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Comments: 1. Which 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?

1. Ecological function. Mature and old-growth forests may best be defined by their ecological functions (e.g., as wildlife habitats, refugia from disturbances, genetic and species conservation, organic matter for nutrient cycling, soil health, hydrologic integrity, carbon capture and storage, etc.)
2. Native biological diversity. Maintains interconnected and interdependent biological diversity of flora and fauna native to physiographic region within short- and/or long-term time scales (from 10,000 years ago to present to evolving climate conditions), from microscopic organisms and fungi within soil to dominant overstory trees.
3. Biological processes. Ecosystem conserves functioning biological processes (e.g., nutrient cycling, recycling, repair, and regeneration).
4. Structural diversity; forests exhibit structural diversity above ground, on ground, and below ground.
5. Age of dominant tree species (be careful of minimums).
6. Size of dominant tree species (be careful of minimums).
7. Decadence; generally in the form of broken-top live trees, standing dead trees (snags), decomposing down trees on land and in streams.

1. What are the overarching old-growth and mature forest characteristics that belong in a definition framework?

1. Structural diversity: from microscopic to large down wood on ground and in streams, to multi-layered canopy with standing snags and large trees with character.
2. Functional diversity.
3. Biological diversity with emphasis on native late-successional flora and fauna species diversity.
4. Age diversity of trees, from sapling to centuries-old (less so in mature stands).
5. Decadence. Entire life cycle of forest present; from birth, growth, decadence, death, to regeneration (again, less so in mature stands).

1. How can a definition reflect changes based on disturbance and variation in forest type/composition, climate, site productivity, and geographic region?

1. Focus on key structural attributes with general overarching ecological functions. For example, in mature and old-growth forests of the Pacific Northwest (PNW) and elsewhere, large standing snags with cavities and large down wood provide similar range of ecological functions for various diverse species across forest types and physiographic regions.
2. Understand that natural disturbances are key ecosystem processes which continually shape dynamic ecological communities and biological diversity. View forests and natural disturbances as an ever-evolving continuum.
3. Strive for flexibility, humility, and adaptability in any definition. Strive to see the forest as a whole, instead of separate acre by acre stands.

1. How can a definition be durable but also accommodate and reflect changes in climate and forest composition?

1. Again, focus on structural attributes and ecological functions that provide the foundations of biological diversity. While forests are naturally dynamic ecological communities, many structural attributes are similar.
2. Allow for flexibility and adaptability.

1. What, if any, forest characteristics should a definition exclude?

1. Minimum age requirements. If a forest stand has the structural attributes and performs the defined and important ecological functions of a mature and old-growth forest, then it should be recognized and conserved as such. For example, a 50 to 80-year-old forest naturally regenerated from a fire with intact biological legacies may still fulfill many ecological functions of a much older forest. Furthermore, the age of a forest is often mistyped and therefore can be an unreliable measurement to use (see below).
2. Minimum basal area or stand density. Great variation exists, even among similar forest types on different slope aspects. Again, strive to see the forest as a whole, instead of discreet acre by acre stands.

Comments specific to the forests of the Pacific Northwest:

The temperate coniferous rainforests of the Pacific Northwest have been analyzed for decades and there exists a wealth of supporting research regarding how to define these mature and old-growth forests. Generally accepted definitions are age-based with young forests defined as 40-80 years old, mature forests as 80-195 years old, and old-growth forests as > 195 years old.[1] However, one must be very careful about assigning ages to different forest stands, as the boundaries between these forests are often blurred or overlap. For example, many stands burned by fire > 120 years ago during early Euro-American settlement, naturally regenerated and have groves of remnant centuries-old trees, as well as large structural elements or biological legacies held over from the fire. Other forest stands were selectively logged 60-80 years ago and seed trees, large 'wolfy' trees, snags, large down trees, etc., were left behind, and these forest stands now also function as old-growth forests. The exception to this of course are forest stands totally clearcut, razed, burned, and planted as monoculture tree farms from approximately 1970 to 2000. These 'managed' stands typically lack the biological legacies present in 'unmanaged' forests.

As you may be aware, forests of the Southwest and Intermountain West are being radically altered by severe drought, insect outbreaks, and wildfire, all surging because of climate change. The forests here in western Oregon so far, thankfully, are holding on. The BLM currently manages more than a million acres of mature and old-growth forests in western Oregon (>600,000 acres of old-growth), with the majority of these older forests found within the Grants Pass, Ashland, Swiftwater, South River, Umpqua, and Myrtlewood Resource Areas of the Medford, Roseburg, and Coos Bay Districts respectively. These are the last of the magnificent lower-elevation western Cascade and Coast Range forests in western Oregon and the entire western coast of the contiguous U.S., and as such they are beyond value. These magnificent forests, wetted by coastal breezes, currently are intact refuges of threatened native biological diversity, storehouses of vital genetic diversity, fountainheads of clean air and water, living treasures of sublime aesthetic beauty, and powerhouses capable of capturing and storing more atmospheric carbon for longer periods of time than any other terrestrial ecosystem on Earth. These forests are truly the marvelous living bulwark keeping our lands livable and our waters replenished. Yet regrettably, these forests managed by the BLM are almost completely overlooked and vastly underappreciated for their spectacular biological diversity and vital ecological functions, by both the public and the agency charged with their welfare.

Regarding the inventory of these mature and old-growth public forests on Bureau of Land Management (BLM) administered lands:

As a long-term BLM employee who has for many years wandered through these magnificent forests and assessed northern spotted owl and marbled murrelet forest habitats throughout the Roseburg District (western Oregon), my experience is that the BLM's current Forest Operations Inventory (FOI) database is notoriously unreliable at capturing all of our mature and old-growth forest stands and it cannot be relied upon for this inventory process. In fact, a review of FOI-aged forest stands, which I took part in during 2014, revealed that fully 59 percent of FOI units (77 percent of acreage) aged between 90-119 years were determined to contain "all or a majority of" high-quality spotted owl habitat characterized as having large diameter trees, high amounts of

canopy cover, and decadence components such as broken-topped live trees, mistletoe, cavities, large snags, and fallen trees.[2] That is, they were determined to be old-growth forests, including 72 percent of stands aged between 90-99 years old.

Fortunately, however, this unreliability of the FOI data set only goes one way, mistakenly assigning younger ages to older stands, but not older ages to younger stands (i.e., stands aged > 80-200 years are indeed mature and old-growth forests). This makes the necessary analysis more doable. The focus of this analysis should be on forest stands aged by the FOI data set as between 60-79 years old, with forest stands aged older than that assumed to be mature and old-growth forests (to accurately assess old growth forests from mature forests a much more thorough review of stands aged between 80-195 years old would be required). LiDAR should be utilized to filter out obvious homogenous younger "managed" stands, however this remote-sensing tool is not effective at capturing many important mature and old-growth forest attributes including broken-topped live trees, large limb structures, cavities, etc. Therefore, field reviews need to be targeted toward heterogenous stands within this age set in order to accurately assess and inventory these public forests as required by EO 14072. Please feel free to contact me to discuss this further.

FOOTNOTES:

[1] The Structure of Young, Mature, and Old-Growth Douglas-fir Forests in Oregon and Washington; Spies, Thomas A., Franklin, Jerry F., 1991.

[2] Recovery Action 32 (RA32) Review of 90-119 year old stands in the Swiftwater (SW) Resource Area, Gayner, E., 2014.