CHAD ROBERTS, PH.D.
SENIOR ECOLOGIST (ESA) (*EMERITUS*)
SENIOR PROFESSIONAL WETLAND SCIENTIST (SWS) (*EMERITUS*)

31 July 2022

Christopher French, Deputy Chief, USDA Forest Service
Tracy Stone-Manning, Director, USDI Bureau of Land Management
Submitted electronically: *https://cara.fs2c.usda.gov/Public/CommentInput?project=NP-3239*

Subject: **RFI on Federal Old-growth and Mature Forests, E.O. 14072**

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 §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 §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.

Sincerely,

Chad Roberts

Chad Roberts, PhD
Conservation Ecologist

References:

Gaines WL, Hessburg PF, Aplet GH, Henson P, Prichard SJ, Churchill DJ, Jones GM, Isaak DJ, Vynne C. 2022. Climate change and forest management on federal lands in the Pacific Northwest, USA: Managing for dynamic landscapes. *Forest Ecology and Management* 504:119794. https://doi.org/10.1016/j.foreco.2021.119794.

Hahm WJ, Rempe DM, Dralle DN, Dawson TE, Lovill SM, Bryk AB, Bish DL, Schieber J, Dietrich WE. 2019. Lithologically controlled subsurface critical zone thickness and water storage capacity determine regional plant community composition. *Water Resources Research* 55:3028-3055. https://doi.org/10.1029/2018WR023760.

Hessburg PF, Charnley S, Gray AN, Spies TA, Peterson DW, Flitcroft RL, Wendel KL, Halofsky JE, White EM, Marshall J. 2022. Climate and wildfire adaptation of inland Northwest US forests. *Frontiers in Ecology and the Environment* 20(1):40-48. https://doi.org/10.1002/fee.2408

Hessburg PF, Miller CL, Parks SA, Povak NA, Taylor AH, Higuera PE, Prichard SJ, North MP, Collins BM, Hurteau MD, Larson AJ, Allen CD, Stephens SL, Rivera-Huerta H, Stevens-Rumann CS, Daniels LD, Gedalof Z, Gray RW, Kane VR, Churchill DJ, Hagmann RK, Spies TA, Cansler CA, Belote RT, Veblen TT, Battaglia MA, Hoffman C, Skinner CN, Safford HD, Salter RB. 2019. Climate, environment, and disturbance history govern resilience of western North American forests. *Frontiers in. Ecology and Evolution* 7:239. https://doi.org/10.3389/fevo.2019.00239.

Hessburg PF, Prichard SJ, Hagmann RK, Povak NA, Lake FK. 2021. Wildfire and climate change adaptation of western North American forests: a case for intentional management. *Ecological Applications* 31(8):e02432. https://doi.org/10.1002/eap.2432.

Filotas E, Parrott L, Burton PJ, Chazdon RL, Coates KD, Coll L, Haeussler S, Martin K, Nocentini S, Puettmann KJ, Putz FE, Simard SW, Messier C. 2014. Viewing forests through the lens of complex systems science. *Ecosphere* 5(1):1. https://doi.org/10.1890/ES13-00182.1.

Franklin JF, Johnson KN. 2012. A restoration framework for federal forests in the Pacific Northwest. *Journal of Forestry* 110(8):429-439. https://doi.org/10.5849/jof.10-006.

Franklin JF, Mitchell RJ, Palik BJ. 2007. *Natural disturbance and stand development principles for ecological forestry*. Gen Tech Rep GTR-NRS-19. USDA Forest Service, Northern Research Station, Newtown Square, PA. 44 pages. https://doi.org/10.2737/NRS-GTR-19.

Jacobsen AL, Pratt RB. 2018. Extensive drought-associated plant mortality as an agent of type-conversion in chaparral shrublands. *New Phytologist* 219:498-504. https://doi.org/10.1111/nph.15186.

Johnston JD, Greenler SM, Reilly MJ, Webb MR, Merschel AG, K. Johnson NK, Franklin JF. 2021. Conservation of dry forest old growth in eastern Oregon. *Journal of Forestry* 119(6):647-659. https://doi.org/10.1093/jofore/fvab016.

Larson AJ, Churchill D. 2012. Tree spatial patterns in fire-frequent forests of western North America, including mechanisms of pattern formation and implications for designing fuel reduction and restoration treatments. *Forest Ecology and Management* 267:74-92. https://doi.org/10.1016/j.foreco.2011.11.038.

Lenihan JM, Bachelet D, Neilson RP, Drapek R. 2008. Response of vegetation distribution, ecosystem productivity, and fire to climate change scenarios for California. *Climatic Change* 87:215-230. https://doi.org/10.1007/s10584-007-9362-0.

Levin SA. 2005. Self-organization and the emergence of complexity in ecological systems. *BioScience* 55(12):1075-1079. https://doi.org/10.1641/0006-3568(2005)055[1075:sateoc]2.0.co;2.

Messier C, Bauhus J, Doyon F, Maure F, Sousa-Silva R, Nolet P, Mina M, Aquilué N, 2, Fortin M-J, Puettmann K. 2019. The functional complex network approach to foster forest resilience to global changes. *Forest Ecosystems* 6:21. https://doi.org/10.1186/s40663-019-0166-2.

Messier C, Puettmann K, Chazdon R, Andersson KP, Angers VA, Brotons L, Filotas E, Tittler R, Parrott L, Levin SA. 2015. From management to stewardship: Viewing forests as complex adaptive systems in an uncertain world. *Conservation Letters* 8(5):368-377. https://doi.org/10.1111/conl.12156.

Millar CI, Stephenson NL. 2015. Temperate forest health in an era of emerging megadisturbance. *Science* 349:823-836. https://doi.org/10.1126/science.aaa9933.

Reilly MJ, Spies TA. 2015. Regional variation in stand structure and development in forests of Oregon, Washington, and inland Northern California. *Ecosphere* 6(10):192. https://doi.org/10.1890/ES14-00469.1.

Safford HD, Butz RJ, Bohlman GN, Coppoletta M, Estes BL, Gross SE, Merriam KE, Meyer MD, Molinari NA, Wuenschel A. 2021. Fire ecology of the North American Mediterranean-climate zone. Chapter 9 (pp 337-392) in CH Greenberg, B Collins (eds.), *Fire Ecology and Management: Past, Present, and Future of US Forested Ecosystems* (Managing Forest Ecosystems 39). https://doi.org/10.1007/978-3-030-73267-7_9.

Safford HD, Paulson AK, Steel ZL, Young DJN, Wayman RB. 2022. The 2020 California fire season: A year like no other, a return to the past or a harbinger of the future? *Global Ecology and Biogeography* (in press). https://doi.org/10.1111/geb.13498.

Schriver M, Sherriff RL, Varner JM, Quinn-Davidson L, Valachovic Y. 2018. Age and stand structure of oak woodlands along a gradient of conifer encroachment in northwestern California. *Ecosphere* 9:e02446. https://doi.org/10.1002/ecs2.2446.

Skelton RP, Anderegg LDL, Diaz J, Kling MM, Papper P, a, Lamarque LJ, Delzon S, Dawson TE, Ackerly DD. 2021. Evolutionary relationships between drought-related traits and climate shape large hydraulic safety margins in western North American oaks. *Proceedings of the National Academy of Sciences USA* 118:e2008987118. https://doi.org/10.1073/pnas.2008987118.

Spies TA, Stine PA, Gravenmier R, Long JW, Reilly MJ (tech. coords.). 2018. *Synthesis of science to inform land management within the Northwest Forest Plan area*. Gen Tech Rep PNW-GTR-966. USDA Forest Service, Pacific Northwest Research Station, Portland, OR. 1020 pages. 3 volumes. https://www.fs.fed.us/outernet/pnw/publications/gtr966/index.shtml.

USDA Forest Service. 2020. *Bioregional Assessment of Northwest Forests*. https://www.fs.usda.gov/detailfull/r6/landmanagement/?cid=fseprd677501.