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DENDROECOLOGY OF PINUS PONDEROSA IN THE UINTA MOUNTAINS, UTAH

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Introduction: Western conifer trees can contain detailed histories of the climatic conditions they have experienced during their lifetimes. Understanding past climate changes and ecological responses broadens our knowledge of natural variability and allows better predictions of how future changes may affect these ecosystems. In order to improve our understanding of the climate history of northeastern Utah, dendrochronological (tree-ring) records from the Uinta Mountains were developed for this project.

The study area was located in the Moon Lake basin on the southern slope of the Uinta Mountains. The watershed contains a natural lake was artificially expanded to a large reservoir (49,500 acre-feet) by the construction of a dam in the mid-20th century. Moon lake is surrounded by montane forest composed of mixed conifer species, including Pinus ponderosa (ponderosa pine). Ponderosa occur in mixed conifer stands of Douglas fir, juniper, aspen, manzanita, and giant sagebrush, among other species on the eastern side of the basin. On the western side of Moon Lake, they occur in both pure and mixed stands, leading to my two hypothesis; that 1) ponderosa pine can provide a tree-ring based climate record, and 2) that the construction of the dam created a barrier that isolated the two communities and has resulted in different ecological impacts over the past several decades. Ponderosa was selected for sampling as it is a climate-sensitive tree that provides clear annual separation in its rings.

Methods: Field surveys of the Moon Lake basin were conducted April-July 2018. General floral assemblages were recorded, and mature and/or fire-scarred Ponderosa were targeted for sampling. A series of 32 tree cores were taken from 20 individuals using a standard increment borer. Ring widths on the processed cores were measured using a Velmex system and MeasureJ2X software. Disconnected segments of the cores (floating chronologies) were eliminated from the analysis. Several cores with uncertain sequences due to cracking or resin obscuring were also omitted. A time series was constructed from decadal growth averages and compared with PRISM climate data[6] and a charcoal analysis from lake sediments[3]. Difference of means tests were conducted to determine there was statistically significant variation in population characteristics between the tree stands on either side of the lake basin.

Results:

- *Population*: The majority of mature Ponderosa observed during field survey were fire-scarred, not unusual for burn-damage-resistant trees often found in areas with frequent fire[2,4]. Many of the trees sampled also exhibited heart rot, indicating ecological stress. The growth rate time series (figure I) developed from samples revealed several significant growth spikes (likely caused by changes in seasonal precipitation), a general gradual decline in growth from the late 18th century through the end of the 19th century, and an abrupt decline in the early-to-mid 1900s, followed by stabilization into a lower growth rate. This rapid decline may have been caused by drought implicated in the midwestern dust bowl phenomenon. An age depth model (figure II) demonstrated that a major recruitment pulse of Ponderosa occurred in the mid-to-late 1800s, during which moisture and fire conditions were favorable to the trees.

- *Precipitation*: When the growth rate time series was compared with an assortment of seasonal precipitation records for the area, wintertime precipitation showed the strongest match. This aligns with previous research suggesting that snow accumulation is the primary moisture source in many western montane forests[5]. A precipitation peak in the early 1900s correlates with a growth spike in the Ponderosa, also identified in other western forests[4]. A later precipitation peak ca. 1980 corresponds with only a minor growth spike, but the peak was brief, and the 20th century decline in growth rates may have minimized its impact. Precipitation data does not reach back far enough to capture the mid-1800s growth spike, but that phenomenon has been noted in other research conducted both locally and regionally[1,4].

- *Intra-basin variation*: Statistical analysis determined that there is less than 70% confidence ($p=0.337$) that there is significant growth rate or age depth variation between the stands of Ponderosa on either side of the lake basin, inadequate to conclude that there is true divergence between the two stands. However, the sample size of this study was relatively small for statistical analysis, further field survey will be necessary to test if this hypothesis is plausible.

- *Fire*: A charcoal analysis from lake sediments[3] did not show significant time overlap with the tree growth series, but several notable associations are apparent. Charcoal peaks (evidence of fire in the basin) follow periods of high precipitation shown in the growth time series (late 1700s, mid 1800s), as the proliferation of plant growth during wet periods provides a fuel source for fires in subsequent years[2]. These charcoal peaks are also aligned with recruitment pulses of the Ponderosa, indicating that these burn-resistant trees benefit from fire removing other competitive plants, as has been suggested in other research[2,4]. Finally, the area experiences a regular fire regime[2,3], which is conducive to maintaining Ponderosa populations[2,4].

Conclusions: The field and laboratory findings depict a once-flourishing population of trees exhibiting symptoms of ecological stress. Gradual reductions in growth rate observed in the time series may be explained as natural slowing of growth as trees mature, but the abrupt decline and depressed growth of the 20th century remains unexplained. It is possible these trees are living at the edge of their ecological niche, and the shifting conditions of the past century are pushing them towards population collapse. Modern fire suppression may also be implicit by allowing competitive species to gain a foothold, as well as accumulating plant matter that may fuel large enough fires to kill the Ponderosa. Further research may provide insight on the climatic factors influencing this forest, as well as the impact of human activity in the area.

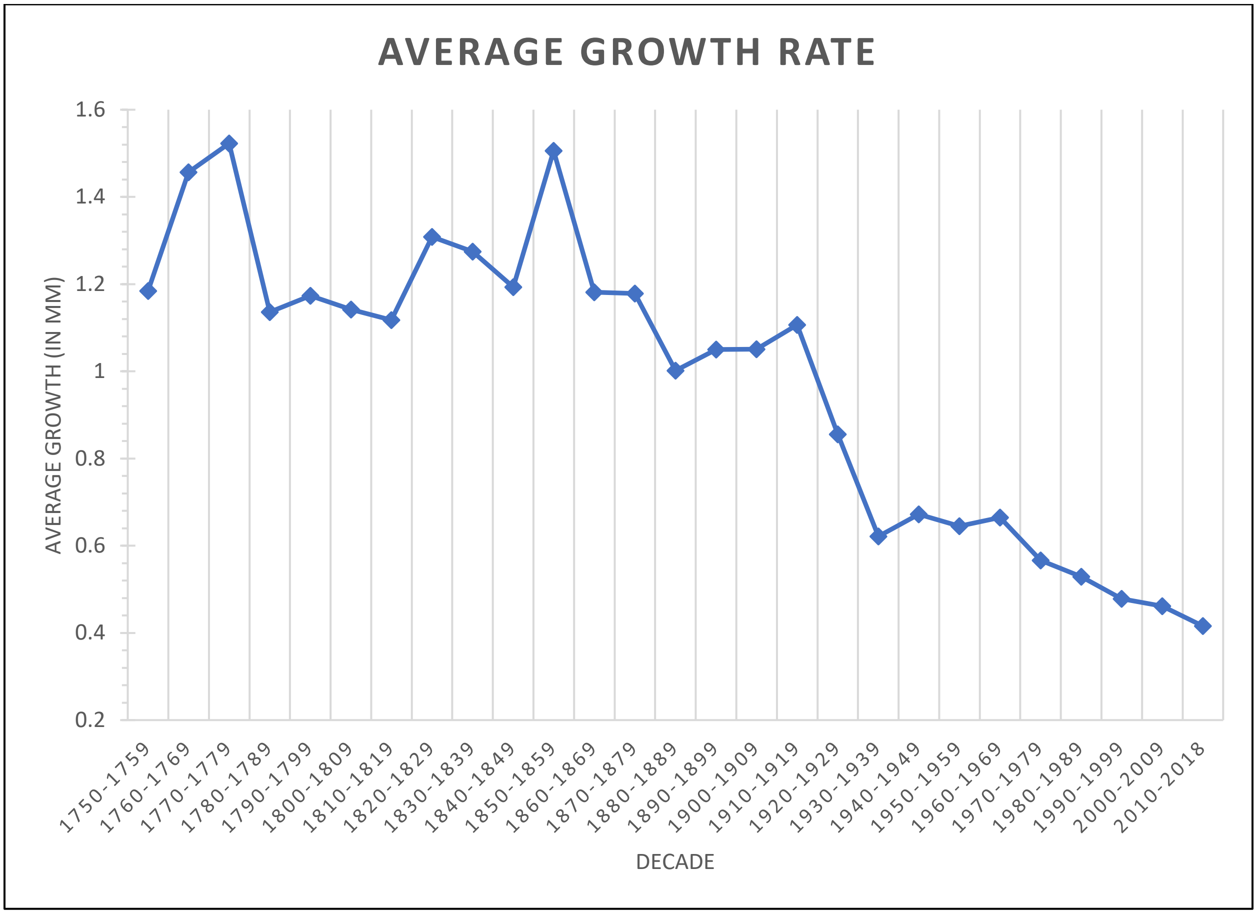

Figure I: Average Growth Rate Series: Decadal growth averages across all samples.

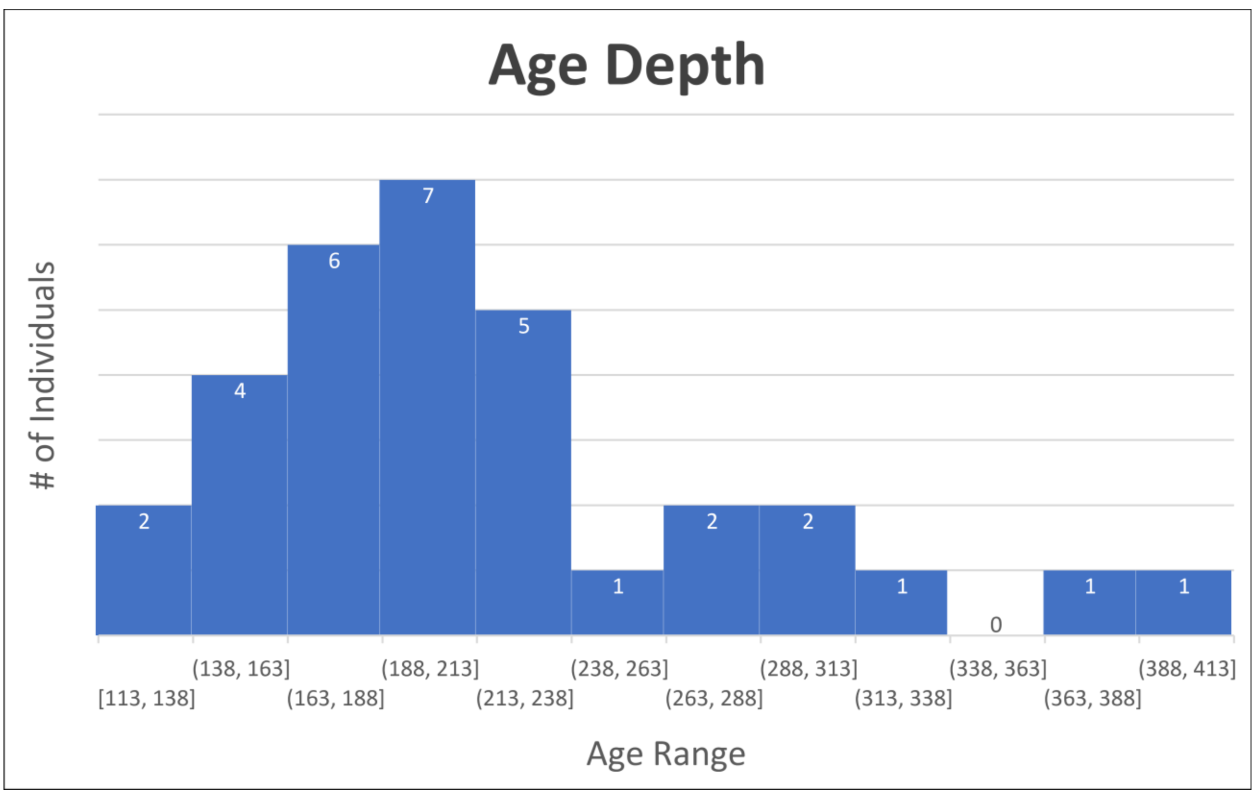

Figure II: Age Depth: Histogram of tree ages, divided into age brackets.

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