerns associated with the methods, and these limitations apply to all research methods.
? All methods for reconstructing historical fire regimes are necessarily indirect and have degrees of uncertainty. They may include, but are not limited to, interpreting evidence of past fires or the extent of fire-dependent ecosystems from historical documents, land surveys, aerial photographic reconstructions, fire-scar and growth-release data from tree rings, tree age and death dates from tree-ring data, climatic data linked with past fires, charcoal and pollen deposits, current characteristics of stands (i.e., structure, species, and stand age distribution), fire perimeter mapping, historical timber survey data, and use of statistical distributions for modeling stand-replacing fire.

CONCLUSIONS
I am very concerned that the SFLMRP will result in adverse and unnecessary impacts to inventoried roadless areas and low-road density areas, fragment and degrade important wildlife habitat and water quality, impact mature forests and riparian areas (along with wildlife and cultural values), and uses methodologies inappropriate to the sampling scope of inference. There is a heavy reliance on fire-scar sampling without disclosure of biases and uncertainties, thinning of mid-size trees that already may possess old growth characteristics, including inappropriate thinning within pinyon-juniper and spruce-fir stands, and road improvements that may increase fire ignitions and undermine the integrity of the watershed. The effectiveness of proposed treatments is highly uncertain because of the likelihood that the region's fire regimes will increasingly shift to large and more intense burns due primarily to climate change (Abatzoglou and Williams 2017) and the extremely low odds that thinned sites will encounter a fire when fuels are lowest (Schoennagel et al. 2017). At a minimum, the agency should do the following:

? Provide an EIS that analyzes the ten major issues noted in my comments (p. 1), includes a range of alternatives focused on community protection (defensible space), and a wildfire management plan that clearly determines the conditions under which fire is to be suppressed vs. managed for ecosystem benefits.
? Compartmentalize the project area into fire management units to determine when to suppress fire for community safety vs. working with fire for ecosystem benefits. (9see https://www.fs.fed.us/rmrs/publications/framework-developing-safe-and-effective-large-fire-response-new-fire-management;https://www.fs.fed.us/rmrs/publications/spatial-optimization-operationally-relevant-large-fire-confine-and-point-protection)
? Make strategic (rather than broad-scale) use of thinning by concentrating on a narrow buffer around heavily used highways and ingress/egress routes for community safety.
? Conduct a minimum road access analysis that decommissions and obliterates more roads to limit impacts to water quality, wildlife habitat and the likelihood of human-caused fire ignitions.
? Protect areas of high conservation and cultural values by conducting only (not primarily) small tree thinning (<12 in dbh) and prescribed fire (if ecologically appropriate).
? Avoid thinning within MSO PACs and owl critical habitat, and within pinyon-juniper and spruce-fir stands.

Importantly, contrary to what is often claimed, insect and disease outbreaks are not associated with increased fire intensity. Insect-fire studies, including a meta-analysis of outbreaks and fire intensity in the Rockies and elsewhere (Romme et al. 2006, Six et al. 2014, Hart et al. 2015, Meigs et al. 2016), have shown that there is no coupling of fire intensity with outbreaks and, in fact, outbreaks may actually lower fire intensity once the needles of dead trees fall to the ground (within 1-3 years) as canopy fuels and therefore crown fires become highly unlikely. Dead trees also do not contribute to fire spread as they do not fall all at once nor result in accumulation of fine fuels (fine fuel accumulation is associated with logging). Dead trees are keystone elements - i.e., biological legacies - that provide essential habitat for cavity nesting birds, denning mammals, and numerous other wildlife. Their role in forest ecosystems needs to be disclosed.
In closing, while wildfire clearly can be devastating to human communities, it is not an ecological catastrophe as often claimed. Thus, at a minimum, the agency needs to define exactly what it means by "catastrophic wildfire" as this view does not comport with the literature on large fires that typically result in pyrodiverse landscapes in dry mixed conifer and dry pine forests. The SFLMRP needs to develop alternatives that focus first and foremost on community protection where there is strong scientific agreement (see Moritz et al. 2014, Schoennagel et al. 2017, Moritz et al. 2018).
I close with a plea that the Santa Fe National Forest protect the amazing cultural and ecologically values inherent to these headwater forests that you have been entrusted to maintain by the public.
PDF enclosures
Bradley et al. 2016; Beschta et al. 2012; Ibisch et al. 2017; Abatzoglou and Williams 2017; Moritz et al. 2018; Cohen 2000; Syphard et al. 2013, 2014; Balch et al. 2017; Meyer 2010; Bessie and Johnson 1995 (abstract only); Margolis et al. 2011, 2017; Parks et al 2016; Baker 2017; Huffman et al. 2008; Romme et al. 2008; Lee 2018; Mitchell et al. 2009; Law et al 2018; Odion et al. 2016; Moritz et al. 2014, 2018; Schoennagel et al. 2004, 2017; Margolis and Balmart 2009; Strittholt and DellaSala 2000; DellaSala and Olson 2011; DellaSala and Frost 2000; Iftekhar and Pannell 2015; Paine et al. 1999; Lindenmayer et al. 2011; Hart et al. 2015; Meigs et al. 2016; Six et al. 2014; Loucks et al. 2003; Selva et al. 2011; Crist et al. 2005