

# Fire scar confirmation of a long-term frequent fire regime in a longleaf pine-bluestem ecosystem, Kisatchie Hills Wilderness, Louisiana

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**Abstract.** We collected nineteen cross sections from dead, remnant fire scarred pine (*Pinus* spp.) trees in a 1 km<sup>2</sup> area of the Kisatchie Hills Wilderness Area, Kisatchie National Forest, Louisiana. Tree-ring widths of dead stumps were measured and crossdated using latewood widths and a latewood chronology developed from cores from live trees. The full master tree-ring chronology spanned the period AD 1595 to 2007 (413 years) while fire scarred remnant wood spanned the period 1595 to 1905 (311 years). Charcoal was present on the exterior of all stumps and dead standing trees. The most fire scars on a single tree was 34 while the majority had over eight scars. A total of 181 fire scars were dated resulting in 115 different fire event years. The full period (AD 1595 to 1905) mean fire interval was 2.21 years (Weibull median interval = 1.83 years). From 1650 to 1793 the mean fire interval was 3.25 years. From 1793 to 1880, when the population density was about 0.3 humans per km<sup>2</sup>, the fire frequency abruptly increased to a state of frequent fire with a mean fire interval of 1.31 years. Microscopic fire scars showed evidence of “biannual burning” (two fire scars in one year) in 1700 and during the 1850s. The majority of historic fires (63%) occurred while trees were forming latewood while 29% of the fires occurred while trees were dormant. Years of severe fires (represented as increased percentage of trees scarred) were associated with historic drought years (e.g., 1751, 1830, 1832, 1863). Overall, this evidence of historic frequent burning confirms what is 1) thought to be the necessary fire frequency required to maintain longleaf pine -bluestem (*Pinus palustris* - *Andropogon*) communities, and 2) is estimated to have been the fire frequency based on predictive models using information about climate and historic human population estimates.

**Background** Compared to the western U.S. large regions of the eastern U.S. are lacking well replicated and spatially distributed quantitative information about historic fire regimes. The goal of this research was to establish new fire history research sites in ecosystems and locations where little to no information exists. See the Joint Fire Science First Look article below describing this research.



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**Filling in the Blanks:**  
**Developing Fire Scar Histories in the Southern and Eastern United States**

**Management Implications**

- Previously unavailable fire chronologies for eastern and southern U.S. forests will help determine the historical role of fire on a regional scale.
- Empirically derived fire histories will help justify burning frequencies for restoration.
- Fire history data will be archived in a permanent database and contribute to a comprehensive, national model.

Forests of the eastern United States are changing for many reasons, including oak decline, insect damage, invasion of exotic species and fuel accumulation. Forest managers are trying to address these changes, maintain forest health, and implement forest ecosystem restoration projects. A vital component of many of these projects involves the use of prescribed fire.

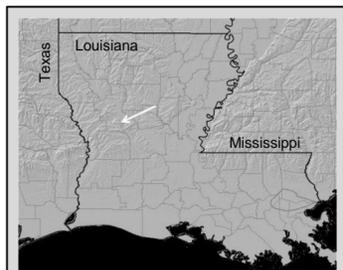
A historical perspective of where, when and how fires burned prior to European settlement is important for understanding long-term interactions between humans and their environment and how forests have developed. Fire history information aids in determining appropriate timing and frequency for prescribed fire use, and helps to justify ecosystem restoration efforts that employ prescribed burning. Detailed information about fire histories can be derived from the study of tree rings. Low to moderate intensity fires often injure or scar surviving trees, leaving a record of their passage in time.

Unfortunately, many regions of the eastern deciduous and southern subtropical forests of the United States are completely lacking long (250+ years) fire scar histories. Currently, there are no fire histories for North Carolina, South Carolina, Florida, Georgia, Alabama, Mississippi, Louisiana and several New England states. As a region the eastern U.S. has lagged behind the western U.S. in terms of historical fire research, partly because eastern fires of the last century have generally been much less severe than their western counterparts. However, wildfires during the last few years in Texas, Oklahoma, Florida, and Minnesota, as well as changes in vegetation and climate, have emphasized the need for fire history research across the entire country.

Time is running out for gathering fire-scar data, as the old trees that hold the information are reaching the end of their lifespan, and remnant wood is decaying. A quantitative assessment of this historic information is needed in order to help managers plan for the rapidly changing climate, land use patterns and human population densities emerging in this century.



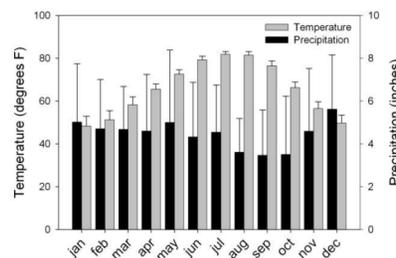
Above: Locations of new fire scar history sites completed during last 3 years through support from the Joint Fire Science Program



The study site lies in Natchitoches Parish within the relatively rough terrain of the Kisatchie Hills Wilderness Area.

## Study Site

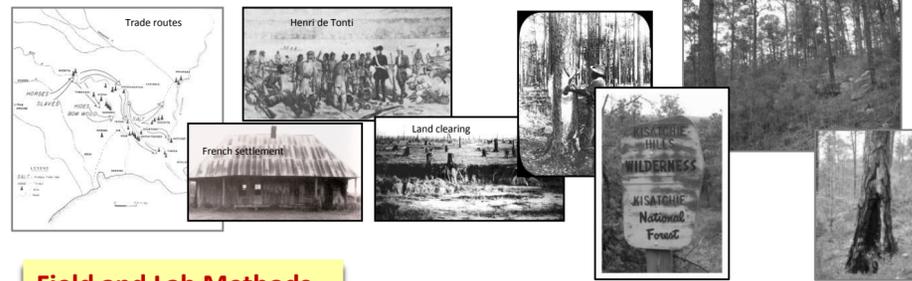
- The site is located on the Kisatchie Ranger District, of the Kisatchie National Forest.
- The site is partly within the Kisatchie Hills Wilderness area and consists of relatively rough topography with sandstone substrate (Catahoula formation)
- This area is approximately 25 km south of the city of Natchitoches and 60 km northwest of Alexandria
- The region is within the Coastal Plains and Flatwoods, Western Gulf section ecoregion (Bailey 1998) and is considered a longleaf pine-bluestem ecosystem.



Above: Monthly temperature and precipitation means (1895-2008) for Louisiana Climate Division 4 (Source: NOAA NCDC)

## History

This region was historically inhabited by the Natchitoches (Natchitoch) tribe of the Caddo-“chinquapin (chink-a-pin) eaters”, (Adeas). The first documentation of European contact near the site occurred near to the present day city of Natchitoches (ca. 1690) by Henri de Tonti. The city of Natchitoches lies on the Red River and is the oldest permanent settlement in Louisiana Purchase territory (est. 1714). The Red River was an important travel and trade route. French outposts occurred on the Red River as early as 1699. Like many locations in the southeast, large-scale forest clearing occurred to create agricultural lands. Turpentine at the site occurred during the late-19<sup>th</sup> and early 20<sup>th</sup> centuries. Clay turpentine pots can still be found in the vicinity of the study area.



## Field and Lab Methods

- We surveyed areas of the Red Dirt Wildlife Management Areas, the Kisatchie Wilderness, and the Kisatchie National Forest for fire scarred remnant pines
- We cut cross sections from 19 remnant pines in a 1 km<sup>2</sup> area in and just outside of the wilderness area
- Samples were sanded and widths of earlywood and latewood portions of rings were measured
- We constructed a latewood-width master chronology from cores of live trees and the dead fire scarred samples. Based on wood anatomy and density we believe the remnant wood is longleaf pine. DNA tests are planned to positively identify the species
- Fire scars were dated to the year and, if possible, season of occurrence
- Fire events were summarized in terms of frequency, temporal changes, and seasonality



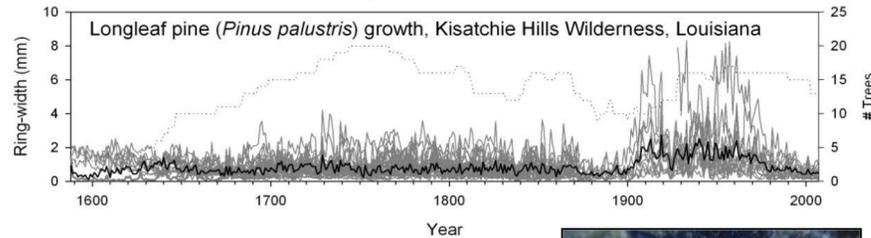
Above: Crosscutting a resinous 12' tall pine snag with a well formed fire scar catface.



Above: Close-up of cat face callus tissue showing over 30 historic fire events on a single stump.



Above: Cross-section of KIS014 with 31 fire scars between 1650 and 1757.



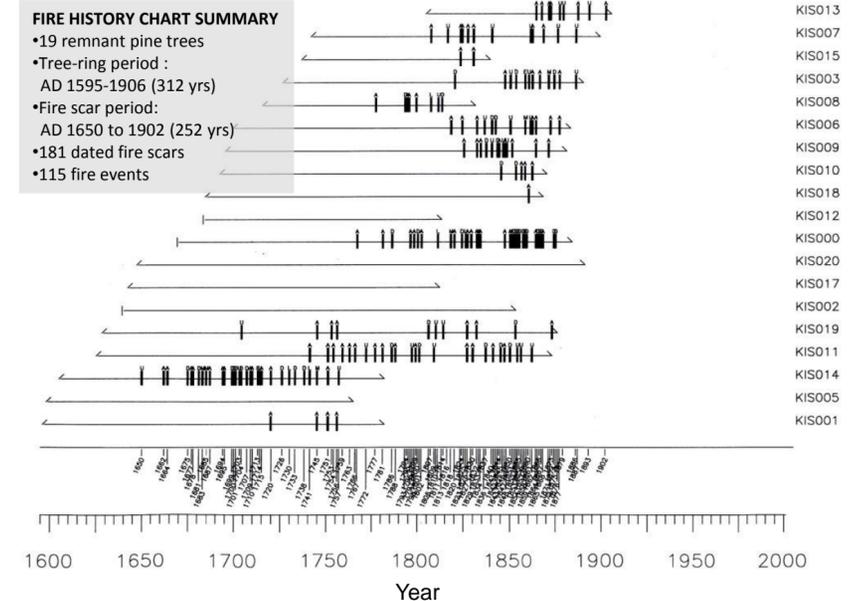
## Biannual burning

In ecosystems with very high productivity, long growing seasons, and the right fuelbed it is possible for more than one fire event to occur in a single year. Biannual burning is described in historic documents, however to our knowledge has never been observed in the fire scar record. Biannual burning occurred as a fire scar in the dormant season, followed by a fire scar in the next late-growing season (latewood), then another fire scar in the subsequent dormant season. We observed what appears to be biannual burning in the year 1700 and during a period during the mid-19<sup>th</sup> century. A total of five years with two fires were identified. Fire interval statistics do not include biannual burning.



## Results

Our research confirmed what is commonly thought about fire in longleaf pine ecosystems: that fires burned frequently. Here at the Kisatchie Hills Wilderness this translated to a fire every 2.1 years over a period 252 years (1650-1902). Our results describe: 1) how the frequency of fires varied through recent centuries, 2) that fire events occurred largely late in the growing season, and 3) how and when the fire regime changed according to human influences. In addition, we discuss evidence for biannual burning (i.e., two scars on one ring) and significant ecological alterations in the wilderness.



Above: The Kisatchie Hills Wilderness Area fire history chart. Each horizontal line represents the length of the tree-ring record of a remnant (dead) pine tree. Bold vertical bars represent the year of a fire scar with the season of the injury coded above each bar (D = dormant season scar, U = undetermined season scar, E = earlywood scar, M = middle earlywood scar, A = latewood scar). The composite fire scar chronology with all fire scar dates is shown at the bottom of the chart.

## In a nutshell

Fire Frequency					Fire Seasonality	Years of biannual burning
Period	Mean	Median*	Min	Max	The location of the fire scar within the tree-ring	
1650-1902	2.21	1.81	0.5	12	62.7% Latewood	1700
1650-1700	3.57	-	0.5	12	28.7% Dormant	1826
1701-1789	3	-	1	6	1.3% Early Earlywood	1852
1790-1902	1.47	-	0.5	8	4.0% Mid Earlywood	1853
					3.3% Late Earlywood	1867

\*Weibull Median Fire Interval

## Altered wilderness

Several site characteristics suggest that the study area may have recently underwent significant changes in longleaf site occupation and soil movement. We found many of the remnant samples (in situ) with fire scars in sandy riparian areas. Currently these areas are dominated by relatively young bottomland hardwoods and loblolly pine. No longleaf were observed occurring in riparian positions, however the samples we collected suggest they historically did. Further evidence of these site alterations included the occurrence of dead standing fire scarred pines that dated to the 17<sup>th</sup> century located within 15 feet from live bald cypress (*Taxodium distichum*) trees and knees.



Above: A remnant pine stump with a fire scarred catface is submerged in water suggesting past site changes.

## Acknowledgements

The authors thank Ed Bratcher and Erik Taylor of the Kisatchie National Forest for assisting this work. We thank Eli Engelken and Kellen Harper for their fieldwork assistance. We especially thank the Joint Fire Science Program for funding this research and promoting fire history research in the southeastern U.S.

