September 30, 2019
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Submitted via: santafeforestplan@fs.fed.us
Submitted by: Dominick A. DellaSala, Ph. D, Conservation Scientist

Re: **Comments on the Santa Fe National Forest Draft Land Management Plan and Draft Environmental Impact Statement (DEIS)**

Please accept these comments for the public record regarding the Santa Fe National Forest Draft Land Management Plan and DEIS. I am a conservation scientist with over 30 years-experience in forest ecosystems, including documenting the importance of fire-mediated biodiversity in dry pine and mixed conifer forests of the West (DellaSala and Hanson 2015[1]). My relevant expertise also includes developing robust conservation strategies for land managers to accommodate wildfires for ecosystem benefits while reducing fire risks to communities. I am submitting the enclosed publications as pdfs in support of my comments, including how extensive logging has increased fire severity in forests (Bradley et al. 2016), limitations of forest thinning in reducing fire intensity (DellaSala et al. 2018), livestock grazing and climate change cumulative impacts on national forests (Beschta et al. 2012), fire ignitions associated with roads (Ibisch et al. 2016), climate change effects on fire regimes (Abatzoglou and Williams 2017), and ecological importance of high severity burn patches in dry pine/mixed conifer forests including New Mexico (DellaSala and Hanson 2019), among other relevant peer reviewed publications. My comments are meant to improve the Forest Service's approach to forest-fire resilience in the Santa Fe National Forest (SFNF) and surroundings with the intent of showing how the agency can and must do better with respect to using the best available science along with involving scientists with a biodiversity perspective on wildfire and not just a fuel centric perspective dominated by fuel management.

The SFNF encompasses 1.6 million acres (nearly the size of Yellowstone National Park) of diverse conifer forests, woodlands, riparian forests, native grasslands and shrublands that make up the scenic beauty and quality of life for surrounding communities, including unmatched recreation, clean water, hunting and fishing, and iconic wildlife species. The SFNF includes nationally significant roadless areas; designated and proposed Wilderness and Wild and Scenic rivers; tribal-cultural sites; and essential habitat for large carnivores, ungulates, and at-risk wildlife such as Mexican Spotted Owl, Southwestern Willow Flycatcher, Jemez Mountain

[1] Note – a copy of the book – a very large pdf – can be purchased here https://www.sciencedirect.com/book/9780128027493/the-ecological-importance-of-mixed-severity-fires. For the purpose of these comments, I included the relative chapter, however, these included editing notes as the publisher did not provide chapter pdfs.

salamander, Rio Grande cutthroat trout, and New Mexico meadow jumping mouse. These and many other species in the project area require intact areas periodically maintained by wildfires of low and mixed severity effects on vegetation that also include occasional large and small patches of high severity fire effects. The SFNF's low elevation forests are predominately influenced by frequent fires of low severity with fire-flare ups that often kill overstory trees (site and landscape heterogeneity). During drought cycles and under extreme fire weather these flare ups can include small and large high severity patches that are important ecologically (DellaSala and Hanson 2019). Upper elevation spruce-fir forests are on centuries long *fire rotation intervals* (landscape scale) where high severity fire effects are characteristic (Margolis et al. 2002) and climatic factors are the top-down driver of fire behavior, not fuels (see Bessie and Johnson 1995). This variability is not appropriately recognized, planned for, or even properly analyzed in the DEIS, which mostly emphasizes mechanical treatments designed to move substantial amounts of closed canopy forests into low fuel condition conducive of low-severity fire effects lacking diversity/heterogeneity at site or landscape levels.

Much of the Santa Fe National Forest biodiversity is distributed along elevation gradients with changes in life zones prominent from valley bottoms and foothills to montane and alpine. Thus, a primary objective of the DEIS should be to maintain landscape connectivity that accommodates biological diversity across life zones and for focal species, species of conservation concern, and at-risk species and ecosystems. The DEIS is deficient in analyzing how connectivity is being impacted specifically by habitat fragmentation in the project area and surroundings (cumulative effects) caused by roads, extensive thinning and forest canopy reductions, ski area development, mining, livestock grazing and infrastructure, off highway vehicles (OHVs), and other developments. Connectivity cannot simply be maintained at the coarse-filter level via vegetation management and very general site-specific measures incorrectly presented as a fine filter approach. Connectivity maintenance requires proper analysis (species-specific trigger points and population viability analysis, see Noon et al. 2003, Schultz et al. 2013) to meet the best available scientific information (BASI) requirement of the 2012 forest planning rule. None of the alternatives in the DEIS meet the BASI requirement for connectivity (Box 1 and Box 2).

Box 1. Ecological integrity. The quality or condition of an ecosystem when its dominant ecological characteristics (e.g., composition, structure, function, connectivity, and species composition and diversity) occur within the natural range of variation and can withstand and recover from most perturbations imposed by natural environmental dynamics or human influence (36 CFR 219.19).

Box 2. Connectivity. Ecological conditions that exist at several spatial and temporal scales that provide landscape linkages that permit the exchange of flow, sediments, and nutrients; the daily and seasonal movements of animals within home ranges; the dispersal and genetic interchange between populations; and the long distance range shifts of species, such as in response to climate change.

Planning deficiencies regarding integrity and connectivity are summarized as follows:

- Connectivity is inadequately addressed by an emphasis on vegetation management in Ecological Response Units (mostly coarse filter), general site-specific measures (inadequate fine filter), and some road closures/decommissioning. Notably, in a comprehensive analysis of biodiversity strategies in a changing climate, connectivity (site-specific structural features, landscape intactness, corridors) was identified as the single most important strategy for enabling plants and wildlife to adapt to climate change and is critical to achieving climate resilient ecosystems (Haber and Nelson 2015). These authors recommend far more measures for maintaining connectivity than what was provided in the DEIS.
- There are substantial roads (6,900 miles) throughout the SFNF, many of which are leaking sediments into streams and pose a barrier and mortality risk to wildlife (vehicle collisions). Roads, cattle, and logging/thinning all affect the biological and physical environment of focal species, at-risk species, and species of conservation concern and this requires fine-scale analysis ("trigger points," and population viability analysis (PVA); as in Noon et al. 2003, Schulz et al. 2013) along with stepped up conservation (see conservation requirement of the planning rule below) that must be analyzed at the appropriate scale using BASI to take a hard look at connectivity and not just providing unsupported claims that vegetation management actions satisfy this requirement.
- The DEIS must analyze connectivity to maintain viable populations of focal species, at-risk species, and species of conservation concern (i.e., via PVA and trigger points) especially in a changing climate and in the context of both direct and indirect cumulative effects (e.g., analyze habitat fragmentation as the antithesis of connectivity).
- A connectivity analysis needs to incorporate cumulative impacts (e.g., livestock, thinning, roads), importance of intact areas (especially connecting life zones along gradients for species movements), and barriers to terrestrial and aquatic focal species, at-risk species, and species of conservation concern along with specific measures for reconnecting habitat. Examples of connectivity analyses include identification of species-specific road density thresholds (generally >1 mi/square mile is problematic for aquatic species), identification and protection of ungulate migration corridors (e.g., deer and elk winter and summer range movements) and large carnivore travel routes (especially along riparian areas) (i.e., the Forest Service must follow approaches in Haber and Nelson 2015).

Maintaining the mixture of fire severity effects on the SFNF is key to meeting the diversity requirements of the 2012 forest planning rule (see section on diversity of plant and animal communities), including mixed-severity fires that produce high-severity patches having unique ecological functions (DellaSala and Hanson 2019). The DEIS is deficient in this regard as it over emphasizes low-severity fire at the expense of mixed-severity fire effects (including high severity patches) essential to ecological processes, ecological conditions, and ecological integrity (Box 1, 3, 4, 5).

Box 3. The selected set of ecological conditions and key ecosystem characteristics related to the composition, structure, ecological processes, and connectivity of plan area ecosystems (terrestrial, riparian, and aquatic), provide the basis for monitoring ecosystem integrity (36 CFR 219.8(a)(1)) and the diversity of plant and animal communities (36 CFR 219.9).

Box 4. System drivers, including dominant ecological processes, disturbance regimes, and stressors, such as natural succession, wildland fire, invasive species, and climate change; and the ability of the terrestrial and aquatic ecosystems on the plan area to adapt to change (§ 219.8)

Box 5. Ecological conditions. The biological and physical environment that can affect the diversity of plant and animal communities, the persistence of native species, and the productive capacity of ecological systems. Ecological conditions include habitat and other influences on species and the environment. Examples of ecological conditions include the abundance and distribution of aquatic and terrestrial habitats, connectivity, roads and other structural developments, human uses, and invasive species.

The DEIS conflicts with the above planning rule requirements in the following ways:

- Alternative 3 (natural process alternative) is erroneously dismissed for Alternative 2 (preferred alternative) that relies on far more mechanical treatments than natural processes. More natural process features from Alternative 3 need to be incorporated into the final plan. Ostensibly, the main reason for the Forest Service rejecting Alternative 3 stems from inaccuracy problems inherent to LANDFIRE, fire scar analysis sampling biases, and inappropriate reference conditions tied to Forest Service research publication GTR-310 that have led to an over-reliance on mechanical treatments to achieve novel ecosystems devoid of most small trees with remaining trees prone to blowdown.
- The DEIS assumes high-severity fire patches are an anomaly of contemporary fire systems and therefore does not properly analyze positive contributions of high-severity patches in contributing to diverse ecosystems (DellaSala and Hanson 2019), particularly high elevation areas that experience characteristic high-severity fires (the predominant fire regime) on long fire rotation intervals.
- High-severity patches are ecological diverse habitats (DellaSala and Hanson 2019) and are important as foraging habitat for raptors such as Northern Goshawks and Mexican Spotted Owls (see Lee 2018), woodpeckers and songbirds (Hutto et al. 2015), small mammals and ungulates (Bond 2015), and may play a role in snowshoe hare/lynx dynamics. This needs to be acknowledged and the at-risk species tables in the DEIS

adjusted to include positive effects of high-severity fires on wildlife instead of all negative effects as incorrectly noted in the DEIS.

- The DEIS does not include sufficient actions for limiting the spread of invasive species via vector management of livestock (maximum permitted stocking rate of 11,400 AUMs is not sufficiently mitigated), roads, and OHVs. Improved foraging habitat for cattle through thinning and infrastructure changes under the preferred alternative is inadequate for addressing the chronic invasive species problems across the SFNF that will accumulate (cumulative effects) over space and time through active management (thinning entries), continued grazing especially in a changing climate (see Beschta et al. 2012) and road developments (see Ibisch et al. 2016 for a review of road impacts, including spread of invasive species).
- The DEIS is completely inadequate in addressing the critical habitat needs and population dynamics of threatened Mexican Spotted Owls (MSO), which require site specific and region-wide population monitoring and not just knowledge of habitat availability. Notably, a federal judge on September 11 enjoined all "timber management actions" in eleven national forests in New Mexico and Arizona for failing to survey and protect the MSO. The SFNF through Endangered Species Act section 7 consultation must engage in specific and region-wide population monitoring to ensure the MSO population is recovering and its habitat protected from thinning and other project actions (e.g., effects of livestock grazing on prey species).

Overall, the DEIS and supporting documents do not meet the BASI requirement of the 2012 forest planning rule with respect to *accurate, reliable, and relevant issues being considered* (Box 6). There are incorrect reference conditions tied to the Forest Service research publication GTR-310 extrapolated from a completely different region, accuracy problems inherent with the LANDFIRE program at the SFNF scale, uncertainties with fire return interval estimates using fire scar sampling, and arbitrary determinations regarding closed canopy forest conditions that has led to an over emphasis on mechanical treatments to achieve desired open forest canopy conditions at the expense of plant and wildlife diversity.

Box 6. § 219.3 Role of science in planning. The responsible official shall use the best available scientific information to inform the planning process required by this subpart. In doing so, the responsible official shall determine what information is the most accurate, reliable, and relevant to the issues being considered. The responsible official shall document how the best available scientific information was used to inform the assessment, the plan decision, and the monitoring program as required in §§ 219.6(a)(3) and 219.14(a)(4). Such documentation must: identify what information was determined to be the best available scientific information, explain the basis for that determination, and explain how the information was applied to the issues considered. (emphasis added)

The DEIS does not sufficiently meet the *conservation* requirement of the 2012 forest planning rule (Box 7).

Box 7. Conservation. The protection, preservation, management, or restoration of natural environments, ecological communities, and species. Conserve. For purposes of subpart A, § 219.9, to protect, preserve, manage, or restore natural environments and ecological communities to potentially avoid federally listing of proposed and candidate species.

Noted deficiencies in the *conservation* requirement include:

- Lack of preservation and protection of natural environments (especially roadless areas, closed canopy mature forests, riparian areas, critical MSO habitat), ecological communities, focal species, at-risk species, and species of conservation concern. Alternative 2, for instance, emphasizes extensive mechanical treatments that may cause irreparable harm to MSO, focal species, at-risk species, and species of conservation concern through major reductions in canopy closure and understory vegetation. Extensive thinning of forest canopies may constitute an adverse effects determination in section 7 consultation for the MSO (and prey species) that uses closed canopy forests for nesting and may use severely burned areas for foraging (see Lee 2018).

Importantly, the DEIS presents a questionable analysis of fire emissions derived from assumptions in the LANDFIRE program and does not include an appropriate analysis of the emissions from logging (in-boundary and transportation/manufacturing of wood products), livestock grazing and infrastructure, and road building/maintenance. An emissions analysis related to all project activities is necessary to properly assess air quality impacts to surrounding communities and CO_2 contributions to climate change with an alternative chosen that minimizes emissions related specifically to forest plan activities (direct, indirect, cumulative emissions impacts).

In sum, I am requesting that the Forest Service modify or include a new alternative that meets the following requirements:

- Identification and protection of specific connectivity areas (e.g., roadless areas, intact riparian and watersheds) for achieving viable populations of focal species, species of conservation concern, and at-risk species in a changing climate (see Noon et al. 2003, Schulz et al. 2013, Haber and Nelson 2015, especially Table 1). Such areas should be protected from mechanical treatments especially habitat of at-risk species (e.g., MSO).
- Consistent with the guidelines for connectivity in Haber and Nelson (2015:Tables 1 and 2), it is essential for the forest plan to identify key characteristics of connectivity (also

Haber and Nelson 2015:Table 3), including composition, structure, process/function at scale: site, landscape, corridors, riparian areas, and wildlife travel routes.

- An analysis and mitigation of how conditions on the SFNF and surrounding areas (logging, roads, development, grazing especially in riparian areas) affect connectivity (cumulative effects analysis).
- Substantial reduction in livestock AUMs and increase in riparian, native meadows, and aspen grove protections, restoration and invasive species containment. This should include opportunities for local conservation groups to purchase grazing leases from willing sellers with the allotments and AUMs permanently retired by the Forest Service. Livestock should be removed from riparian areas and curtailed in areas with native plant communities.
- Accuracy determination and field verification (and error correction) of LANDFIRE and forest canopy determinations, particularly in relation to site-specific reference conditions and ecologically appropriate definitions of closed canopy forests; the >30% closed canopy definition in the DEIS is arbitrary and has resulted in excessive canopy reduction measures to achieve "open" conditions.
- Use of multiple lines of evidence (e.g., see Odion et al. 2014a, Moritz et al. 2018) in estimating historic fire regimes and recognition/ analysis of the importance of mixed-severity fire effects on plant and wildlife diversity, including small and large patches of high-severity fire effects characteristic of drought cycles, fire flare ups, and upper elevation forests.
- A substantial reduction in mechanical treatments that are otherwise resulting in novel forest conditions that lack integrity and climate resilience because of the over-emphasis on open forest conditions that retain few trees. Forests opened by excessive thinning lack understory shrubs, forbs and small trees that contribute to climate resilience (see Baker and Williams 2015, Baker 2018); small trees may also have mature/old growth characteristics because of slow growth rates and more of them need to be maintained as an important understory cohort for future old-growth development (e.g., by creating small gaps and leaving many more tree cohorts).
- A focus on community wildfire risk reduction through partnerships with private landowners that emphasize defensible space measures for homes instead of extensive thinning in the backcountry.
- A substantial reduction in livestock grazing including large no-grazing zones that more aptly address cumulative effects of livestock, infrastructure, and climate change (see Beschta et al. 2012).
- A reduction in project related carbon dioxide emissions by a project level comparison of emissions alternatives.

My detailed comments and supporting publications follow this signature page.

Sincerely,

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UNCERTAINTIES OF FIRE SCAR METHODOLOGY, REFERENCE CONDITIONS, AND FAILURE TO MEET BASI REQUIREMENTS OF THE PLANNING RULE

The 2012 planning rule requires forest plans to meet the best available scientific information (BASI) standard during planning assessments. Ryan et al. (2018) provide specifics on how best to meet this standard illustrated in their Figure 2:

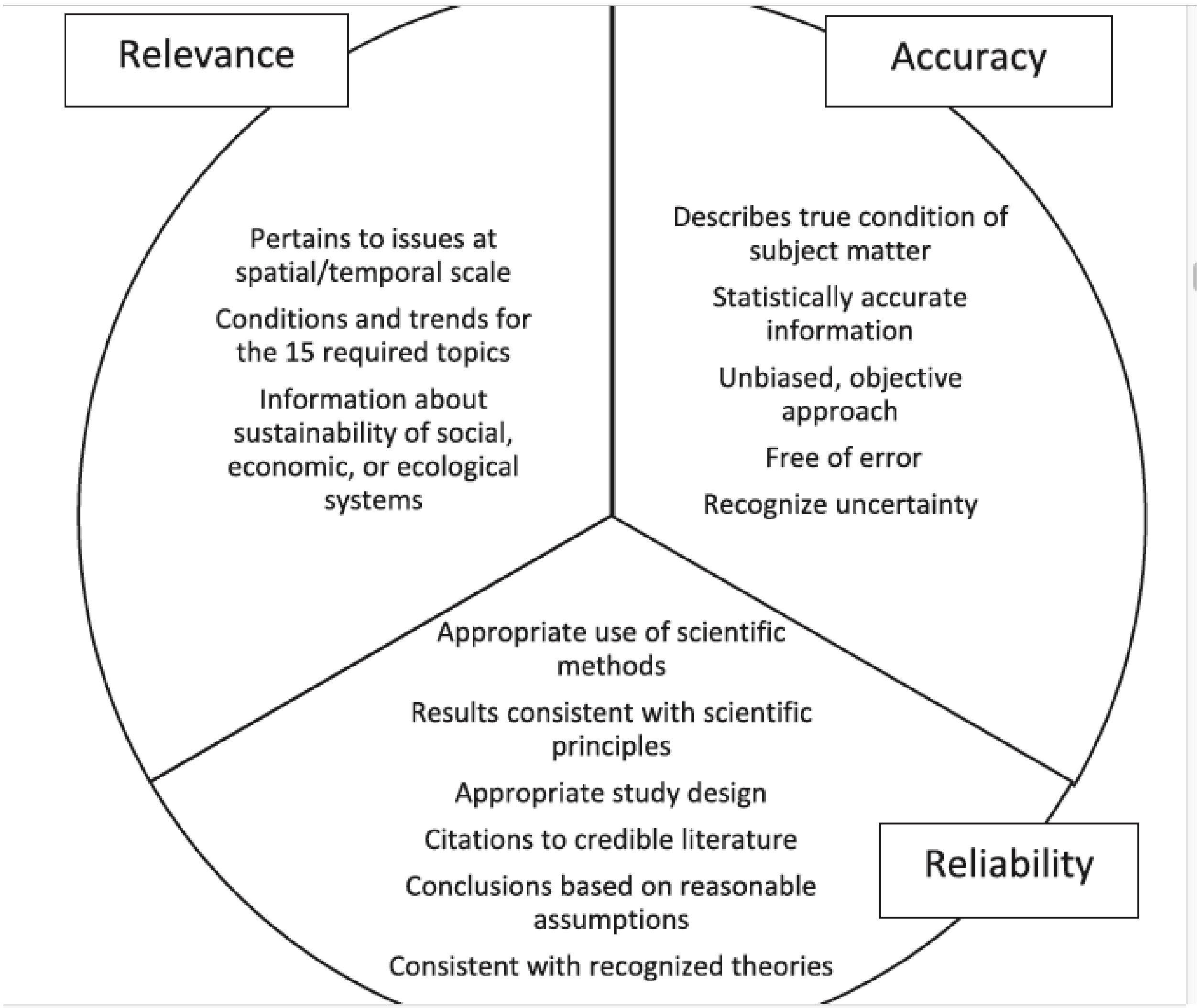
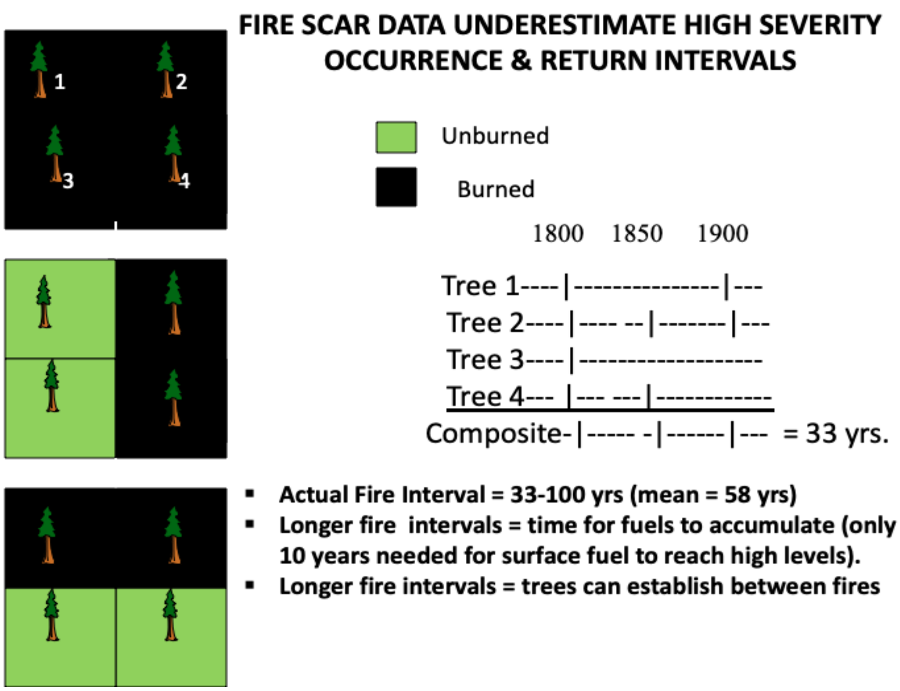


Figure 2 (from Ryan et al. 2018). Criteria for determining best available scientific information (BASI). Source: Forest Service Handbook 1909.12.07.12

According to Ryan et al. (2018) "the definition of BASI is contained in the "zero code" chapter of the handbook and specifies three primary criteria: accuracy, reliability, and relevance (FSH 1909.12.07.12), in addition to referencing the Data Quality Act (PL 106–554) for guidance on evaluating available information (Figure 2). Available is defined as information that currently exists in a form useful for the planning process without further data collection, modification, or validation (FSH 1909.07.01).

Based on the BASI standard above (especially Ryan et al. 2018: Figure 2), there are two main problems with the DEIS fire assumptions: (1) over reliance on fire scar estimates used to determine fire return intervals that are then extrapolated over large areas instead of the more appropriate use of multiple lines of evidence used to calculate *fire rotation intervals* (landscape scale; see Odion et al. 2014a, Moritz et al. 2018); and (2) accuracy and reliability problems with use of LANDFIRE to estimate reference and contemporary conditions in forest plan analyses (discussed below).

Fire return intervals are biased - While local sampling is important for estimating fire return intervals at the stand level, there are significant uncertainties with extrapolating fire scar point sampling data over large landscapes often used by researchers to re-construct historic fire regimes for comparisons to contemporary conditions (Baker 2017). They include sample-site selection bias, lack of tree scars in fire-killed trees (thereby underestimating high severity occurrence), and inappropriate extrapolation of site-specific data to draw landscape-level inferences (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, variability in CFI estimates is masked whenever the mean return interval is used (instead of the range or scope-of-inference is inappropriately extrapolated from sites to large areas and whenever measures of central tendency (rather than the range) are used in fire return intervals.

This results in a cascade of errors beginning with a bias toward very short fire return intervals (i.e., because the mean and not the range was used), conclusions that historic conditions were predominately open forests (especially when open is arbitrarily defined using LANDFIRE, see below), conclusions that contemporary forest conditions are way out of bounds, and, the inappropriate need for aggressive mechanical treatments. To fix this problem, the best estimator of fire intervals at landscape scales is to use the fire rotation interval (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) supplemented wherever possible with the paleo-ecology literature that can be used to reduce sampling bias associated with shorter sampling timelines and lack of high severity detectability from 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 DEIS 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 DEIS area beyond just fire-scars, and include paleo-ecology studies from comparable 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).

As an example, a key fire-history study for the Santa Fe watershed is Margolis and Balmat (2009). These researchers indicate that the historical low-severity fire rotation in this 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 and some dense forests 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 interval estimates 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 small tree and 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-maintenance (short return intervals). It is essential to manage for this variability at the site and landscape scale to accommodate wildlife that require a range of severity effects on vegetation: low, moderate and high severity. In other words, when it comes to fire, nature is complex (e.g., mixed severity) while management tends for uniformity (mainly low severity) typically at the expense of fire-mediated biodiversity.

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

> "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 DEIS needs to greatly scale back thinning except where thinning of small trees is needed to re-introduce fire nearest homes.

Problems with GTR-310 reference conditions - The DEIS tiers to GTR-310 (Restoring Composition and Structure in Southwest Frequent Fire Forests). However, GTR-310 does not even align with the geographic scope of the SFNF, as the SFNF 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 inappropriate (Moritz et al. 2018) and thus GTR-310 cannot be relied on for project-specific descriptions or actions.

The DEIS relies upon General Technical Report 310 as a primary source for desired conditions in the SFNF. This is inappropriate because none of the reference studies were from the Sangre de Cristo Mountains, and the two locations in the Jemez Mountains represent just 12 acres of sampled forest. The DEIS should instead rely on site-specific reference conditions and exercise caution when extrapolating fire regimes and forest structures from one geographic location to another given differences in vegetation, fire rotation intervals, elevation gradients, regional climate, and the influence of a rapidly changing climate on contemporary and future fire conditions (see Moritz et al. 2018). Thus, applying the "Flagstaff fire model" derived from GTR-310 is completely inappropriate for the SFNF.

ACCURACY PROBLEMS WITH LANDFIRE NEED FULL DISCLOSURE AND CORRECTION

Fire regime condition class (FRCC) and LANDFIRE vegetation models and maps are used by the Forest Service in planning assessments. These approaches are useful at large spatial scales (national) but they have well known accuracy problems at the project level that need full disclosure, cross validation with field data, and error correction.

For instance, Swetnam and Brown (2010) examined accuracy of LANDFIRE and FRCC assessments in Utah for similar vegetation types as in the DEIS planning area (Box 7).

Box 7. "LANDFIRE map data were found to be ~58% accurate for BpS and ~60% accurate for existing vegetation types. Results suggest that limited sampling of age-to-size relationships by different species may be needed to help refine reference condition definitions used in FRCC assessments, and that more empirical data are needed to better parameterize FRCC vegetation models in especially low-frequency fire types."

Zhu et al. (2006) tested the vegetation mapping protocol of LANDFIRE and likewise *concluded mapping accuracies of 60% or better at 30-m spatial resolution*. Notably, such low accuracy determinations do not comport with Ryan et al. (2018) summary of BASI criteria (their Figure 2 above) and the intent of the Data Quality Act.

Helmbrecht and Blankenship (2016) tested the ability of LANDFIRE to accurately reflect the true or accepted geographic location of features finding problems with errors in feature locations, source data, precision of field measurements, and data entry. Problems in map unit assignments may arise through "*errors or limitations in remote sensing data, field plots, statistical modeling, processing logic, or a combination of these and other factors*" (emphasis added). This is especially the case for forest vegetation and fuels data depending on the age of the source data. For instance, LANDFIRE data are updated every two years but by the time the data are delivered to the user, the data are 3 or more years out of date.

To correct for these problems, Helmbrecht and Blankenship (2016) recommend (and the DEIS should as well) include the following:

1. update for landscape changes that have occurred since the LANDFIRE version,
2. calibrate to local data and knowledge,
3. improve the thematic agreement (accuracy),
4. change the spatial or thematic resolution (e.g. lump or split map units),
5. modify the map unit classification,
6. create additional data versions that reflect temporal variability (e.g. peat soils being available for burning in drought situations, or exotic annual grasses being present in wet years but not dry years),
7. facilitate comparative analysis by creating data versions (e.g. analyzing pre- and post-treatment effects or comparing treatment alternatives),
8. analyze future conditions (e.g. modifying data to represent future conditions under a climate change scenario).

In Northern Idaho, Hyde et al. (2015) evaluated two LANDFIRE fuel loading raster options: (1) Fuels Characteristic Classification Systems (LANDFIRE-FCCS); and (2) Fuel Loading Model (LANDFIRE-FLM) vs. measured fuel loadings for a 20,000-ha mixed conifer study area. They found that the LANDFIRE-FCCS layer showed 200% higher duff loadings relative to measured loadings that led to 23% higher total mean consumption and emissions when modeled in FOFEM. The LANDFIRE-FLM layer showed lower loadings for total surface fuels relative to measured data, especially in the case of coarse woody debris that led to 51% lower mean total consumption and emissions when modeled in FOFEM. Additionally, LANDFIRE-FLM consumption was *59% lower relative to that on the measured plots, with 58% lower modeled emissions*. The authors concluded that these differences in fuel loadings led to significant differences in consumption and emissions depending upon the data and model chosen. The DEIS therefore needs to disclose how errors in fuel loading consumption were addressed in emissions determinations regarding wildfires and how these errors were corrected.

In the Sierra Nevada region, Odion and Hanson (2006) found FRCC *was not able to accurately predict occurrence of high-severity fire* (Box 8).

Box 8. "We found that the proxy for fire suppression effects, Condition Class, was not effective in identifying locations of high-severity fire. Condition Classes 2, 3, and 3+ in the McNally fire all had similar fire severity proportions. When the same Condition Class criteria were applied to the other two fires, we found that fire severity generally decreased rather than increasing from Condition Class 2 to 3+. In short, Condition Class identified nearly all forests as being at high risk of burning with a dramatic increase in fire severity compared to past fires. Instead, we found that the forests under investigation were at low risk for burning at high-severity, especially when both spatial and temporal patterns of fire are considered. The lack of an observed relationship between Condition Class and fire severity suggests that exogeneous forces such as weather, climate, topography, and neighboring vegetation (for example, pyrogenic shrubs) largely determine fire-severity patterns in forests."

Vogelmann et al. (2014) recognized four major potential sources of error associated with field plot data used in LANDFIRE:

1. Errors occur frequently in the identification of species and measurement of vegetation structure in the field (for example, in the data for one prototype field plot, a misplaced decimal point indicated a shrub height of 60 feet).
2. The vegetation on some field plots has undoubtedly changed between the time the field data were collected and when the imagery was acquired.
3. Geo-location errors in plot and imagery data result in inaccurate characterization of some imagery pixels.
4. The assignment of plots to specific vegetation classes will have errors associated with the wide array of opinions among professional field ecologists regarding the field classification of any given field plot.

To correct for these problems, Vogelmann et al. (2014) suggest (and the DEIS should follow) that the Forest Service conduct a suite of accuracy assessment methods for LANDFIRE, ranging from mostly qualitative assessments (such as the critical inspection of products, consultation with regional experts, and comparisons with existing data sets) to more quantitative analyses (such as cross-validation assessments, traditional accuracy assessments at the superzone level, and select evaluations at local levels). These combined approaches will provide the Forest Service with the accuracy information necessary to facilitate the appropriate use of the data in the DEIS.

Cruz and Alexander (2010) note additional problems with related fire modeling summarized in their abstract. The Forest Service needs to disclose errors associated with use of these models in the DEIS:

Abstract. To control and use wildland fires safely and effectively depends on creditable assessments of fire potential, including the propensity for crowning in conifer forests. Simulation studies that use certain fire modelling systems (i.e. NEXUS, FlamMap, FARSITE, FFE-FVS (Fire and Fuels Extension to the Forest Vegetation Simulator), Fuel Management Analyst (FMAPlus[!]), BehavePlus) based on separate implementations or direct integration of Rothermel's surface and crown rate of fire spread models with Van Wagner's crown fire transition and propagation models are shown to have a significant underprediction bias when used in assessing potential crown fire behavior in conifer forests of western North America. The principal sources of this underprediction bias are shown to include: (i) incompatible model linkages; (ii) use of surface and crown fire rate of spread models that have an inherent underprediction bias; and (iii) reduction in crown fire rate of spread based on the use of unsubstantiated crown fraction burned functions. The use of uncalibrated custom fuel models to represent surface fuelbeds is a fourth potential source of bias. These sources are described and documented in detail based on comparisons with experimental fire and wildfire observations and on separate analyses of model components. The manner in which the two primary canopy fuel inputs influencing crown fire initiation (i.e. foliar moisture content and canopy base height) is handled in these simulation studies and the meaning of Scott and Reinhardt's two crown fire hazard indices are also critically examined.

DellaSala et al. (2015) further summarize the problems with fuel models and simulations not comporting with field data and resulting in over-emphasis of efficacy of fuel reduction treatments and these uncertainties need to be addressed in the DEIS as follows:

"Fuel reduction also has been overpromised to be effective, using questionable logic and unvalidated models. First, fire intensity in most forest types is much more strongly affected by wind than by fuel. High fire-line intensity, the primary fire characteristic that promotes crown fires, is the product of the energy released by burning fuel and the rate of spread of fire (Alexander, 1982). Energy release by fuel varies over perhaps a 10-fold range, however, whereas rate of spread can vary over more than a 100-fold range; thus a high rate of spread caused by strong winds can easily overcome the limited reductions in fuel that are feasible (Baker, 2009). This was confirmed by a recent analysis of the 2013 Rim Fire in California, which concludes: "Our results suggest that even in forests with a restored fire regime, wildfires can produce large-scale, high-severity fire effects under the type of weather conditions that often prevail when wildfire escapes initial suppression efforts. . . . During the period when the Rim fire had heightened plume activity... no low severity was observed [in thinned areas], regardless of fuel load, forest type, or topographic position" (Lydersen et al., 2014, p. 333). Second, common fire models used to show that forests would be fire-safe after fuel reductions have an underprediction bias and are not validated. These flawed models include NEXUS, FlamMap, FARSITE, FFE-

FVS, FMAPlus, and BehavePlus (Cruz and Alexander, 2010; Alexander and Cruz, 2013; Cruz et al., 2014). The underprediction bias means that these models often predict that fuel reductions would reduce or eliminate the potential for crown fires in forests, when in fact fuel reductions do not achieve this effect. Fixing these models would be difficult and has not yet occurred (Alexander and Cruz, 2013). Also, these models have not been sufficiently tested and validated using a suite of actual fires, in which case they would likely be shown to fail (Cruz and Alexander, 2010). Alternative validated models are available and could be further developed, but they are not being used (Cruz and Alexander, 2010). Further, studies of tree mortality in thinned areas following fire do not typically take into account the mortality caused by the logging itself before the fire, leading to further biased results."

As further noted by DellaSala et al. (2015) "these concerns should raise red flags about the effectiveness of fuel treatments, as well as issues regarding liability and responsibility. Imagine if a company sold airplanes with identified flawed designs and without adequate test flights, which then crashed. There are thus sound scientific reasons to closely scrutinize government wildland fuel-reduction programs. Meanwhile, we need to be honest and warn the public that living within or adjacent to natural forests prone to burn is inherently hazardous. Only treating fuels in the immediate vicinity of the homes themselves can reduce risk to homes, not backcountry fuel reduction projects that divert scarce resources away from true home protection (Cohen, 2000; Gibbons et al., 2012; Calkin et al., 2013; Syphard et al., 2014)."

Closed Canopy Conditions Arbitrarily Defined - the DEIS arbitrarily defines closed canopy conditions in the mixed conifer-frequent fire and ponderosa pine ERUs as when *woody cover exceeds 30%* (DEIS: Figure 14, Figure 16), using LANDFIRE to determine the reference/baseline condition and contemporary departure indices for alternative analyses. The preferred alternative is based on moving closed canopy forests into desired open canopy conditions over 50 years. Closed canopy forests in some cases currently exceed 70% overstory cover and thus extensive thinning in the preferred alternative constitutes a major change in overstory cover impactful to species requiring closed canopy conditions. Large interspaces will be created across the landscape with substantial reductions in canopy cover and percent of forests in closed conditions to meet this arbitrarily defined "open" reference condition, creating novel ecosystems that do not comport with the ecological integrity or diversity requirements of the planning rule.

Importantly, Scott (2008) documented seven potential shortcomings with the canopy and fuel related provisions of LANDFIR, including:

- canopy cover values are too high,

- data discontinuities exist within and between map zones,
- canopy bulk density values are too low for use in FARSITE,
- canopy base height is too high to generate crown fire,
- treelist data sources may not be best for canopy fuel calculations
- alternative canopy fuel calculation programs may produce different results
- Refreshing and calibrating LANDFIRE data is needed

Scott (2008) reported that the dead fuel moisture model is especially sensitive to errors in canopy cover and concludes:

"Moreover, canopy cover mapping errors may lead to significant indirect fire modeling effects. Because canopy cover is a keystone variable, these indirect effects are difficult to quantify. If canopy cover is overestimated, LANDFIRE may subsequently map the incorrect fuel model, incorrect CBD, incorrect CBH, etc., all of which can strongly affect fire modeling outputs in a geospatial fire analysis."

"Because it is used as an independent variable, the importance of an accurate canopy cover layer in the LANDFIRE process should not be underestimated."

THE DEIS NEEDS TO RECOGNIZE THE ECOLOGICAL IMPORTANCE OF MIXED-SEVERITY FIRES, INCLUDING LARGE AND SMALL HIGH SEVERITY PATCHES FOR POSITIVE CONTRIBUTIONS TO PLANT AND WILDLIFE DIVERSITY

While low elevation pine and mixed conifer forests are predominately maintained by frequent fires of low severity effects on vegetation, there are occasional canopy flare ups and high-severity patches related to local fire-weather conditions, slope, aspect, elevation, and vegetation condition. This variability in fire effects needs to be maintained under the diversity requirement of the planning rule. Instead, the DEIS includes no analysis of the positive effects of mixed-severity fire influences on plant and wildlife communities, especially in upper elevation forests where fires are on centuries long rotation intervals (landscape scale) and produce diverse ecosystem effects including the creation of complex early seral forests (Swanson et al. 2011).

Notably, high-severity fire patches generate "biological legacies" (large live and dead trees, logs, shrubs) essential to forest succession and the maintenance of complex early seral forest conditions (Swanson et al. 2011, DellaSala et al. 2014, DellaSala and Hanson 2015, DellaSala and Hanson 2019). Large and small high severity patches provide important foraging habitat for Mexican Spotted Owls (federally listed, Lee 2018), Northern Goshawks (at-risk species), ungulate foraging habitat (Bond 2015), snowshoe hare/lynx dynamics, woodpeckers (including at-risk species: Lewis's woodpecker) and songbirds (Hutto et al. 2015), bats (Chambers and Saunders 2013), and boreal owls (at-risk species) in upper elevation spruce-fir forests. The DEIS inappropriately and arbitrarily assumes high-severity patches constitute wildlife habitat degradation (e.g., DEIS Volume 1: Tables 51, 57; "catastrophic fire analysis" p. 244).

Using LANDFIRE, the DEIS inappropriately assumes that current fire return intervals are highly departed from reference conditions (86%) as is fire severity leading to what the DEIS claims is a departure from NRV (DEIS Volume 1:89). However, based on a study of high-severity patches in dry pine and mixed conifer forests across the West, including New Mexico, large (>400 ha) high-severity fire patches have not been increasing since the 1990s (DellaSala and Hanson 2019.

From DellaSala and Hanson (2019):

Over the entire time series, 1984-2015, there was a significant increasing trend in the combined total area of CESF [complex early seral forests] patches >400 ha in each year ($\tau = 0.407$, $p = 0.001$), but no trend in patch size ($\tau = 0.009$, $p = 0.802$). However, when the data were analyzed by time periods, there was only a significant difference in the annual area of CESF habitat created by high-severity fire relative to the earliest time period (1984-1991), but no significant differences were detected among time periods since the early 1990s (Table 1, Figure 2). With regard to size of individual large CESF patches, there were no significant differences detected among time periods (Table 2).

Table 1. Critical values ($q_{0.05,4}$), absolute difference between mean of ranks ($|R_A\text{-}R_B|$), standard errors (SE), and test statistics (q) to assess statistical significance, at $\alpha = 0.05$, of any differences between the four time groups ("1" = 1984-1991, "2" = 1992-1999, "3" = 2000-2007, and "4" = 2008-2015) for total annual area of CESF patches >400 ha using the Nemenyi non-parametric test for multiple comparisons between groups with an equal sample size (n = 8 years for each time group). Statistical significance of levels of q are shown as "Y" (significant) or "N" (not significant).

Time group comparison	$q_{0.05,4}$	$\|R_A\text{-}R_B\|$	SE	q	Significant? ($q > {}_{0.05,4}$?)
1-2	3.63	45.0	26.53	1.70	N
1-3	3.63	108.0	26.53	4.07	Y
1-4	3.63	107.0	26.53	4.03	Y
2-3	3.63	63.0	26.53	2.37	N
2-4	3.63	62.0	26.53	2.34	N

3-4	3.63	1.00	26.53	0.04	N

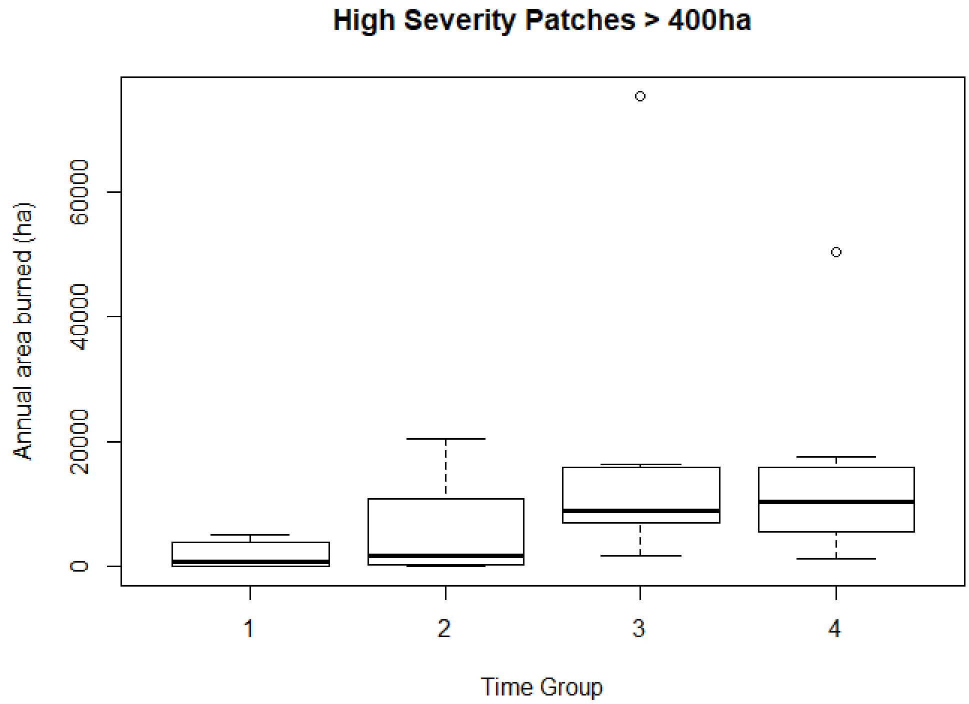


Figure 2 from DellaSala et al. Annual area of large patches (>400 ha) of high-severity fire in the four time periods ((“1” = 1984-1991, “2” = 1992-1999, “3” = 2000-2007, and “4” = 2008-2015).

Thus, the DEIS claims about uncharacteristically severe fires, for which mechanical treatments are based upon, cannot be substantiated by empirical data (including from New Mexico) and thus the DEIS does not meet the BASI requirements.

Importantly, Hutto et al. (2016) recommended that managers maintain ecological integrity of western dry pine and mixed-conifer forests through a more informed approach to the importance of mixed and high-severity fires. Here is their abstract:

Abstract. *We use the historical presence of high-severity fire patches in mixed-conifer forests of the western United States to make several points that we hope will encourage development of a more ecologically informed view of severe wildland fire effects. First, many plant and animal species use, and have sometimes evolved to depend on, severely burned forest conditions for their persistence. Second, evidence from fire history studies also suggests that a complex mosaic of severely burned conifer patches was common historically in the West. Third, to maintain ecological integrity in forests born of mixed-severity fire, land managers will have to accept some severe fire and maintain the integrity of its aftermath. Lastly, public education messages surrounding fire could be modified so that people better understand and support management designed to maintain ecologically appropriate sizes and distributions of severe fire and the complex early-seral forest conditions it creates.*

DellaSala et al. (2017) recommend that managers include mixed-severity effects in dry pine and mixed conifer forests to achieve ecological integrity and plant diversity. And while much of the

DEIS project area can be assumed to be in a xeric pine condition, mixed-severity fire effects, including large and small high-severity patches are indeed characteristic, need to be maintained, and are being grossly underestimated in ecological importance throughout the DEIS. Thus, the DEIS does not meet the BASI requirements of the planning rule as well as the diversity, ecological processes, ecological conditions, and integrity provisions as noted.

BIASED APPROACHES, AREAS OF AGREEMENT & DISAGREEMENT NEED TO BE ACKNOWLEDGED AND CORRECTED

Bias: The DEIS needs to clearly state scientific disputes (disagreements) and avoid 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 DEIS:

- Action bias – tendency to take actions even when it is better to delay action (in this case the impacts of aggressive thinning 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 in the DEIS 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 in the DEIS 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 as in the DEIS).
- 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).

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 DEIS 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, invasive species, 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. 1998, 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.

ROAD IMPACTS AND ROADLESS AREA IMPORTANCE NEED TO BE ANALYZED TO COMPLY WITH CONNECTIVITY REQUIREMENTS OF THE PLANNING RULE

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 excessive roads and that more roads can and should be decommissioned and obliterated rather than improving and building more roads. The DEIS 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 DEIS 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[2]. Water quality must be assessed in relation to road improvements, greater road access, thinning impacts, and road-stream intersections.

In sum, the DEIS 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.

2Particularly 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

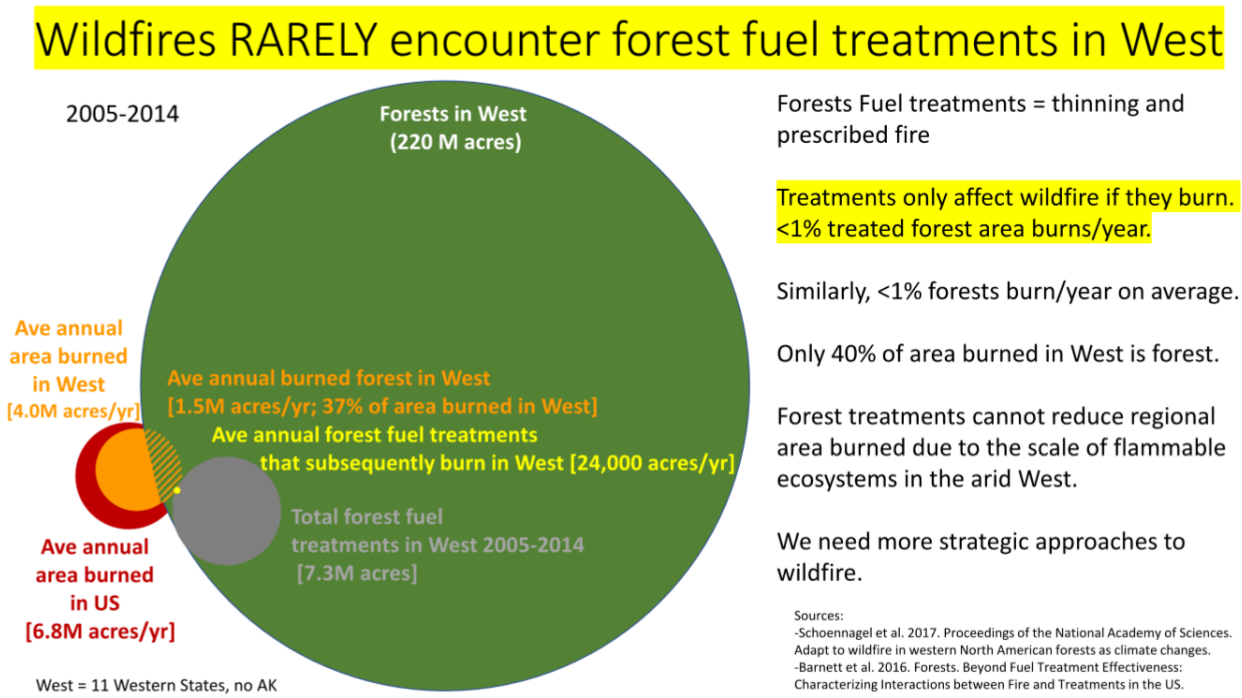
Ibisch et al. (2016) provide a global synthesis of road-related impacts including: wildlife mortality (vehicle collisions); poaching pressure; sediment increases (runoff); chemical contamination; carbon emissions; spread of invasive species; fire ignitions; and habitat fragmentation among others. These impacts can extend out to 1 km on either side of the road prism. Thus, 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 areas is well-documented in the literature (Strittholt and DellaSala 2001, Loucks et al. 2003, Crist et al. 2005, Ibisch et al. 2016) and emphasized in landmark Forest Service policies such as the Roadless Conservation Rule[3] and Interior Columbia River Basin strategy[4]. At a minimum, the DEIS 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 et al 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., see Roadless Conservation Rule, Columbia River Basin strategy, DellaSala and Frost 2001).

LIMITATIONS OF THINNING ON FIRE BEHAVIOR IN A CHANGING CLIMATE NEED TO BE RECOGNIZED AND CORRECTED

The figure below illustrates 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 invalidates the DEIS 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).

[3] https://www.fs.usda.gov/roadmain/roadless/2001roadlessrule
[4] https://www.fs.fed.us/r6/icbemp/html/ICBEMP_Frameworkmemorandum-and-strategy_2014.pdf



Moreover, the DEIS 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 soil damage (excessive soil heating) facilitating the spread of invasive plants and delaying forest succession (especially if livestock grazing also occurs, Besctha et. al 2012).

Excessive opening of the tree canopy can also lead to higher wind penetrance and rapid fire spread, particularly if thinning is conducted on steep slopes and in remote areas with limited access making fine fuel consumption via pile burning impractical. In a warming climate where more extreme fire weather is likely, thinning is even less likely to alter fire behavior (Abatzoglou and Williams 2017, Schoennagel et al. 2017).

CUMULATIVE IMPACTS OF LIVESTOCK GRAZING IN A CHANGING CLIMATE NEED TO BE FULLY ANALYZED AND GREATLY REDUCED

Livestock grazing and associated infrastructure in combination with climate change are causing extensive cumulative effects in the SFNF that are not properly analyzed or mitigated by the DEIS. The DEIS acknowledges that livestock have contributed to degradation of ecosystem resilience (DEIS Volume 1:5) but the alternatives contain numerous contradictions stating, for example, that the DEIS (Volume 1:13) "aims to provide *healthy* forested and non-forested lands that would supply forage for both livestock and wildlife" (Volume 1:13) and that it will "provide sustained multiple uses, products, and services in an *environmentally acceptable manner* (including timber, livestock forage, recreation opportunities, and leasable and locatable minerals) (emphasis added, DEIS Volume 1:16), all the while maintaining grazing at ecologically unacceptable levels (maximum of 11,400 AUMs).

The DEIS (Volume 1:37) recognizes that livestock grazing is "*not a natural process*" (emphasis added), yet, continues grazing under all planning alternatives even though it is inconsistent with ecological processes, ecological integrity, and ecological condition requirements of the planning rule (as noted in the boxes above). None of the alternatives meet these requirements given the high level of grazing maintained.

Importantly, the DEIS does not meet the BASI requirement of the planning rule by failing to analyze cumulative impacts of livestock from roads, infrastructure, and especially climate change. Besctha et al. (2012) noted livestock use affects a far greater proportion of BLM and Forest Service lands than do roads, timber harvest, and wildfires combined by altering vegetation, soils, hydrology and wildlife species composition and abundance "*in ways that exacerbate the effects of climate change on these resources*" (emphasis added). Livestock also contribute to greenhouse gas emissions globally (18% of the total anthropogenic emissions) and in the SFNF, thus, the DEIS needs to analyze livestock-related emissions.

Beschta et al. (2012) recommended large areas free of livestock use to "help initiate and speed the recovery of affected ecosystems as well as provide benchmarks or controls for assessing the effects of grazing versus no grazing at significant spatial scales in a changing climate."

The DEIS analyzed and dismissed Alternative 3 (lower livestock use) and dismissed a no grazing alternative as out of scope. However, Alternative 2 is deficient in meeting the ecological integrity, ecological condition, and ecological processes requirement of the planning rule. Therefore, the Forest Service needs to develop a new alternative or modify Alternative 2 to meet the specific recommendations of Beschta et al. (2012: Table 2) as follows.

Beschta et al. (2012:Table 2). Priority areas for permanently removing livestock and feral ungulates from Bureau of Land Management and US Forest Service lands to reduce or eliminate their detrimental ecological effects

- Watersheds and other large areas that contain a variety of ecotypes to ensure that major ecological and societal benefits of more resilient and healthy ecosystems on public lands will occur in the face of climate change
- Areas where ungulate effects extend beyond the immediate site (e.g., wetlands and riparian areas impact many wildlife species and ecosystem services with cascading implications beyond the area grazed)
- Localized areas that are easily damaged by ungulates, either inherently (e.g., biological crusts or erodible soils) or as the result of a temporary condition (e.g., recent fire or flood

disturbances, or degraded from previous management and thus fragile during a recovery period).

- Rare ecosystem types (e.g., perched wetlands) or locations with imperiled species or communities (e.g., aspen stands and understory plant communities, endemic species), including fish and wildlife species adversely affected by grazing and at-risk and/or listed under the ESA
- Non-use areas (i.e., ungrazed by livestock) or exclosures embedded within larger areas where livestock grazing continues.
- Such non-use areas should be located in representative ecotypes so that actual rates of recovery (in the absence of grazing impacts) can be assessed relative to resource trend and condition data in adjacent areas that continue to be grazed.
- Areas where the combined effects of livestock, wild ungulates, and feral ungulates are causing significant ecological impacts.

Notably, Ratner et al. (2018) document extensive impacts of livestock grazing on aspen groves in in Utah and their findings are generally applicable west-wide and therefore to the DEIS. These researchers found livestock significantly suppressed aspen sprout growth and trampled soils in study plots. They noted that livestock tended to concentrate in aspen groves due to forage availability and shading, even on allotments where livestock grazing is "controlled" and under "moderate" grazing. Ratner et al. (2018) recommended reducing livestock pressure via exclosures at least until aspen height exceeds browsing height and this will require periodic repetition (exclosures) to ensure proper aspen regeneration. At a minimum, exclosures should include entire aspen clonal areas and this needs to be incorporated into the DEIS.

Finally, the DEIS needs to allow for permanent allotment retirement and significantly reduced livestock grazing. This needs to include an analysis of the cumulative effects of *livestock grazing and climate change* and emissions related to livestock use, roads, and infrastructure. The DEIS (Volume 1:31) only allows for continuation of even vacant or understocked allotment and therefore should be modified or a new alternative developed to permanently retire vacant or understocked allotments and allow for voluntary buyout of grazing leases by conservation groups.

RIPARIAN AREAS NEED MORE EFFECTIVE PROTECTION, CONSERVATION, AND RESTORATION ESPECIALLY FROM LIVESTOCK AND THINNING TREATMENTS

The DEIS (Volume 1:153) correctly notes that although riparian areas occupy < 3% of the landscape, they support ~ 80% of the forest's plant and animal diversity, including several at-risk species (e.g., Mexican Spotted Owl, Lewis's Woodpecker, Arizona willow, Jemez Mountain salamander, masked and water shrew, New Mexican meadow jumping mouse, Northern leopard frog, Rio Grande chub, cutthroat trout, and sucker). Hubbard (1977; cited in Kauffman et al.

1984) report that 16-17% of the entire breeding avifauna of temperate North America reside in just 2 New Mexico river valleys and 77% of 166 nesting birds in the southwest depend on riparian habitat (Johnson et al. 1977 cited in Kauffman et al. 1984). Thus, riparian areas need stepped up conservation measures, especially protection from livestock grazing, given their exceptional importance in southwestern dry ecosystems.

Riparian areas also congregate livestock that have a strong preference for stream-side areas and wet montane meadows with high forage production. Livestock degrade this important wildlife habitat type in many ways, including soil compaction, spread of invasive species, stream-bank erosion, hydrological alterations, water quality and stream temperature degradation, and trampling effects (Kauffman et al. 1984, Besctha et al. 2012).

Kauffman et al. (1984) list several ways livestock grazing impacts can be reduced in riparian areas that should be readily adopted by the DEIS:

- Exclusion of livestock grazing;
- Alternative grazing schemes (e.g., late season – after bird nesting);
- Salting, alternative water sources, fencing, range riders to keep livestock out;
- Instream structures (e.g., trash catchers, gabions, small rock dams, individual boulder placement, rock jetties, and silt log drops) for increasing water table in areas of former wet meadows as well as improving fish habitat;
- Combining rest rotation with check dams (although the rest-rotation system may increase trailing and trampling damage, causing streambank erosion and instability);
- Selection of cattle with a preference for upland areas over riparian (cattle are known to have group-specific preferences)

Because of the disproportionate use of wildlife in riparian areas (especially at-risk species) and the extensive livestock damage in the area, the DEIS should incorporate the best elements from Alternative 3 with some notable additions as follows:

- Double the objectives in Alternative 2 (DEIS Volume 1:Table 3, p. 58) for restoring composition and structure in riparian vegetation.
- Within the riparian management zone, move toward desired conditions for vegetation types that are outside of or trending away from natural range of variability by restoring the composition and structure of 30 miles of stream every 10 years. Actions that could improve riparian areas would include removing invasive plant species, stabilising stream channels, planting native species, promoting natural revegetation of bare ground, and redirecting other uses (e.g., providing other watering sources or closing areas to camping – note this redirection needs to include redirecting cattle and not just "other uses").

- Complete aquatic restoration on priority projects on 60 miles of aquatic habitat (e.g., increasing pool quantity, providing stream cover, removing or installing fish barriers, restoring beaver populations, treating invasive aquatic species, etc.) every 10 years to benefit aquatic species.
- Every 10 years, restore native fish species to 40 miles of streams where nonnative fish are absent and where natural or human-made fish barriers exist.
- Further reductions in road densities throughout the forest and avoidance of permanent or temporary roads, particularly those that parallel or cross streams.
- Additionally, an emphasis on beaver reintroduction is complimentary with the above improvements.
- The DEIS should include large no-grazing riparian zones where cattle are fenced out and permanently removed to allow riparian recovery and reintroduction of beaver populations.

FOCAL SPECIES, AT-RISK SPECIES, SPECIES OF CONSERVATION CONCERN NEED TO BE MONITORED AND HABITAT PROTECTED FROM THINNING AND GRAZING

The DEIS (Volume 2:312) states that "the 2012 Rule does not require or prohibit monitoring of population trends of focal species. Instead, it allows the use of any *existing or emerging approaches for monitoring the status of focal species* that are supported by current science" (emphasis added). However, the DEIS is deficient in meeting the BASI requirement of the planning rule as it inadequately monitors population viability of species and does not provide enough habitat protection measures for focal species, species of conservation concern, and at-risk species. Specifically, the DEIS needs to meet the BASI requirement for these species with respect to connectivity (Haber and Nelson 2015), PVA (Noon et al. 2003), and species-specific "trigger points" (Schulz et al. 2012).

The DEIS largely bases management of these species on coarse-filter approaches. The DEIS site specific measures are very general and insufficient as a fine-filter approach.

Importantly, The Committee of Scientists (COS 1999[5]) stated, ''Habitat alone cannot be used to predict wildlife populations'' and ''diversity is sustained only when individual species persist; the goals of ensuring viability and providing for diversity are inseparable. For this reason, the fine-filter species assessment is critical." To meet the BASI requirements, therefore, the Forest Service must appropriately provide fine-filter approaches following recommendations of the COS (1999), Noon et al. (2003) and Schultz et al. (2012) as follows.

[5]COS (1999) https://www.fs.fed.us/emc/nfma/includes/cosreport/Committee%20of%20Scientists%20Report.htm

Noon et al. (2003) note: “to assess the viability of species, at least three assumptions must hold true: (1) attributes that define the coarse filter (i.e., dominant vegetation types) are sufficient and reliable surrogates for habitat and can effectively predict the occurrence of a given species; (2) managing coarse-filter attributes will address the factor(s) currently limiting abundance, density, and persistence of each species; and (3) the spatial resolution of the coarse filter matches the scale at which given species respond to environmental heterogeneity. Although these assumptions may be valid for some species in many circumstances, especially species that are small-bodied, abundant, and tightly linked to a particular vegetation community, the likelihood that the assumptions are met for all, or even most, species in an assemblage is low. For that reason, landscape planning employs “fine-filter” assessments, which are based on direct measures of the status and trends of individual species or on models of population viability to evaluate the needs of species at risk of decline. Noon et al. (2003) report numerous prediction errors associated with coarse-filter approaches that need supplementation with species-specific analyzes. For instance, forest planning needs to include PVA methods in its monitoring and adaptive management approach to better ensure coarse-filter requirements are representative of the community of interest.”

Similarly, Schultz et al. (2012) indicate monitoring plans must include species-specific trigger points that initiate a review of management actions and provisions to ensure species-specific (fine filter) monitoring will be well funded and implemented. The *trigger points must be enforceable and ensure* that specific project actions cease should they further impair the viability of select species (especially the case for at-risk and listed species).

Schultz et al. (2012) note the 2012 planning rule requires “at least, some amount of direct species measurement may be needed to assess the effectiveness of the ecological conditions provided under the coarse-filter approach in achieving the goal of conserving the biological diversity of the area (USFS 2012:124).”

Schultz et al. (2012) provide recommendations for incorporating more specific fine-filter monitoring lacking in the DEIS, as summarised:

- Focusing on distribution, rather than traditional measures of population size and growth rate, which greatly increases the efficiency of broad-scale monitoring programs.
- Advancements in wildlife monitoring, based on detection/non-detection data, including the use of sign surveys, genetic evaluation, and historical presence–absence survey data decrease the cost of monitoring changes in distribution, which can be inferred from the proportion of sample units at which the species is detected.
- Area occupied by a species can be used as an effective measure of a species’ spatial distribution.

- Temporal and spatial patterns in detection/non-detection monitoring data allow inference to changes in animal abundance, the single most influential parameter that provides insights into likelihood of species persistence.

The methods above recommended by Noon et al. (2003) and Schultz et al. (2012) along with connectivity measures recommended by Haber and Nelson (2015) should be applied to all 36 at-risk species, all 32 species of conservation concern, and all 7 focal species in the project area.

Mexican Spotted Owl (MSO) - The Santa Fe National Forest contains 198,888 acres of designated critical habitat for this owl. MSO requires dense conifer forests for nesting; however, will forage in recently severely burned areas (Lee 2018). The main factor involved in the decline of this species has been habitat destruction from logging; severe fire is not necessarily a habitat loss (Lee 2018), yet the DEIS assumes this to be the case. Large and small patches of severe burns juxtaposed with fire refugia for nesting may provide optimal habitat for MSO (Lee 2018). And while much is not known about how thinning affect MSO and its prey, declines in habitat and prey species have been noted for Northern Spotted Owl (see Odion et al. 2014b for review and analysis) and California Spotted Owl (Stephens et al. 2014). For all three subspecies of owls, removal of large trees (before/after fire) and reducing canopy cover (e.g., below 60% for NSO) constitutes habitat degradation that has been linked to nest occupancy failures (Lee 2018).

Thus, at a minimum, thinning units need to be dropped from MSO critical habitat and demographic monitoring implemented for this at-risk species.

FIRE EMISSIONS ARE OVER-ESTIMATED USING LANDFIRE AND EMISSIONS FROM PROJECT ACTIVITIES NEED TO BE ANALYSED FOR DIRECT, INDIRECT, AND CUMULATIVE EFFECTS

The DEIS pays an inordinate amount of attention to emissions from wildfires yet includes no analysis of emissions from livestock grazing, livestock infrastructure and transport, thinning and road development and maintenance. Therefore, the DEIS is deficient in assessing cumulative impacts of emissions and air quality to the surrounding community from project activities.

With respect to fire emissions, the DEIS needs to pay attention to the literature on wildfire emissions from related studies in dry pine and mixed conifer forests as follows.

For instance, Mitchell (2015: chapter 10 in DellaSala and Hanson 2015) has an excellent summary of ineffectiveness of thinning and reduction of carbon stores from thinning.

"While such treatments [referring to thinning and prescribed burning] can sometimes be effective in reducing fire severity, if and when fires occur in thinned areas (Rhodes and Baker, 2008), they can come at the expense of carbon storage. The majority of carbon stored in leaves, leaf litter, and duff is typically consumed by high-severity wildfire and often constitutes the majority of the carbon emissions during the a given fire, yet most of the carbon stored in forest biomass (stem wood, branches, and coarse, woody debris) remains unconsumed even by high-severity wildfires. Consequently, fuel removal via forest thinning almost always reduces carbon storage more than the additional carbon that a stand is able to store when made more resistant to wildfire. For this reason, removing large amounts of biomass to reduce the fraction by which other biomass components are consumed via combustion is inefficient (Mitchell et al., 2009). Fuel reduction treatments that involve the removal of overstory biomass (i.e., intermediate-sized and large trees) are, perhaps unsurprisingly, the most inefficient methods of reducing wildfire-related carbon losses because they remove large amounts of carbon for only a marginal reduction in expected fire severity (Figure 10.2)."

"The majority of carbon stored in montane forest ecosystems of western North America remains unconsumed, even in high-severity wildfires. Large carbon stores in the bole biomass of large forest trees are not consumed, and the substantial proportion of carbon stored in forest soils is only slightly consumed. Most of the carbon emissions in a wildfire are from combustion of litter, duff, and woody debris. In the 2002 Biscuit Fire, CFs for total forest biomass (i.e., trees, snags, shrubs, woody fuels, litter, duff, and soil), weighted according to their respective prefire biomass, were 0.13, 0.15, and 0.21 for low-, medium-, and high-severity fires, respectively. Such factors can be even lower among stands with a higher proportion of carbon storage in bole biomass that likewise remains unconsumed in high-severity wildfires, such as Sitka spruce (P. sitchensis)/Western Hemlock (T. heterophylla) forests in the coast range of the Pacific Northwest (Smithwick et al., 2002;Mitchell et al., 2009). The application of fuel treatments can be effective in reducing fire severity and carbon emissions, but such treatments come at the cost of a net reduction in carbon storage relative to fire alone (Mitchell et al., 2009)."

In a recent global study of pyrogenic carbon emissions, Jones et al. (2019) concluded that "large wildfires convert a significant fraction of the burned vegetation biomass into pyrogenic carbon that can be stored on site for centuries to millennia and this stored carbon is underestimated in emissions calculations. The amount of carbon emitted globally from wildfires is in fact buffered by pyrogenic carbon production resulting in burned landscapes becoming a significant carbon sink." The value of this sink is not even reported in the DEIS nor is it estimated in LANDFIRE and it needs to be in the forest plan. Here is the Jones et al. (2019) abstract, the pdf is attached.

Abstract

Landscape fires burn 3–5 million km^2 of the Earth's surface annually. They emit 2.2 Pg of carbon per year to the atmosphere, but also convert a significant fraction of the burned vegetation biomass into pyrogenic carbon. Pyrogenic carbon can be stored in terrestrial and marine pools for centuries to millennia and therefore its production can be considered a mechanism for long-term carbon sequestration. Pyrogenic carbon stocks and dynamics are not considered in global carbon cycle models, which leads to systematic errors in carbon accounting. Here we present a comprehensive dataset of pyrogenic carbon production factors from field and experimental fires and merge this with the Global Fire Emissions Database to quantify the global pyrogenic carbon production flux. We found that 256 (uncertainty range: 196–340) Tg of biomass carbon was converted annually into pyrogenic carbon between 1997 and 2016. Our central estimate equates to 12% of the annual carbon emitted globally by landscape fires, which indicates that their emissions are buffered by pyrogenic carbon production. We further estimate that cumulative pyrogenic carbon production is 60 Pg since 1750, or 33–40% of the global biomass carbon lost through land use change in this period. Our results demonstrate that pyrogenic carbon production by landscape fires could be a significant, but overlooked, sink for atmospheric CO_2.

We repeat from above our concerns about problems with LANDFIRE fire emissions as follows.

In Northern Idaho, Hyde et al. (2015) evaluated two LANDFIRE fuel loading raster options: (1) Fuels Characteristic Classification Systems (LANDFIRE-FCCS); and (2) Fuel Loading Model (LANDFIRE-FLM) vs. measured fuel loadings for a 20,000 ha mixed conifer study area. They found that the LANDFIRE-FCCS layer showed 200% higher duff loadings relative to measured loadings that led to 23% higher total mean consumption and emissions when modeled in FOFEM. The LANDFIRE-FLM layer showed lower loadings for total surface fuels relative to measured data, especially in the case of coarse woody debris that led to 51% lower mean total consumption and emissions when modeled in FOFEM. Additionally, LANDFIRE-FLM consumption was *59% lower relative to that on the measured plots, with 58% lower modeled emissions*. The authors concluded that these differences in fuel loadings led to significant differences in consumption and emissions depending upon the data and model chosen. The DEIS therefore needs to disclose how errors in fuel loading consumption were addressed in emissions determinations regarding wildfires and how these errors were corrected.

CONCLUSIONS AND NEED FOR GREATLY IMPROVED PREFERRED ALTERNATIVE

Based on the above analysis, deficiencies in the DEIS, and need for an improved or new alternative to better meet the BASI and planning rule requirements, I am requesting that the SFNF revise the DEIS to include the following actions.

- **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[6]) and related home fire-risk reduction work (Syphard et al. 2013, 2014). Community and fire-fighter safety actions should be directed at home protection and anthropogenic fire-ignitions along high-use roads (especially ingress/egress; see Balch et al. 2017). As noted above, research demonstrates that there is a very low (<1%) probability of thinned areas encountering a fire when fuels are lowest (Schoennagel et al. 2017). Therefore, it is imperative that the Forest Service strategically direct limited resources at protecting homes rather than extensive thinning in the backcountry that does nothing for home protection.

- **Reduce human-caused wildfire ignitions (see Balch et al. 2017) associated with road access**. The Forest Service needs to conduct project-specific transportation plans to determine the probability of human-caused fire ignitions in relation to road densities, road improvements, and increased human access along improved roads. These plans should address a broad scope of road-related impacts and choose an alternative based on minimal road access.
- **Protect high value conservation areas from logging/thinning/road improvements.** The DEIS 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 (closed canopy) forests within the project area will be maintained and restored to levels comparable to historic or documented reference conditions.
- **Disclose 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 DEIS primarily relies on fire-scar sampling to determine the dominant fire regime present yet does not disclose 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 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 (Parks et al. 2016, Margolis et al. 2017) increase fire severity. This uncertainty is most significant and must be analyzed to determine the need for and limitations of extensive fuels treatments based predominately on assumptions regarding frequent-fire regimes that may become increasingly unlikely in a rapidly changing climate. Additionally, variability in fire return

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

(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 DEIS needs to fully disclose its characterization of a low-severity fire regime, and "open" forest conditions (reference sites) with respect to heterogeneity 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 allow for sufficient shrub and small tree recruitment (see Baker 2017).

- **Substantially reduce livestock grazing in riparian areas and high value conservation areas.** Stepped up conservation and restoration need to be in the forest plan, including large no-grazing zones (exclosures), additional riparian and wet meadow/spring protections, road obliteration, invasive species removals, and beaver reintroductions.
- **More fully disclose and avoid impacts to at-risk species like the Mexican Spotted Owl (MSO).** There is no discussion of importance of mixed-severity wildfires in maintaining foraging habitat for spotted owls (Lee 2018, pdf enclosed). Instead, the DEIS incorrectly assumes, without site-specific data on owl occupancy or region-wide population trends, that wildfire (mostly high severity) degrades MSO habitat. 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 and the Forest Service needs to conduct population monitoring to assess MSO demographics and region-wide population trends.
- **Analyze and maintain connectivity especially for at risk, focal, and species of conservation concern.** The forest plan needs to properly analyze connectivity as noted herein including PVA, trigger points, and species/landscape specific measures that properly integrate coarse and fine-filter approaches under the BASI and connectivity requirements of the 2012 forest planning rule and the noted literature cited herein.
- **Reduce emissions from logging and roads.** A stated intent of the DEIS is to provide for resilience to climate change yet there is no requirement of an 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). Project-specific alternatives must be developed to minimize emissions with alternatives selected that produce the lowest emissions. Alternatives should be compared in CO_2 equivalents, including the social cost of carbon[7].

[7] See https://19january2017snapshot.epa.gov/climatechange/social-cost-carbon_.html

- **Provide a cost-benefits analysis of managing wildfires for ecosystem benefits by working with fire under safe conditions.** The DEIS must disclose project-related costs of thinning, prescribed fire, and road improvements in comparison to managing fire for ecosystem benefits as a viable alternative (e.g., refer to the Cohesive Wildland Fire Management Strategy for wildfire ecosystem benefits[8] 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 and the Forest Service is accountable for implementing those actions accordingly.
- **Thinning to create open canopy forests at the expense of closed canopy forests needs to be greatly reduced and more strategically (surgically) applied.** The over-reliance on thinning stems from accuracy problems noted in the LANDFIRE program, biased fire scar fire estimates, inappropriate extrapolations from the Forest Service research publication GTR-310, and a failure to recognize site-specific and landscape heterogeneity. Thus, thinning treatments need to be greatly scaled back and strategic in application (mostly nearest homes).
- **In limited cases where thinning occurs, forest canopies need to be more fully maintained for closed canopy species associates by**: (1) stops and gaps (explain for the general reader) in thinning to for increased site heterogeneity; (2) retention of much more basal area (as compared to site-specific reference sites) especially around tree cohorts to make them wind firm; (3) retention of old/mature trees on site (based on increment core analysis and not just diameter at breast height); (4) in cases where tree thinning is necessary within the drip line of large mature trees, girdle those trees and leave standing on site as biological legacies; (5) retain more shrubs, forbs, and native grasses by reducing the interval between successive prescribed fires to allow for understory recruitment; and (6) fell and tip large trees in stream-side areas to create in-stream structures rather than thin and remove those trees from the site.
- **"Surgically" applied thinning treatments should be limited to the most drastically altered forests,** most notably, pine plantations in the Jemez and spruce/fir clearcuts on the eastern side of the SFNF.
- **Restoration and conservation measures should be greatly increased to address the following needs not sufficiently met in the DEIS**: (1) beaver reintroduction in riparian areas; (2) large livestock exclosures especially in riparian areas, wet meadows, and aspen groves; (3) road closures and road obliterations to provide connectivity; (4) defensible space within a narrow buffer (~60 feet) around homes; (5) ingress/egress routes for community protection; (6) increases in invasive species removal and containment; and

[8] See https://www.forestsandrangelands.gov/strategy/

(7) identification and protection of site and landscape specific habitat for focal species, species of conservation concern, and at risk species.

- **Compartmentalize the SFNF into fire management units** to determine when to suppress fire for community safety vs. working with fire for ecosystem benefits.[9]
- **Conduct a minimum road access analysis** and decommission/obliterate more roads to reduce impacts to water quality, wildlife habitat and human-caused fire ignitions.

In closing, while I respect the ability of the Forest Service to apply BASI to forest planning decisions on the Santa Fe National Forest, I remain greatly concerned that the noted inadequacies in the DEIS have not met the BASI standard. Instead the preferred alternative will (1) fragment and degrade important wildlife habitat; (2) jeopardize at-risk species (MSO), focal species, and species of conservation concern; (3) degrade water quality (mainly from roads, livestock, tree thinning), impact mature forests and riparian areas (along with wildlife and cultural values); and (4) uses methodologies (e.g., LANDFIRE, fire scar sampling, GTR-310) inappropriate to the SFNF. There is a heavy reliance on fire-scar sampling without disclosure of biases and uncertainties and thinning in stands that may possess old growth characteristics by moving them increasingly into open canopy conditions that lack overstory and understory structures. The efficacy of Alternative 2 mechanical treatments is highly uncertain because of the likelihood that the region's fire regimes will increasingly shift to larger 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).

Additionally, and contrary to what is often claimed by the Forest Service, insect and disease outbreaks are not associated with increased fire intensity. Insect-fire studies, including analysis of outbreaks and fire intensity in the Rockies and elsewhere (Romme et al. 2006, Kauffman et al. 2008, Bond et al. 2009, Black et al. 2011, Six et al. 2014, Hart et al. 2015, Meigs et al. 2016, Talucci and Krawchuck 2019) have repeatedly shown that there is no coupling of increased fire intensity with insect outbreaks. Instead, 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 legacies that provide essential habitat for cavity nesting birds, denning mammals, and numerous other wildlife. Their role in forest ecosystems needs to be better disclosed and maintained.

While wildfire clearly can be devastating to human communities, it is not an ecological catastrophe as often claimed. The Forest Service needs to develop better supported consensus

[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

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).