GROWTH PATTERNS AND AGES OF TREES FROM MARTIN PARK NATURE CENTER, OKLAHOMA COUNTY, OKLAHOMA

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ABSTRACT

This paper provides insight into ages and patterns of radial growth from mature trees at Martin Park Nature Center, Oklahoma County, Oklahoma. A total of 80 trees were sampled and crossdated using dendrochronology from the three most common genera at Martin Park Nature Center: *Quercus*, *Celtis*, and *Ulmus*. The oldest trees at the park were *Q. macrocarpa* and *C. laevigata* with individuals dating back to the 1920s and 1930s. A pulse of *C. laevigata* recruitment occurred in the 1960s that likely reflected changes in land-use as the property transitioned from private ownership to the City of Oklahoma City. A sequence of growth suppressions and releases was identified in *C. laevigata* that is related to park maintenance and forest development at the park.

INTRODUCTION AND STUDY AREA

Martin Park Nature Center (MPNC) is an approximately 54.8 ha area owned and managed by the City of Oklahoma City. The property was purchased by the City in 1962, converted to a park in 1963, and named after Dr. J.T. Martin (N. Garrison, former naturalist MPNC, personal communication 2022). Prior to 1963, the property was privately owned and was originally homesteaded in 1895 (General Land Office Records 2022).

Martin Park Nature Center is within the Cross Timbers Transition (Level IV) ecoregion (Woods et al. 2005) in central Oklahoma (Figure 1). This ecoregion is known as an ecotone between the grasslands of the Central Great Plains ecoregion to the west and Cross Timbers ecoregion to the east. Common trees within the Cross Timbers Transition ecoregion include *Juniperus virginiana* L. (eastern redcedar), species of *Quercus* including *Q. marilandica* Muenchh. (blackjack oak), *Q. stellata* Wangenh. (post oak), and *Q. macrocarpa* Michx. (bur oak), and species of *Ulmus* including *U. americana* L. (American elm) and *U. rubra* Muhl. (red elm).

Soils at MPNC reflect the presence of streams and periodic flooding. A pair of creeks, Spring Creek and Bluff Creek, dissect MPNC. Soil classifications include Ashport silt loam, Pulaski fine sandy loam, and Lawrie silt loam that are alluvium derived from sedimentary rock associated with floodplains (Web Soil Survey 2022). Elevations at MPNC range from 331.3 m at the north side of the park to 334.9 m at the south side of the park. Mean annual temperature for Oklahoma County is 60.3ºF and mean annual precipitation is 84.8 cm (National Centers for Environmental Information 2022).

In collaboration with William Hagenbuck, Martin Park Nature Center naturalist, I identified trees at MPNC as part of a plan to create educational materials for park guests about the ages of trees along the

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trails at MPNC. The focus of tree aging was on the common tree species at MPNC, including *Q. macrocarpa*, *U. americana*, *U. rubra*, and *Celtis laevigata* Willd. (sugarberry). This manuscript reports tree ages, estimates of tree establishment dates, and patterns of radial growth that provide insight into land-use patterns at MPNC.

Figure 1 The forested landscape at Martin Park Nature Center, Oklahoma County, Oklahoma. Photo is from the central portion of MPNC. Photo by C. King.

METHODS

To build an educational portfolio about tree ages at MPNC for the general public, common native tree species were selected for sampling during Fall 2018 and Spring 2019 to estimate age and establishment dates. Specifically, *Q. macrocarpa*, *U. americana*, *U. rubra*, and *C. laevigata* trees that were > 8 cm diameter at breast height (DBH) were identified for sampling, with the assumption that the oldest members of each species would be > 8 cm DBH. Increment cores were collected as close to the base of each tree as possible using a 5.15 mm (diameter) Haglof increment borer. Increment core samples were collected low on the tree bole in order to estimate a more accurate establishment date for each tree. Trees were selected along trails at MPNC and within the southern third of the park because of the presence of large diameter *Q. macrocarpa* within the floodplain. These larger diameter trees were selected at the request of MPNC. Increment cores were stored in plastic drinking straws for return to the TREELab at the University of Central Oklahoma (UCO) for processing and crossdating. Additional data collected for each increment core included species and diameter at breast height (DBH).

Each individual increment core was glued on wooden mounts at the TREELab. Increment cores were sanded with progressively finer sandpaper (80-grit to 1200-grit) in order to identify individual cells under a binocular microscope (Stokes and Smiley 1996). To determine age at coring height for each increment core, tree-ring widths were measured to the nearest 0.001 mm using a Velmex TA Measuring System (Velmex, Inc., Bloomsfield, NY), a binocular boom microscope, and recorded using Measure J2X software (VoorTech Consulting, Holderness, NH). Tree-ring series of each increment core were crossdated to assign calendar years to each tree-ring using COFECHA (Holmes 1983) and graphical visualization. In the event that the increment core missed the pith, the number of tree-rings missing to the pith were estimated using Speer (2010). This method uses the 10-year pattern of growth closest to the pith to estimate the number of tree-rings missing to estimate pith date.

RESULTS AND DISCUSSION

A total of 80 increment cores were collected from *Q. macrocarpa* (n = 23), *U. americana* (n = 6), *U. rubra* (n = 4), and *C. laevigata* (n = 47). The largest diameter tree that was sampled was a *Q. macrocarpa* (DBH = 96.3 cm). The oldest trees sampled for each species include 93 years (*Q. macrocarpa*), 87 years (*C. laevigata*), 53 years (*U. americana*), and 43 years (*U. rubra*) (Figure 2). Several large diameter *Q. macrocarpa* exist within the floodplain of MPNC along the south side of the park. A few of these were selected for sampling that resulted in the oldest trees found at MPNC.

Approximately 40% (n = 32) of trees sampled began growing in the 1960s (Figure 3). The species that established during the 1960s were *C. laevigata* and *U. americana*. A possible explanation for the establishment of the 1960s tree cohort was likely the transition from private ownership to the City of Oklahoma City. This may have resulted in changes in land-use patterns that promoted the natural establishment of trees. Trees of several species were planted at MPNC after the City of Oklahoma City developed the park but did not include *C. laevigata* and *U. americana* (N. Garrison, former naturalist MPNC, personal communication January 2022). I was unable to find information pertaining to previous land-use before the development of MPNC. Previous research at E.C. Hafer Park in Edmond, Oklahoma County, Oklahoma (King and Cheek 2015) documented farming land-use prior to the City of Edmond purchasing the property. Following the purchase of the future E.C. Hafer Park property, King and Cheek (2015) identified a pulse of tree recruitment in the 1950s that corresponded to a change in land-use from farming practices to minimal use. A similar pattern may have occurred at MPNC following the purchase of the property by the City of Oklahoma City.

Patterns of annual growth in tree-rings can provide important insight into events that may have been occurring around the tree at the time of tree-ring formation (Fritts 1976; Orwig and Abrams 1997; Speer 2010; Cowdon et al. 2014) or provide information about tree senescence (Cailleret et al. 2016). An interesting set of radial growth patterns emerged in several *C. laevigata* that were not observed in the other species at MPNC (Figure 4). I noted that approximately 49% (n = 23) of *C. laevigata* demonstrated a rapid growth suppression (Figure 5). The initiation of growth suppression varied from the mid-1970s (n = 9; Figure 4D), mid-1980s (n = 5; Figures 4A and 4B), and mid-1990s (n = 9; Figure 4C). For eight trees, the growth suppression was sustained through 2018. The other *C. laevigata* (n = 15) exhibited increased annual growth following growth suppression. All but two trees were part of the 1960s cohort.

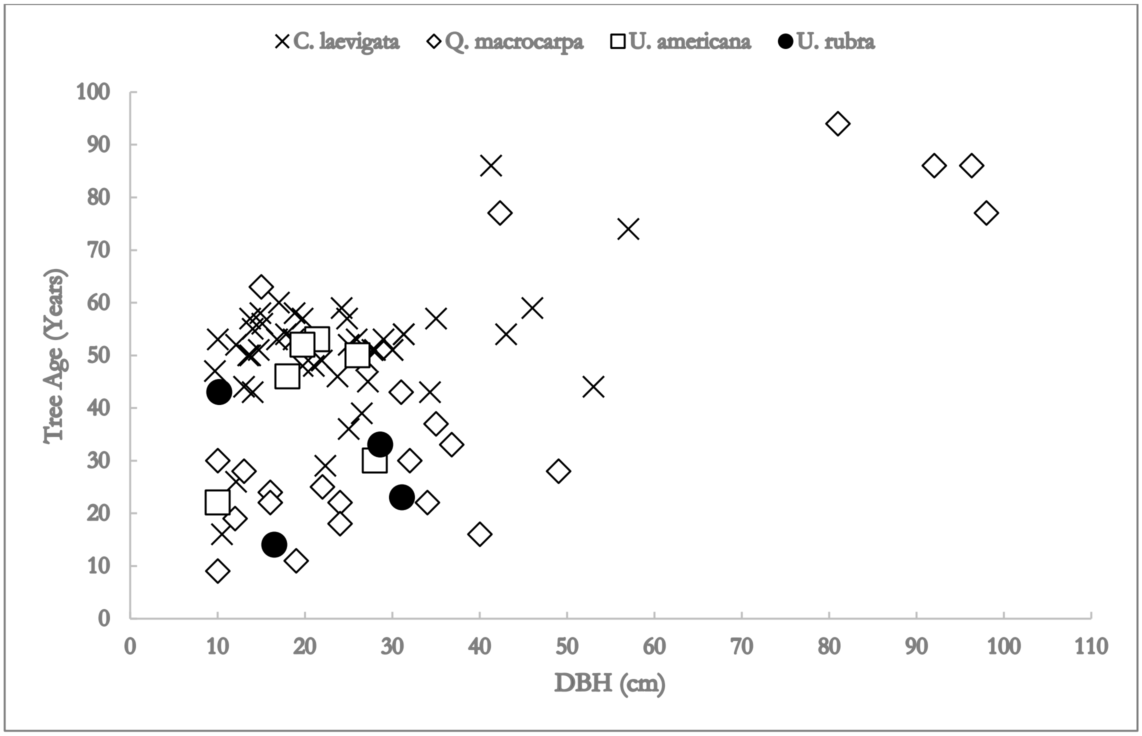

Figure 2 Diameter at breast height (DBH) and tree age for trees cored in Fall 2018 and Spring 2019.

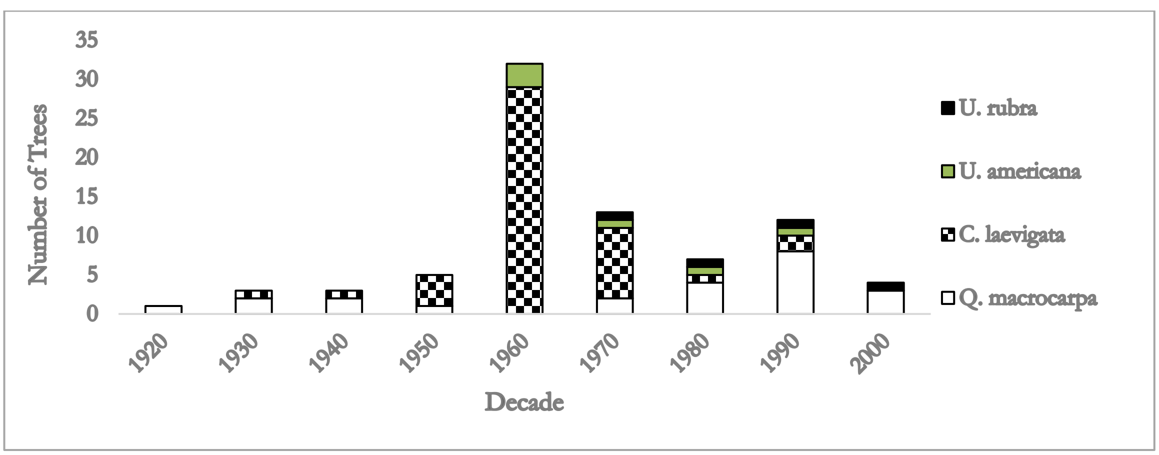

Figure 3 Number of trees that established by decade. Approximately 38% of the trees sampled established during the 1960s. The oldest tree sampled was a bur oak that dated to 1925 (93 years old at time of sampling). A sugarberry also dated to 1931 (87 years old at time of sampling). A large cohort of sugarberry established during the 1960s (29 trees).

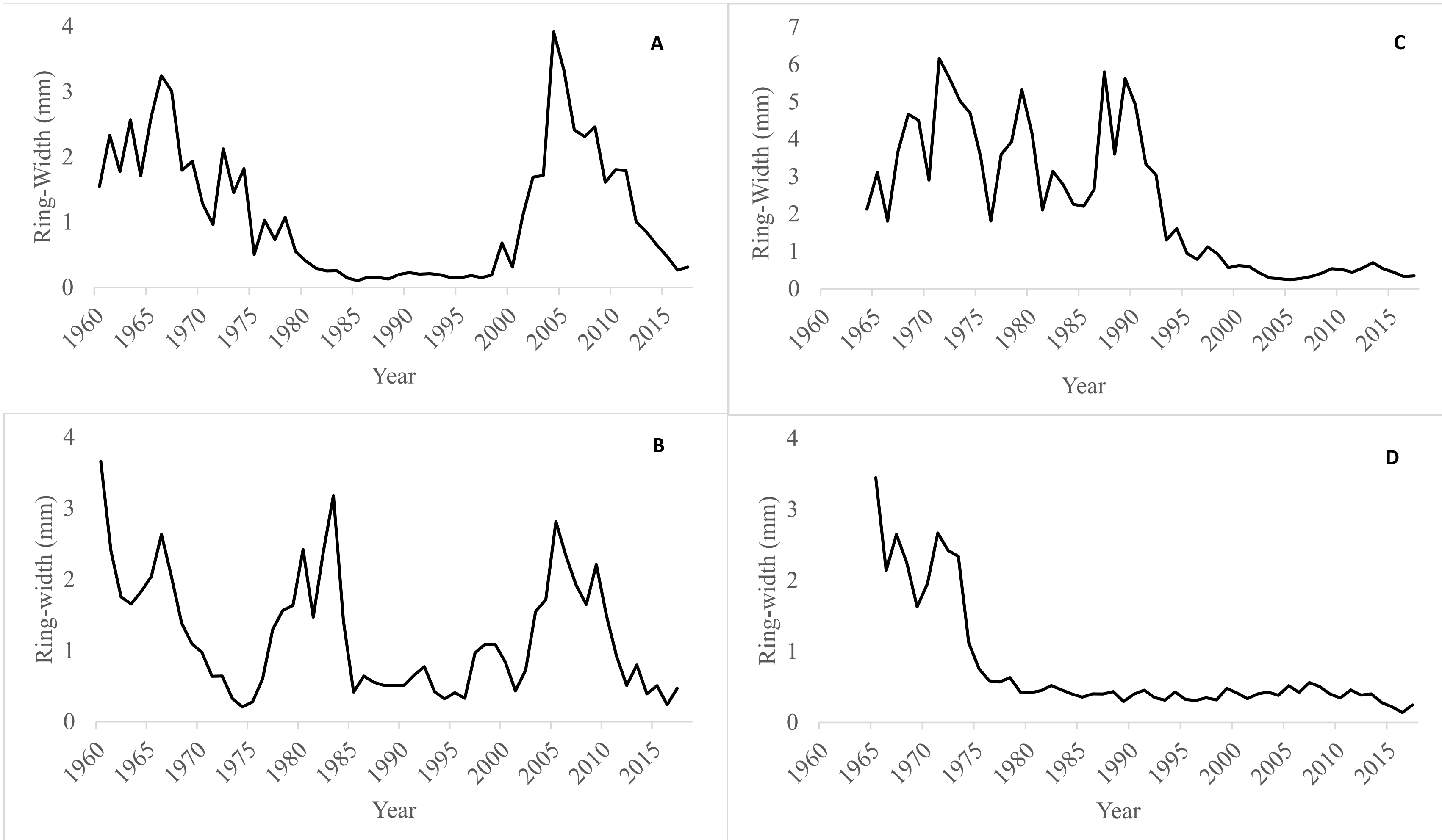

Figure 4 Examples of radial growth patterns in *C. laevigata* at Martin Park Nature Center, Oklahoma County, Oklahoma. Samples A and B represent examples of trees that exhibited declining radial growth with a subsequent growth release in 2002 (A) and 2003 (B). Samples C and D demonstrate sustained growth suppression beginning in 1993 (C) and 1975 (D). Please note different y-axis range in C.

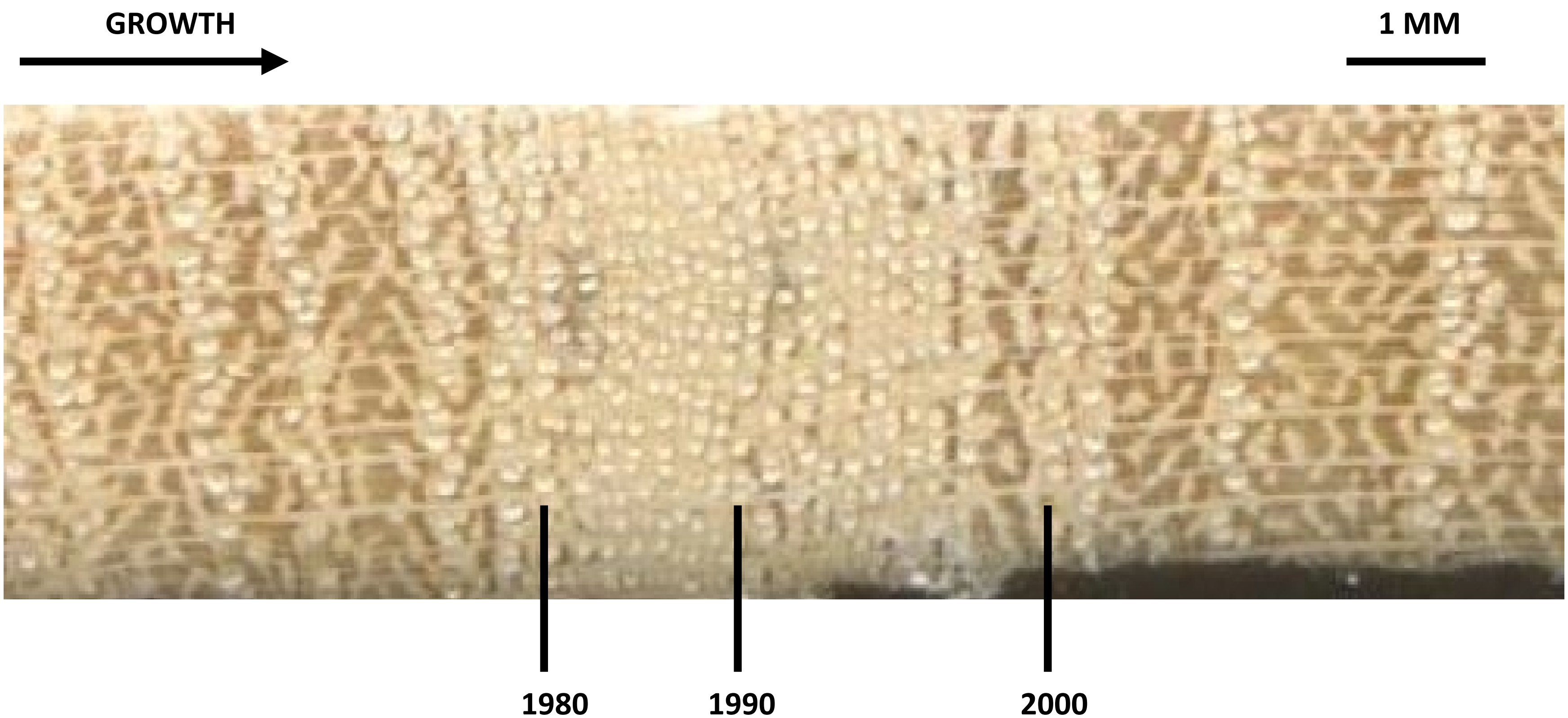

Figure 5 Example of growth suppression in *C. laevigata* at Martin Park Nature Center. Annual growth is from left to right. This sample corresponds to the suppressed growth seen in Figure 3A. Note prior to 1979, ring-widths were wider than the period 1979 through 1998. Subsequent to 1998, ring-widths returned to similar widths when compared to pre-1979.

Several factors likely contributed to this variability in *C. laevigata* growth not seen in the other species that were sampled at MPNC. One explanation is that rapid growth changes are due to regular trail maintenance that resulted in periodic removal of trees near the trails. Damage due to falling stems and/or trees removed leaf area that reduced growth rates of retained *C. laevigata* (Figures 4C and 4D). Maintenance could have also opened the canopy that facilitated some *C. laevigata* to be released from competition that resulted in sustained increases in annual growth until the tree reached an overstory position in the canopy (Figures 4A and 4B). Previous research at E.C. Hafer Park, that is approximately 14 km from MPNC, noted growth releases of trees that was attributed to the development of trails (King and Cheek 2015). Growth releases and suppressions of surviving trees are a common response to canopy disturbances (wind, human activities), particularly in the Eastern Deciduous Forest (Abrams and Orwig 1996; Stan and Daniels 2014; King and Muzika 2014). Suppressions in growth (Figure 4C and 4D) can also be attributed to canopy closure that resulted in reduced light availability to understory *C. laevigata*. This species is considered shade tolerant but responds favorably to being released from a suppressed position in the understory (Kennedy, Jr. 1990). It is not surprising, therefore, that *C. laevigata* is exhibiting suppressed growth but also can rapidly increase growth rates when released. The other species that were sampled are shade tolerant (*U. americana*, *U. rubra*) or intermediately shade tolerant (*Q. macrocarpa*) and may have had responses similar to *C. laevigata*. The numbers of each of the other species sampled was limited relative to *C. laevigata*, so it's possible that, by chance, I did not capture growth responses similar to those seen in *C. laevigata*.

I document ages of trees found at Martin Park Nature Center in Oklahoma City, Oklahoma County. *Quercus macrocarpa* are the oldest trees with the oldest individual dating back to 1925. Additionally, a *C. laevigata* individual dates to 1931, which is currently the oldest representative that I have found in Oklahoma. *Celtis laevigata* is a largely unstudied tree species in dendrochronology and older individuals are likely present in Oklahoma due to their ability to survive in shaded environments while still developing annual growth rings.

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