To: Director, Ecosystem Management Coordination, US Forest Service
From: James Johnston, PhD
Re: Comments on Land Management Plan Direction for Old-Growth Forest Conditions across the National Forest System (via https://cara.fs2c.usda.gov/Public//CommentInput?Project=65356)

Thanks for the opportunity to provide comments about the Forest Service's proposal to revise direction for forest plans to provide augmented conservation of old-growth forest conditions. My comments are based on more than ten years of scientific research about the successional and disturbance dynamics that give rise to old-growth forest conditions. These comments are most relevant to conifer and hardwood forests of the 11 western states. My comments have three major themes:

First, the vast majority by area of old-growth forest conditions on national forest lands in the 11 western states are seasonally dry, fire prone forests.

Second, old growth trees in seasonally dry, fire prone stands are in dramatic decline.

Third, dry forest old growth cannot be conserved except by significant active management that relinks the characteristic ecological pattern-process feedbacks that maintain old-growth conditions.

Old growth conservation is primarily a matter of conserving dry forest old growth.

The vast majority of old-growth forest by area in the national forest systems are seasonally dry, fire prone forests ("dry forests", *sensu* Hagmann et al. 2021). These forests often receive significant precipitation during the winter and spring, but also experience significant aridity during the summer months. This distinctive climate pattern once entrained a distinctive disturbance regime in which winter and spring precipitation produced significant fuel and arid conditions in the summer dried fuel. Convection storms and human ignitions resulted in frequent fire for hundreds if not thousands of years before the establishment of the national forests and adoption of fire exclusion practices (North et al. 2022, Hessburg et al. 2005, Hessburg and Agee 2003).

Some of the language of the NOI gestures towards the successional and disturbance patterns that are characteristic of dry forests, for instance:

> The structure and composition of old-growth forests is highly place-based and can range from old, multi-layered temperate coniferous forests with high amounts of dead wood in the form of standing snags and coarse wood to old, single-storied pine forests or oak woodlands with open canopy structure and fire-maintained herb and litter dominated understories.

But the heart of the standards which would constrain agency action reads:

> a) Vegetation management in old-growth forest conditions must be for the purpose of proactive stewardship, to promote the composition, structure, pattern, or ecological processes necessary for the old-growth forest conditions to be resilient and adaptable to stressors and likely future environments. Proactive stewardship activities shall promote one or more of the following:
>
> i. amount, density and distribution of old trees, downed logs, and standing snags;
> ii. vertical and horizontal distribution of old-growth structures, including canopy structure;
> iii. patch size characteristics, percentage or proportion of forest interior, and connectivity;
> iv. types, frequencies, severities, patch sizes, extent, and spatial patterns of disturbances;
> v. return of appropriate fire disturbance regimes and conditions;
> vi. successional pathways and stand development;
> vii. connectivity and the ability of native species to move through the area and cross into adjacent areas;
> viii. ecological conditions for at-risk species associated with old-growth forest conditions;
> ix. the presence of key understory species or culturally significant species or values;
> x. species diversity, and presence and abundance of rare and unique habitat types associated with old-growth forest conditions; or
> xi. other key characteristics of ecological integrity.

The first requirement is not specific as to amount, density, and distribution of old trees, down logs, or snags which could easily be read simply to require a lot of trees and a lot of down logs or standing stands. But many dry forest old-growth stands that historically experienced frequent fire had few down logs or standing snags—frequent fire tends to quickly consume standing and down dead wood. Many of these stands were historically extremely low density stands and are not likely to have significant old-growth structure into the future except at very low densities (see North et al. 2022). The second requirements could be read to mandate specific canopy characteristics, including multiple canopy layers. But most resilient dry forest old growth has extremely heterogeneous canopy characteristics at fine scales, although often little in the way of multiple canopies at coarse scales. The third requirement speaks to patch size characteristics. Many historical dry forest stands had distinct clumpy structures at fine scales, but little in the way of coarse grain patch dynamics (Johnston et al. 2021, Churchill et al. 2013). Dry forest old growth is not best conceptualized or managed in terms of patch dynamics in the same way as moist and productive old growth in which succession can be reset by disturbance across coarse patches (Johnston et al. 2021).

Old trees in dry forests are experiencing significant declines

Historically, dry old forest was distributed across tens of millions of acres of national forest land. Analyses of historical records suggests that the vast majority of many national forest units were in a dry forest old-growth condition consisting of low density stands dominated by widely spaced, fire- and drought-resistant older trees (see for instance Stephens et al. 2018, Hagmann et al. 2017, Clyatt et al. 2016, Stephens et al. 2015, Dolanc et al, 2014, Hagmann et al. 2014, Hagmann et al. 2013). There is significant evidence that old trees remaining in these stands after more than 120 years of active fire suppression are experiencing significant mortality (see for instance Anderegg et al. 2022 and Fettig et al. 2019).

In my long-term study areas on the Malheur National Forest, a typical interior west national forest dominated by dry forests, I have observed an almost 30% decline in trees >150 years old over the last ten years (Figure 1).

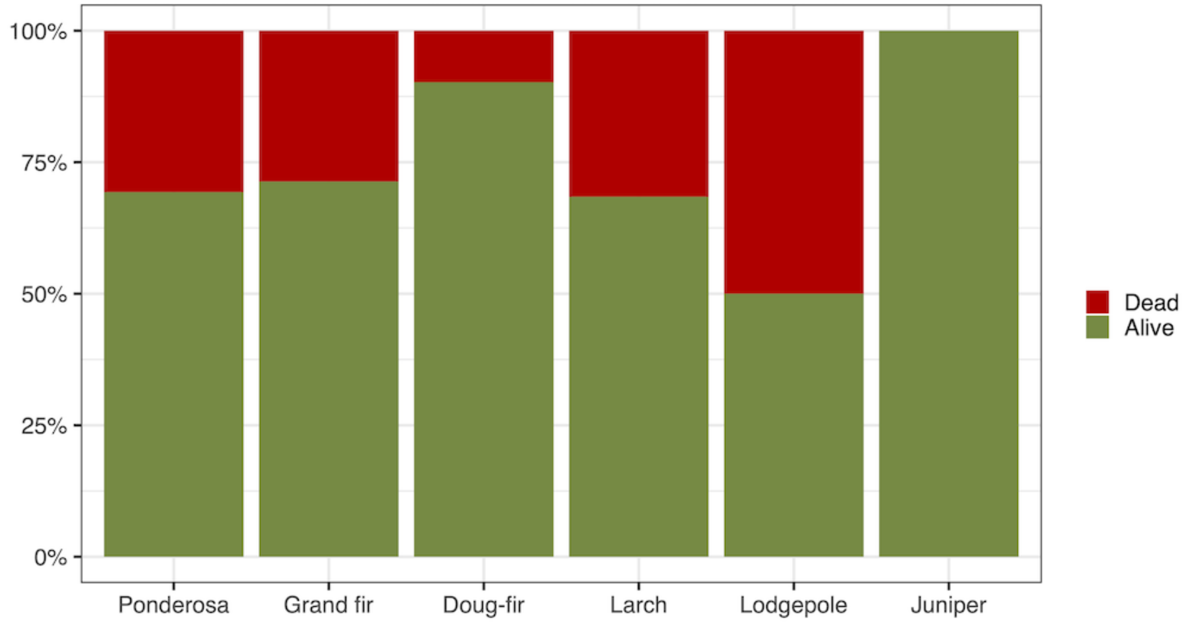

Figure 1. Mortality of approximate 1,000 trees >150 years of age on the Malheur National Forest over the last ten years. Mortality of all trees by species over ten years = 29.3%.

Dry forest old growth cannot be conserved except by significant active management

Active management that restores forest resiliency at stand and landscape scales is critical to conservation of old trees. Increases in stand basal area and forest density have reduced drought resistance of old trees (Voelker et al. 2019). Old trees are at elevated risk of mortality when young trees compete for light and water (Bradford and Bell 2017, Millar and Stephenson 2015, Fettig et al. 2007, Kolb et al. 2007, Waring and Law 2001, Kolb et al. 1998). Competition with shade tolerant fir is an important influence on mortality of dry forest old growth species like larch and ponderosa pine because true fir species use more water (Johnston et al. 2019, Gersonde and O'Hara 2005).

Restoring historical competition dynamics characterized by low basal area, low stand density, and a relatively higher proportion of shade intolerant species has been shown by a variety of studies to increase the resistance of stands to drought, insects, and fire disturbance effects associated with a warming climate (e.g., Vernon et al. 2023, Tepley and Hood 2020, Vernon et al. 2018, Sohn et al. 2016, Larsson et al. 1983, Mitchell et al. 1983). Tree vigor has been shown to be an important predictor of mortality (Keen et al. 2020, Cailleret et al. 2017, Dobbertin 2005) and fuel treatments have been shown to improve tree growth (Vernon et al. 2023, Thomas and Waring 2015), increase drought resistance (Vernon et al. 2018), and reduce susceptibility to bark beetle outbreaks (Hood et al. 2016, Zausen et al. 2005). Other tree physiological characteristics, such as resin production, are important chemical defenses against bark beetles (Ferrenberg 2014) and the mobilization of non-structural carbohydrates (NSC) may facilitate growth during periods of stress and recovery following disturbance and seasonal change (Vernon et al. 2023, Tixier et al. 2019, Iwasa and Kubo 1997).

My research on the Malheur National Forest demonstrates that trees in thinned stands exhibit greater radial growth and less non-structural carbohydrates in wood fiber (indicating that those elements have been mobilized to produce defensive compounds and leaf, bole, and root mass) (Vernon et al. 2023, Figure 2).

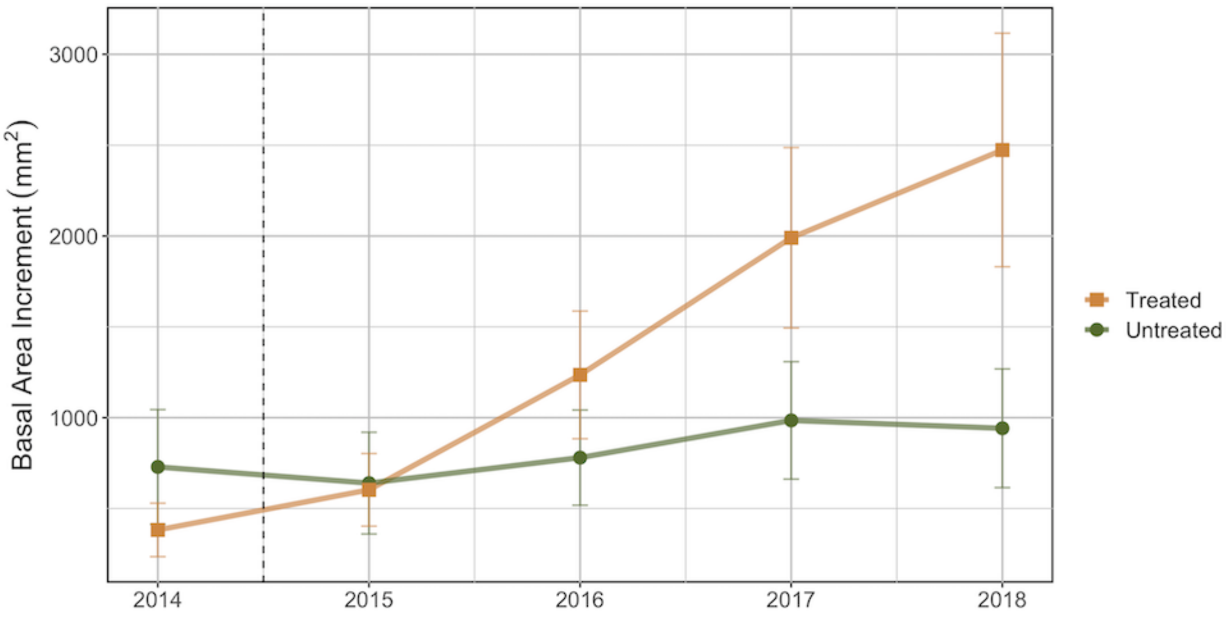

Figure 2. Average radial growth of trees over time in thinned and unthinned stands in the Marshall Devine planning area. Thinning occurred between the first and second year of measured growth (dotted line).

The goal of forest restoration is not to engineer a particular point-in-time forest condition, but to facilitate a range of desirable future forest responses to climate and disturbance processes. Drought, fire, insect attack and other perturbations are inevitable. Restoration treatments should be designed to adapt stands so that stands and landscapes will interact with these processes in such a way as to maintain key forest structures and continue to provide desired wildlife habitat, water quality, recreation, and other human uses. Several principles of forest restoration presented in a variety of scientific syntheses that describe forest restoration activities in seasonally dry forests, including Hessburg et al. (2016), Stine et al. (2014), Agee and Skinner (2005), Brown et al. (2004), and especially Franklin and Johnson (2012) and Franklin et al. (2013) may inform the mature and old growth amendment, including:

1. Retain all older trees, generally defined as trees that established prior to extensive Euro-American interventions on the landscape beginning in the mid to late 1800s.

2. Improve the survivability of older trees by removing ladder fuels and reducing competition around older trees.
3. Thin forests to reduce forest density and shift composition from late seral shade tolerant species to early seral shade intolerant species.
4. Reduce surface fuels by reintroducing fire to stands following treatment.
5. Increase forest diversity at both the stand and landscape scales by varying treatment intensity, creating openings, and leaving untreated areas.
6. To the extent possible, integrate upland forest restoration treatments with management of invasive species, wildlife habitat, roads, stream crossings, and range developments.
7. To the extent possible, take advantage of opportunities to conduct restoration activities in special habitats like hardwood stands, riparian areas, and meadows.

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