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Comments: Comments on the RFI are included in the attached PDF.

The Request for Information (RFI) correctly describes a science-based conclusion that must govern any definition that the agencies may adopt: "Today, most scientists agree that old-growth forests differ widely in character with age, geographic location, climate, site productivity, and characteristic disturbance regime." The variability in forest ecosystems having 'old forest' characteristics in the Pacific Northwest is well-portrayed in Reilly & Spies (2015), documenting the occurrence of old trees and late-seral structural characteristics in numerous forest communities, which are variously composed of dominant tree and shrub species, at different elevations and different geographic locations. Any approach to identifying the composition, structure, and processes provided by these differing communities must be crafted so that it will encompass the seral stages in local ecosystem types across this range of variation, including 'mature' and 'old growth' stages, as well as 'complex early-successional' stages. The approach must also incorporate ecological understanding about the effects of climate change, particularly increased drought and fire; how will those ecosystems respond in future climates, including how management actions pursuant to the definition will affect fuels loading and subsequent fire (Safford et al. 2022)?

For the Forest Service, this requirement is already established in the 2012 Planning Rule (36 CFR [sect]219), which directs that management sustain the ecological integrity of forest ecosystems and their capability to provide ecological services for America's citizens. The criteria that define 'mature' and 'old-growth' are fundamentally the same criteria that the 2012 Planning Rule identifies for maintaining sustainability. The characteristics of mature and old-growth forests in any of the many ecosystem types in National Forest landscapes must be defined in terms of a framework that achieves those criteria in different regional ecosystems. As the RFI indicates, those characteristics will vary according to regionally dominant tree species, elevation, soil conditions, hydrology, and other ecological conditions, variables that affect management outcomes (and which must be monitored), rather than parameters that can be specified by managers.

The 2012 Planning Rule represents a substantially advanced understanding of ecosystem processes in federal landscapes. The agencies must develop and implement an essential focus on the ecological dynamics in forested landscapes, rather than focusing management on separate stands within those landscapes (Hessburg et al. 2019, 2021, 2022; Gaines et al. 2022). For example, the advanced understanding of ecosystem dynamics reflected in the quoted RFI excerpt above mandates a management focus that combines the dynamic processes across multiple stands in these landscapes through time. Individual stands may burn, losing mature and/or old-growth characteristics, but other stands in the landscapes may enter later successional stages, and the management focus must be flexible enough to include those shifting dynamics into planning for desired outcomes, with stand conditions integrated across entire landscapes.

Because ecological conditions vary widely across federal landscapes, it appears to be infeasible to craft a simplistic, overarching 'definition' for mature and old-growth conditions that will apply everywhere across those landscapes. The kinds of issues that arise when a specific definition of 'old-growth' is identified are well-illustrated by the Northwest Forest Plan (NWFP). The 1994 plan identified 'old-growth forests' with a definition based on the 'moist' coastal forests in western Washington, Oregon, and northwestern California. That definition is wholly inappropriate for the 'dry' inland forests in much of the Pacific Northwest, and the definition in the adopted 1994 NWFP definition WILL NOT lead to sustainable ecosystems in much of the region, where mature and old-growth forests have a different relationship with fire (Spies et al. 2018, USDA Forest Service 2020). Similar consideration apply for the 'Eastside Screens' (Johnston et al. 2021, Hessburg et al. 2022).

Forest Service and BLM lands cover such a vast range of conditions that a simplistic definition will only ever

apply in subsets of those lands for short intervals, and the subsets to which it applies will change through time. The most pressing issue for the agencies will likely be incorporating the effects of increased aridity and fire on the perceptions of the land's managers. Forested ecosystems are intrinsically 'complex adaptive systems' (Levin 2005; Filotas et al. 2014; Messier et al. 2015, 2019), and must be expected to change through time as the environmental gradients and stressors to which they're exposed are altered. Future conditions in federal landscapes will more and more frequently fail to resemble those of the (even recent) past. Projected future conditions resulting from climate-change are intrinsically uncertain, but regularly include development of 'novel (or no-analog) ecosystems' unlike today's, and future management will likely need realignment to altered conditions to maintain desired ecosystem services (Millar & Stephenson 2015). A simplistic definition for 'mature and old-growth' conditions will likely be inapplicable to actual conditions on the ground in many places, most of the time.

Numerous forest ecologists have addressed strategies to maintain older-age attributes in western conifer-dominated landscapes. Among the better-known strategies is an emphasis on the managed retention of 'legacies' within landscapes through time (Franklin et al. 2007, Franklin & Johnson 2012, Johnston et al. 2021). What constitutes legacies is greatly dependent on the predominant dynamics in each landscape, but in general legacies are elements of older ecosystem stages that are retained within younger stands. The most frequently identified legacy type is older trees, snags, and down logs in managed forest stands, but such elements are relevant primarily for moist forests. However, retaining old trees is also a retention element important in dry forests (Johnston et al. 2021). Old trees are often large trees, but retaining old trees is a superior strategy than designating retention based primarily on tree diameter. The point is to maintain legacies that achieve the objectives of the ecosystem management framework developed for the landscape in which a project occurs.

In the past decade an additional factor relevant for maintaining conifer forest resilience to increasing drought and fire has emerged, the reestablishment and retention of the variable stand structures that result from the frequent interaction of forest stands with fire. Forest stands that have not been managed with a full-suppression fire policy in recent decades typically demonstrate an 'individuals-clumps-openings' (ICO) stand structure (Larson & Churchill 2012). This structure has been identified as a characteristic structure in pre-settlement conifer forests in the western US, and as more resilient than current management regimes are to the effects of increased fire in frequent-fire western landscapes (Johnston et al. 2021). Appropriate variations in the ICO structure in varied frequent-fire forested landscapes are likely to be desirable elements addressed by the old growth strategy developed pursuant to E.O. 14072.

Management in western US forests, especially in California and southwestern Oregon, includes additional considerations resulting from a Mediterranean-type climate, which largely lacks summer precipitation. Mediterranean-type landscapes worldwide, including those in the western US, are well-populated with shrublands. Moreover, federal lands in western landscapes, especially in California, host a wide diversity of regionally adapted hardwood tree species that make up a significant part of federal landscapes. California's hardwoods, particularly its oak (*Quercus*) species, are well-adapted to drought and fire (Schriver et al. 2018, Hahm et al. 2019, Skelton et al 2021), and future California landscapes are projected by many biogeographers and climate scientists to host more hardwood- and shrubland-dominated landscapes than exist today (Lenihan et al. 2008, Safford et al. 2021). Maintaining 'mature' hardwood woodlands and mixed conifer hardwood forests is arguably a strategy for assuring delivery of ecological services from future landscapes. However, dynamics in hardwood forests and shrublands may be more tenuous under climate change than those in higher-elevation landscapes (Jacobsen & Pratt 2018), and are less well studied than are those of conifer forests. Any policy crafted by the agencies pursuant to E.O. 14072 to address mature and old-growth management in conifer-dominated landscape must also consider these alternative regional landscapes, where current management directions seldom consider maintaining older age classes.

The most important element that must be incorporated into a newly developed strategy for managing and

maintaining mature and old-growth forests is an understanding that the strategies in agency management plans of the mid- and late-20th Century were ill-advised and based on insufficient understanding of western ecosystems, emphasizing commodity production at the expense of ecosystem integrity. In response to legitimate public concerns at the close of the 20th Century, federal agencies developed strategic approaches for protecting ecological values associated with older-forest conditions, but owing to incomplete understanding of those ecosystems those strategies also were ill-prepared to achieve their objectives. An enormous increase in scientific understanding has occurred during the past 20 years, which can lead to management strategies that are informed by increased ecosystem understanding, while anticipating the effects of climate change-related stressors that were not widely appreciated in the 20th Century.

To summarize, short answers are incorporated below to the five bullet-points identified in the RFI.

"(1) What criteria are needed for a universal definition framework that motivates mature and old-growth forest conservation and can be used for planning and adaptive management?"

The criteria identified in the 2012 Planning Rule (36 CFR [sect]219) for maintaining sustainable ecological processes and services on National Forest landscapes explicitly identify elements that will result in the protection and maintenance of mature and old-growth characteristics on Forest Service and BLM lands. Maintaining ecological processes is the essential basis for sustainably managing all federally owned landscapes.

"(2) What are the overarching old-growth and mature forest characteristics that belong in a definition framework?"

Characteristics that maintain mature and old-growth landscape elements differ according to a wide variety of local conditions, and must be defined based on the ecosystem dynamics operating in the landscapes of interest (i.e., 'moist' forests require a different set of characteristics than do 'dry' forests). Generally, mature and old-growth forests will include old trees and other elements of advanced successional processes, but specific characteristics can only be defined based on local and regional ecological processes, climate, soils, and hydrological conditions. In most landscapes large trees will be essential characteristics of mature and old-growth forests, but tree age is generally more important than tree size. Carryover legacies of longer-term forest successional processes within managed landscapes are an essential characteristic of most old-growth forest ecosystems. To address the consequences of climate change, compositional and structural stand characteristics must be based on local and regional fire and fuels dynamics.

"(3) How can a definition reflect changes based on disturbance and variation in forest type/composition, climate, site productivity and geographic region?"

An ecologically sustainable landscape is a product of the interactions of ecosystem elements, including the biotic composition, structure, and processes with the soils and hydrological processes in the landscape. Mature and old-growth characteristics are part of the successional processes that occur in those landscapes, but the specific locations and successional stages of various stands in those landscapes will inevitably vary or 'shift' through time. The appropriate definition must incorporate a landscape-oriented focus that includes mature and old-growth elements in those landscapes, but typically the landscapes will exhibit 'non-equilibrium dynamics', such that each successional stage will vary in both total area and in physical location through time, based on disturbances and variations in forest type/composition, climate, and site productivity within each geographic region.

"(4) How can a definition be durable but also accommodate and reflect changes in climate and forest composition?"

A definition for 'mature' and 'old-growth' based on recognizing and implementing natural ecological/successional processes, as defined by regionally based ecosystem dynamics, is a durable management approach that can readily accommodate the effects of climate change (including drought and increased fire) on landscape

composition, structure, and processes. Such a definition recognizes the importance of understanding variations in ecosystem dynamics across various regions within the US and how climate change affects them; that definition also recognizes the critical importance of monitoring to the definition's implementation. The definition requires sufficient flexibility in its ecological framework to accommodate adaptive realignment in ecosystem composition, structure, and processes when climate change forces landscapes outside prior domains of stability. The definition must fundamentally be based on maintaining ecological processes, and not on specific stand conditions.

"(5) What, if any, forest characteristics should a definition exclude?"

The definition should avoid prescribing specific stand or landscape compositions or stand structures, tree sizes, and similar details. These conditions will vary throughout covered federal landscapes, and no specific set of conditions will address mature and old-growth conditions everywhere. Such details can only be identified regionally by managers who understand the ecological dynamics in the regions they manage, and how those dynamics affect the services those landscapes provide.

Thank you for this opportunity to comment on the scientific basis for managing or public lands.

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