Comments by Dr. Neil Pederson, Senior Ecologist at the Harvard Forest, on Old-Growth Forests on USFS Lands

I am entirely thrilled to see real action being taken to identify and conserve old growth forests across the United States. I have been studying old-growth forests as a scientist since the early 1990s. There was a great revival in the eastern United States among citizen scientists, professors, and scientists in the rediscovery, study, and documentation of old-growth forests. It coincided with my Master's Degree work in what is now the Congaree National Park. Home to towering Pines, Oaks, and a plethora of other tree species and raucous and species fauna, including Timber Rattlesnakes, Cottonmouths, Kingsnakes, Sturgeon, Barred Owls and their family chatter, and the great Pileated Woodpeckers, I fell in love with the oldest forests in the landscape and made it a centerpiece of my research wherever I went. Not heavily supported by the federal government, the movement faded as people moved on to other jobs, aged, or, in a few sad cases, passed from this Earth.

President Biden's Executive Order on "Strengthening the Nation's Forests, Communities, and Local Economies" gives me great hope that these homes to a rare and sacred stage of ecological life will be allowed to flourish and thrive with continued environmental change without fear of being lost to the axe. Protecting our remaining mature and old-growth forests and trees from logging and development on federal public lands represents one of the simplest and most cost-effective climate policies the U.S. can deploy. Literally nothing needs to be done on-the-ground and no money spent (except on the effort to map them), we simply need to restrain ourselves from logging, that is, the cutting and removing of mature and old forests/trees, from these areas.

In an essay, I will address the main questions posed on the Request for Information (RFI) on Federal Old-growth and Mature Forests web page, specifically

- 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?

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

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

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

- What, if any, forest characteristics should a definition exclude?

I believe that the primary criteria needed for a universal definition framework that motivates mature and old-growth forest conservation for planning and adaptive management is age structure of the forest and the disturbance history that can be subsequently derived from that structure. This is best accomplished using the tree-ring record. I believe the common characteristic or criteria a universal definition framework across the diversity of forests across the United States circles around the history of each forest and land-use that can be inferred from the trees. Understanding if it was heavily cut under a European colonist culture is key. Millennial-length paleoecology records all show that when folks from the European colonist culture arrived and became a larger population, land clearing and heavy forest cutting triggered a significant disruption in the ecology of forests that is unprecedented over the prior 10,000 years. That signal of the disruption is the spike of Ambrosia pollen. There are some records that show some fluctuations back in time, but none compare with the pull amount and sudden rise once the European colonist culture took control of the landscape. That was a pivotal moment in the forests landscapes in what is today called the United States.

I cannot speak to what old-growth forest is to the indigenous people who lived in and with the landscape prior to European colonization. I believe it is imperative to listen to and work with indigenous leaders on what is old-growth forest going forward and ways to manage these forests that are congruent with times before European colonization. It seems to me that many people would agree that the forests managed by indigenous forests would universally agreed upon as old-growth forest.

My personal view is that an overarching old-growth and mature definition framework for all forest types in the US can be derived using a few characteristics. Perhaps characteristics is not the correct term? To me, the fundamental elements are Time, ecological processes, and land-use history. I acknowledge that this viewpoint was essentially put forth by Dr. Charlie Cogbill a few decades ago and very strongly influences my thinking.

See, I used to think tree age and the type and amount of downed wood could be used as characteristics to define old and mature forests. I have now recently been in forests dominated by broadleaf hardwood species, like Maple-Beech-Birch, where the amount of deadwood is low. Most of the deadwood in those forests were recently deposited onto the forest floor. Large pieces of wood with advanced decay are very infrequent. And yet, when we explore and study the age structure and history of these forests, it appears that they were never cut. To me, this is an old-growth forest.

This approach and framework, to me, will be especially useful in ecosystems dominated by short-lived species such as Aspen. You can have mature or old-growth forests in these forest types even when stem ages are less than 100 years.

Accordingly, age has become less important to me than land-use history. The development of forests over time is a process composed by disturbance, climate, and environmental change. To me, an old-growth forest could be dominated by trees that are only 60-70 years old if it was disturbed by a hurricane, fire, ice storm, etc. in the preceding decades. A striking example of this is the Harvard Pisgah Tract in Pisgah State Forest in New Hampshire. Dominated by old Eastern White Pine and Easter Hemlock in the 1930s, it was blown down by the 1938 Hurricane. No salvage logging took place in that stand, so all ecological processes proceeded uninterrupted. Many trees only date to the early 20th century as they were saplings or advanced growth before the hurricane. Using the process definition put forth by Charlie Cogbill, it is an old-growth forest. Stands next to this stand were heavily logged soon after the hurricane and then again in the 1960s and thus, to me, are not old growth. There are other forests like this in the Northeastern US, like Heart's Content and Cathedral Pines in Cook Forest. I'm sure there are many more forests that are not ancient, but still old growth.

Uninterrupted ecological processes, in the absence of land clearing of heavy logging, are the creators of old-growth forests, whether they are young or not and whether by disturbance or natural disease and the longevity of dominant species. To me, the only way to truly know if we have old, mature forests is precisely knowing their histories. Biomass, structure, and other characteristics can be important clues, but such characteristics can develop under different conditions.

The term mature forest, which might be harder to define, is likely best understood in the context of land use. I have visited forests where large trees next to stone walls or old fields are falling over and creating pit and mound topography. These forests have not seen an axe or plow since the early 1800s. There are forests in recovery and, if allowed to develop relatively uninterrupted by the axe, saw, or under management principles of indigenous, traditional ecological knowledge, will resemble an old-growth forest in the coming decades. "Creation" of old-growth forests through light management will be an incredible legacy for the Biden Administration and people living in the US today. They will be gifts to the future on par of the creation of Yosemite, the Adirondacks, and other natural gems in our world.

I believe this definition, a definition based on ecological processed can reflect changes based on disturbance and variation in forest type/composition, climate, site productivity and geographic region and be durable enough to also accommodate

and reflect changes in climate and forest composition. It is the dominant North American culture that needs to be flexible and adaptable for a more universal definition to be adopted. As such, I believe the consideration of the ecology of each system and the history of each landscape can be considered under a universal framework using the process and development history outlined above. Tree species matter to us and those who inhabit these forests, but in terms of Time and ecological processes, it matters much less. Forests are in constant change, with some periods more variable than others. We need to remove ourselves and "needs" from static compositions and structures and let Nature flex with the variations of Life. We expound on this idea and approach in the following article and model of forest development after the citation:

Pederson, N., A.B. Young, A.B. Stan, U. Ariya and D. Martin-Benito. 2017. Low-hanging DendroDynamic Fruits Regarding Disturbance in Temperate, Mesic Forests. In Dendroecology: Tree-ring Analyses Applied to Ecological Studies, M. Amoroso, L. Daniels, P. Baker, J. J. Camarero, Eds. (Springer). pp. 97-134.

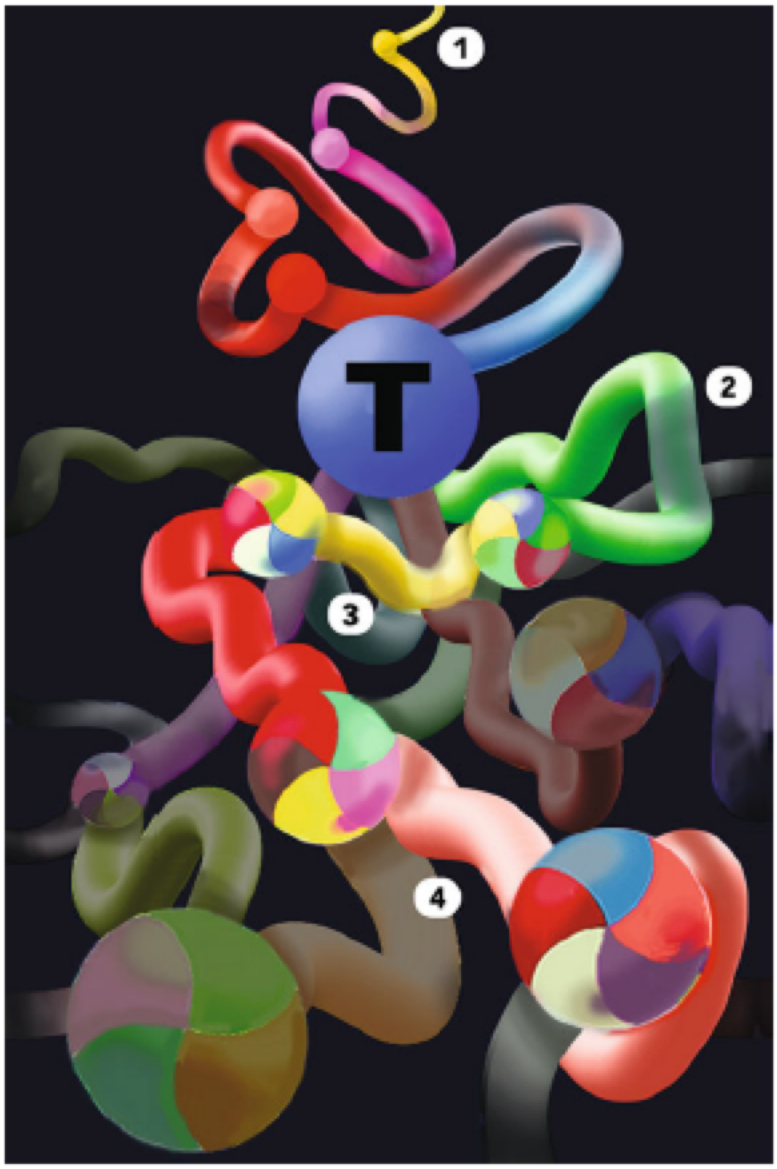

Figure Caption: The N-dimensional, Forest Development model. Potential forest development occurs on each trajectory (pathway). Disturbance is represented by a ball on the trajectory. The disturbance with 'T' represents the current forest. The trajectory starting with (1) is paleoecological history. The trajectory leading to (2) represents the future. Significant alteration in forest composition changes the color of the trajectory. Background disturbances that kill trees, but do not significantly alter TMFs, are represented by the mortal coils (curves) on each pathway. A disturbance with multiple colors represents potential trajectories. We limit the number of trajectories for clarity. The dimmed trajectories are paths not traveled. See Pederson et al. (2017) for more details.

The primary forest characteristics that should be excluded for old-growth forests should be stumps or evidence of heavy logging by a European approach and things like stone walls. For mature forests, these features can be included, should 150 or so years have elapsed since the last logging or farming event.

The cultural and ecological value of that great forests in the landscape that have evolved with only the slightest human influence (until climate change) cannot be understated. These forests are often home to the oldest trees in the landscape. Such trees inspire awe and peace in people who are fortunate to be in their presence. The eons of time packed into the development of these forests cannot be replicated. They are their own unique snowflakes of ecology. And, from a scientific perspective, old-growth forests are some of the best laboratories in the world to understand Nature on its own term. The information stored in the structure of the forests, growth rings in all trees, and the deep and diverse soils will inform us on living in harmony with forests.

Information that I am able to glean from these forests gives insight on how these forests respond and growth following extreme climatic events similar to the ones we are experiencing today. Conserving old-growth forests now will provide pleasure and peace to visitors while also providing incredible study areas for future scientists.

New research is showing that old forests in the Northeastern US store more carbon than working or logged forests and have trees that are growing at higher rates than working forests. A great way to pull carbon out of the atmosphere and the keep it out of the atmosphere for centuries to slow climate change is preservation. Given what we know about older forests, I urge the Biden Administration to declare a moratorium and then protect mature and old-growth forests on public lands. The definition of these forests is tricky, but it is not unreasonable to consider 120-150 year old forests as mature. I have witnessed forests at these and greater ages taking on the appearance of old growth forests. The ecological processes that shape old-growth forests are constantly with us. All we need to do is provide the palette for these processes and allow them to move from second-growth to old-growth conditions. As already stated, adhering to this goal will remove and store a substantial amount of carbon from the atmosphere.

Forest ecosystems are vital to the lives of all that inhabit them or are adjacent to them. Cleaner air and water for all and greater structural in the forest for all flora and fauna enriches our life, locally and globally. We now see that ecology is global. What happens in one part of the world impacts the quality of lives of those nearby and on the other side of the Earth. Our actions, based on knowledge, passion, and science, can make a better world for all of us today and into the distant future.