What Are the Consequences of Cutting Old Ponderosa Pine Trees?  
A Systematic Review

By Dr. Liz Kalies, ERI Research Associate

INTRODUCTION
In ponderosa pine forests, restoration treatments (including thinning and prescribed burning) are being implemented to reduce the threat of stand-replacing fire and to restore ecosystem structure, composition, and function to within the natural range of variability. In implementing treatments, old trees (>150 years) are typically retained due to their relative rarity and assumed ecological importance, and because old trees take centuries to replace. The oldest ponderosa pine have unique morphological and presumably functional characteristics and can exceed 700 years in age (Huckaby et al. 2003). The morphology of such trees often includes large trunks and branches, deeply furrowed bark, deformities in crown structure, epicormic branching, big mistletoe brooms, or external fire scars (Harrington and Sackett 1992; Huckaby et al. 2003; Morgan et al. 2002; Swetnam and Brown 1992), and thus they may have different functions than younger trees related to these different structures. As treatments are implemented at increasingly larger scales, a wide variety of thinning treatments, including cutting old trees, have been proposed. We used systematic review methodology to specifically address the question: What are the consequences to ecosystem function of cutting old ponderosa pine trees; particularly, do old trees serve a different function than younger trees?

METHODS
We searched Web of Science and Google Scholar in April 2013 and selected studies that met three criteria: (1) Subject: old ponderosa pine trees or stands, in any region; defined as trees >150 years of age; (2) Comparator: young ponderosa pine trees or stands; and (3) Outcome: any ecosystem function or service, including but not limited to biological diversity, fire/drought/insect resistance, carbon sequestration, social values, etc. We scored each study based on the study design (randomized, replicated, and controlled=5, replicated=4, controlled=3, observational=2, or inadequate due to problems with methodology=1), the quality of the journal (Journal Impact Factor™), and the number of times it has been cited in the scientific literature (according to Google Scholar). The final quality of evidence scores were calculated as: (quality of design) + (impact factor) + (citations/year), and binned in categories of High (score>20), Medium (10<score<20), or Low (score<10).
RESULTS

- Our weight-of-evidence summary showed that studies with greater strength demonstrated positive effects of old trees on ecosystem properties, compared to younger trees, in terms of cone production, basal area increment, and soil respiration (Table 1). Young trees show higher growth efficiency and photosynthetic rates, but there is no difference between old and young trees in terms of nutrient cycling (Table 1). Finally, old-growth stands of trees store more total ecosystem carbon than young trees (Table 1).

- Lower scoring studies (score of 3) showed that old trees have higher scenic beauty than younger trees (Table 1). All the wildlife studies had a quality of evidence score of 3; they produced a variety of positive, negative, and neutral impacts, implying that old-growth stands and younger stands often have different species compositions, and maintaining both types of stands on the landscape leads to higher overall wildlife diversity and abundance. Similarly, the only genetic study we found (score of 3) showed that old trees are no more genetically diverse than young trees, but have a different genetic composition and thus add diversity to the landscape (Table 1).

MANAGEMENT IMPLICATIONS

The weight-of-evidence (Table 1) indicated that both old and young ponderosa pine trees provide ecological functions; however, young trees are quick to grow and prevalent on the landscape. Further, since some important ecosystem functions are related to tree age (e.g., carbon storage, quality of wildlife habitat, social values, etc.), it is important to differentiate over the range of “old trees” from 150 to 700+ years old when making management decisions. In the Southwest, trees older than 400 years are very uncommon, and over 500 years old are incredibly rare (Swetnam and Brown, 1992). Further, while a 500-year-old tree is replaceable, a living tree that was alive in 1510 is not; nor is its dendrochronological record. There is a dearth of empirical studies on old ponderosa pine trees in terms of their value over young trees, which was a major result of this review. Given that old trees take centuries to “replace,” the precautionary approach suggests old ponderosa pine trees should be protected during management activities. More studies that specifically examine tree age and control for size are needed; if some ecosystem functions could be obtained with simply fast-growing, large trees, that information would be beneficial from a management perspective.

Table 1. Response variables; results in terms of whether old trees had a positive (+), negative (-), or neutral (0) effect on the response variable compared to young trees; quality of evidence scores; and citations for studies that met search criteria.
REFERENCES


Contact

Dr. Liz Kalies, Liz.Kalies@nau.edu

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