An assessment of annularity in Sand live Oak (*Quercus geminata*) and Turkey oak (*Quercus laevis*) in centrial Florida

Meng Yuan Cui, Ze'ev Gedalof – University of Guelph – Department of Geography
Michael G Andreu – University of Florida - College of Agricultural and Life Sciences

Climate and Ecosystem Dynamics Research Laboratory

Abstract

The Tiger Creek Preserve in central Florida has one of the highest concentrations of threatened and endangered plants and animals in the United States. Historically it was probably a longleaf pine savanna, but fire exclusion in recent decades has almost certainly led to increased basal area by mid-story oaks (mainly *Quercus geminata* and *Q. laevis*). Determining the date of establishment of these trees, as well as the early fire history of the site, would provide evidence to support appropriate management of this ecosystem as well as insights into how quickly these sites degrade in the absence of fire. Here we evaluate the annularity of these oaks from cross sections of Q. virginiana and Q. laevis collected from the Preserve using dendrochronological techniques. Cross sections from both species were scanned at high resolution and ring widths were cross-dated and measured by two groups working independently. Preliminary results suggest that *Q. laevis* produces annual rings reliably, and that the independent groups came to nearly identical results. Rings are present in *Q. virginiana*, but they are often difficult to discern and the annularity in this evergreen species growing at Tiger Creek is not yet clear. Fire scars are present in both species in the early portion of their growth, but not in recent decades. Growth climate analysis of *Q. laevis* shows good correlations to measures of moisture availability.

Introduction

The Tiger Creek Ecological Preserve is located on the southeast side of Lake Wales, central Florida. This region has a unique longleaf pine/wiregrass sandhill ecosystem. It provides habitat to many threatened and endangered species. Therefore, it is important for researchers and planners to develop a better understanding of the ecosystem in this region. This region was historically impacted by frequent but low-intensity wildfires, which maintained the structure of this forest to have uneven-aged longleaf pine and some mid-story oaks (Greenberg et al., 2019; Tanner et al., 2018). Previous research has shown that the dominance of longleaf pine and oaks has shifted a lot in the past 20,000 years, but this balance was altered after European settlement (Greenberg, 1999). In the 1930s, large-scale wildfire exclusion degraded the high pine ecosystem, and the oaks started to dominate the landscape since then (Greenberg, 1999). Therefore, understanding the oaks in this region will help to develop a better understanding ecosystem dynamics and guide restoration efforts. Because these oaks are growing in a relatively warm, near-tropical region, their dormant season can be different. The tree rings can have faint boundaries due to the uncertain dormant season, and their annularity is unknown. The purpose of this study is to fill this knowledge gap by assessing the dendrochronological potential of these trees. Specifically, our research questions are:

1. Do Sand live oak and Turkey oak have annual rings?
2. What other information can these oaks tell us?

Figure 1. Cross-section samples for Sand live oak (left) and Turkey oak (right)

Study Site

The cross-section samples for both Turkey oak and Sand live oak were collected from Tiger Creek Ecological Preserve, Central Florida, USA. The location of the Tiger Creek Ecological Preserve is shown in Figure 2. Climate normals during the study period are shown in Figure 3.

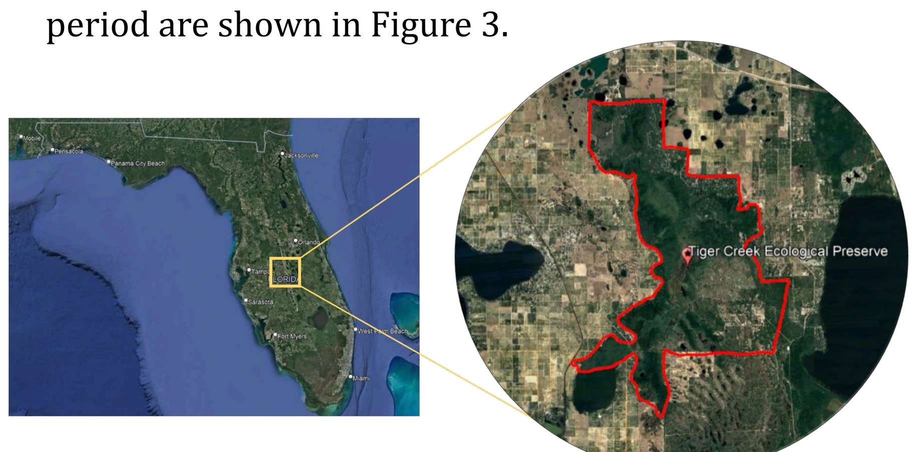

Figure 2. Location of Tiger Creek Ecological Preserve in Florida

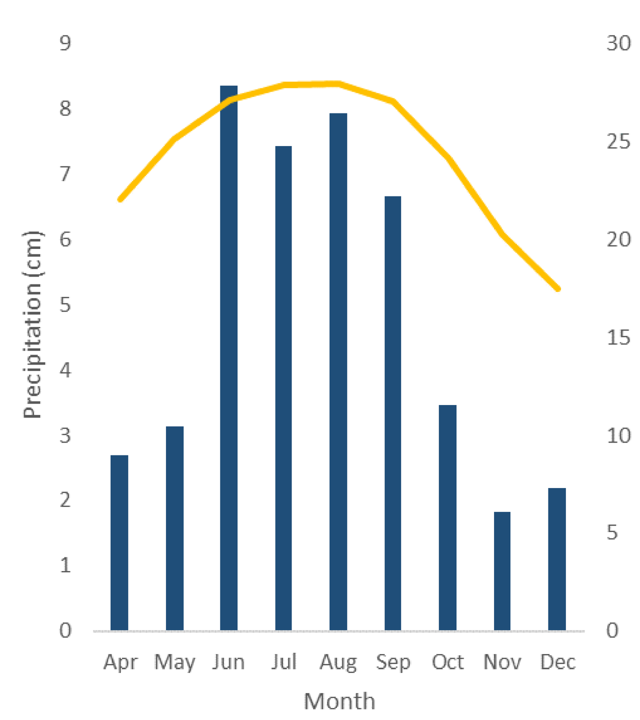

Figure 3. Monthly average (1990-2013) precipitation (bars) and temperature (line) in central Florida

Methods

Twenty Turkey oak and twenty-one Sand live oak cross-section samples were collected from the study site. The site chronology was developed using standard tree-ring analysis methods. Pearson's coefficient was calculated to determine the correlation between the site chronology generated from Arstan and climate parameters (PDSI, temperature, precipitation). Climate data were downloaded from National Climatic Data Centers. Both current and previous year's monthly climate data were used to calculate the correlation between climate and ring width index. After the months with the highest correlation with tree-ring growth were determined, the climate reconstruction was then determined using the site chronology and PDSI for the months with the highest correlation. Comparisons between predicted PDSI and observed PDSI were calculated and graphed to visualize the results.

Results

Both chronologies from Turkey oak and Sand live oak were analyzed using COFECHA. The outputs are listed in Table 1. Turkey oak has an interseries correlation of 0.581, and Sand live oak has an interseries correlation of 0.096. Due to the difficulty in identifying tree-ring boundaries for Sand live oak, as well as the low correlation value, we tentatively conclude that Sand live oak rings do not have annularity. However, Turkey oak does have annual tree rings and does have the potential for dendrochronological analyses. Closer analyses were performed for Turkey oaks. The correlation analyses were performed to determine the relationship between site chronology and climate factors. Monthly data from the previous year to the current year were used for the calculation. The results were graphed in Figure 4. The climate reconstruction was developed using the regression model generated from the regression analysis between site chronology and PDSI. The regression model is shown in Figure 5. The comparison of observed and predicted PDSI from 1990-2013 was graphed in Figure 6.

Table 1. Summary of tree-ring data for Turkey oak and Sand live oak

	Master series	Number of samples	AIO*	AMS*
Turkey oak	1990-2013	20	0.581	0.502
Sand live oak	1955-2013	21	0.096	0.454

*AIO: Average interseries correlation ; AMS: Average mean sensitivity

Major Findings

1. The sand live oaks have indistinct ring boundaries which increased the difficulties in tree-ring identification. Interseries correlation was low (less than 0.1). It is unlikely that sand live oaks are applicable for dendrochronological research.

2. The tree-rings for Turkey oaks grow annually. The interseries correlation were relatively high (0.581), and calendar years were consistent between analysts. It is likely that Turkey oak has dendrochronological potential.

3. The tree-rings of Turkey oak are impacted by climate conditions. However, the sensitivity was relatively low (Figure 6). The overall, the predicted values have a similar pattern, and appear stable over time.

4. Turkey oaks are able to record fire events. Several fire scars were shown in the cross- sections collected from Tiger Creek. Further analysis is needed.

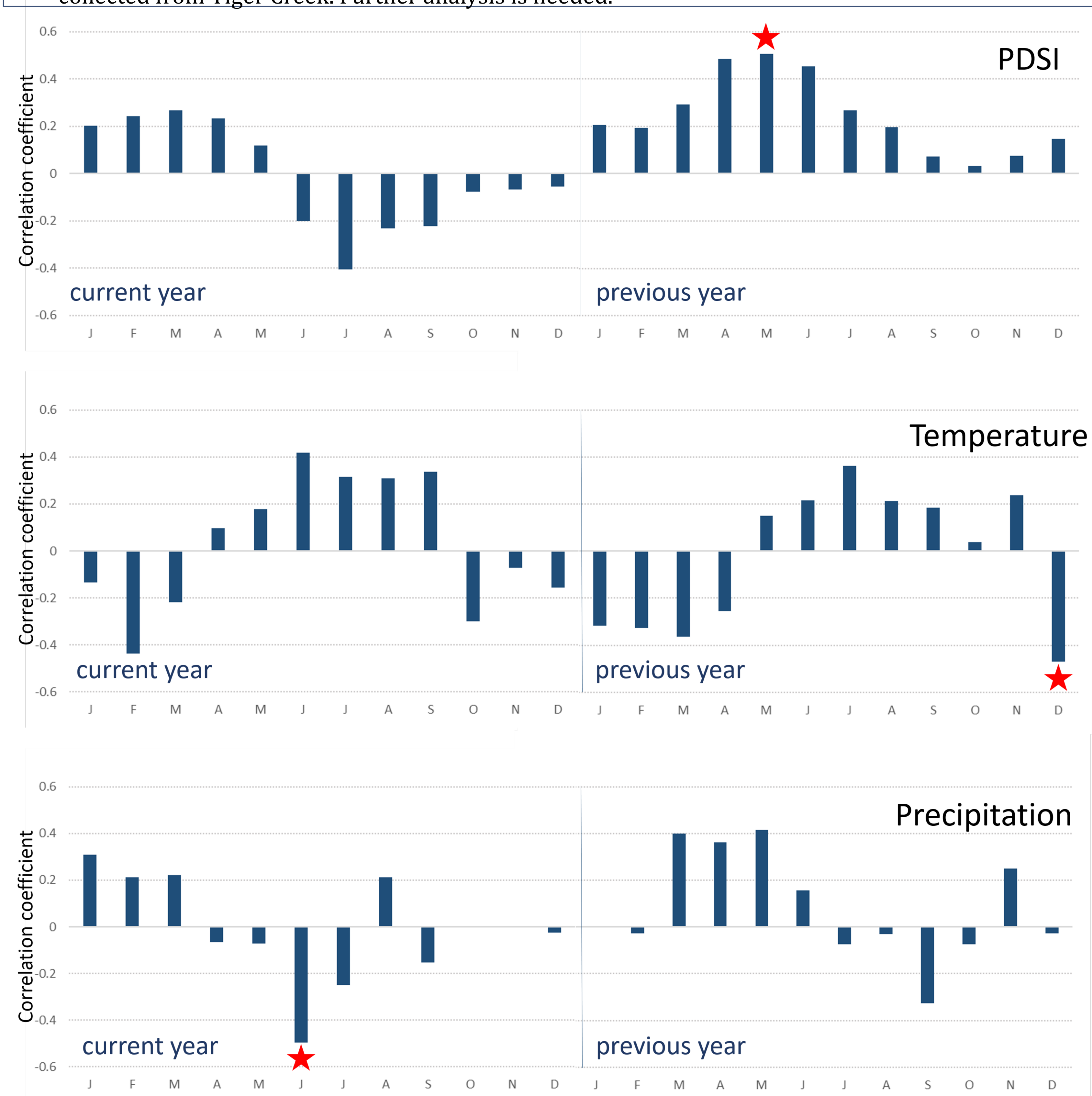

Figure 4. Correlation between tree-ring index (1990-2013) of Turkey oaks (n=20) and Palmer Drought Severity Index (PDSI), temperature, and precipitation (α=0.05). Months with the highest correlation are marked with ★

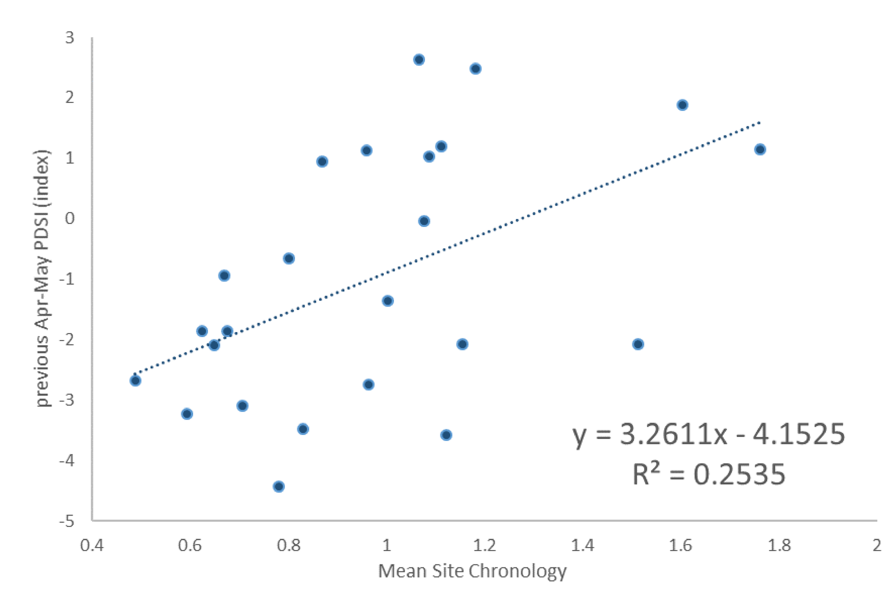

Figure 5. Relationship between mean site chronology and previous Apr-May PDSI, equation was used to predict PDSI in Figure 6.

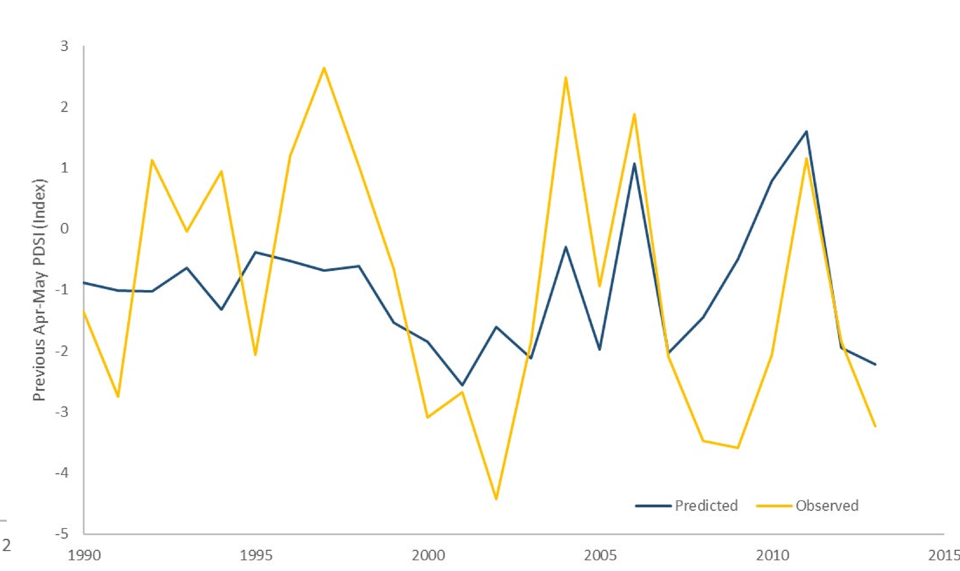

Figure 6. Comparison of observed and predicted PDSI from 1990-2013 using the model generated from the regression analysis

Conclusion

Sand live oak has faint and fuzzy ring boundaries. The interseries correlation was very weak. It is unlikely that Sand live oak grows annual rings reliably according to this study.

Turkey oak has the potential for dendrochronological analyses. The interseries correlation of 0.581 showed a meaningful signal for ring-growth patterns. However, the sample sizes in this study were relatively low, and the Turkey oak samples collected were relatively young. The results would be stronger if more Turkey oak samples of older age were used for the analysis. Further research on fire events recording, as well as the response of Turkey oak to climate oscillations such as the Atlantic Multidecadal Oscillation (AMO) should be analyzed.

Figure 7. Turkey oak cross-section with multiple fire scars recorded

References

Corogin, P. T., & Judd, W. S. (2009). Floristic Inventory of Tiger Creek Preserve and saddle blanket scrub preserve, Polk County, Florida. *Rhodora*, *111*(948), 448–502. **Greenberg, C,H.,** (1999). Age, Composition, and Stand Structure of Old-growth Oak Sites in the Florida High Pine Landscape: Implications for Ecosystem Management and Restoration. *Natural Areas Journal 19*, 30-40. **Greenberg, C. H., Zarnoch, S. J., & Austin, J. D.** (2019). Short-term response to season of burn by Amphibians and reptiles in a Florida longleaf pine – Wiregrass Sandhill. *Canadian Journal of Forest Research*, *49*(12), 1580–1589. https://doi.org/10.1139/cjfr-2019-0219 **Tanner, B., Douglas, M., Greenberg, C., Chamberlin, J., & Styers, D.** (2018). A macroscopic charcoal and multiproxy record from peat recovered from depression marshes in Longleaf Pine Sandhills, Florida, USA. *Quaternary*, *1*(3), 25. https://doi.org/10.3390/quat1030025