

# SWS Research Brief

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## Did River Bottoms Burn? Bamboo, Wind & Fire in Bottomland Hardwood Forests

### Background

America's bottomland hardwood forests are lush, verdant, and wet – and virtually fireproof. Their shady canopies and sparse understories often contain little flammable fuel. However, two hundred years ago many of these floodplain forests contained dense stands of native bamboo called “canebrakes” that were miles long and probably depended on fire. What does it mean that vast thickets of fire-loving bamboo occurred in these wet riverine forests?



Photo by Virginia Velez-Thaxton

**Figure 1. Lush, wet, and verdant describe bottomland hardwood forests.**

Bottomland hardwood forests occur in alluvial floodplains of the southeastern USA. Their diverse tree species tolerate varying periods of flooding, so small changes in elevation determine which species occur where. These forests have been host to numerous wildlife species, including Louisiana black bears, Florida panthers, canebrake rattlesnakes, and ivory-billed woodpeckers. The forests were severely logged for timber and later cleared for farmland. Levee building destroyed their natural flood-regime. Today, these forests cover approximately one quarter of their previous extent, and several resident

wildlife species are rare or extinct. Efforts to restore bottomland hardwood forests have recently increased, as has a need for information about restoration techniques and pre-European conditions.

Canebrakes are large, dense stands of the native North American bamboo called “giant cane” or “river cane” (*Arundinaria gigantea*; Fig. 2). Wildlife havens and America's most nutritious fodder for livestock, canebrakes are now virtually gone. Remnants are increasingly valued as habitat and for their beneficial effects on water quality. Cane still occurs throughout its range, but mostly in small patches.

To understand the potential role of fire in bottomland hardwood forests, one must consider the context of other interacting disturbances that occur there. Before river channelization, forests were flooded during most years in late winter and early spring; however, sloughs and bayous dried out during periodic droughts. Hurricanes, tornados, violent thunderstorms and ice storms made gaps, both large and small, in the old-growth forest canopy. Fine fuels from these events decomposed quickly, but dense regenerating vegetation would have filled forest gaps for years. This dense vegetation would have been highly flammable during droughts.

A light-loving species outcompeted by much taller trees, cane may need fire or some other disturbance to attain the expansiveness and dense structure characteristic of canebrakes. Cane in large gaps can produce new stems at twice the rate as cane under forest canopy. However without periodic disturbance, new stems production eventually slows, and stands of cane decline over several years and are



USDA photo negative #54-FSA-3208

**Figure 2. Pecano Plantation circa 1905 near Waterproof, Louisiana in Tensas Parish.**

then likely to be overtopped by young trees. Because of this dynamic, large canebrakes indicate the occurrence of some periodic disturbance like fire. My colleagues and I have demonstrated that fire accelerates new stem production in open-grown cane stands, replaces dying, older stems with vigorous new ones and removes competing vegetation. Cane is very pyrogenic in dry conditions, and the dense cane stands that resprout after burning may set up a positive feedback that makes fire recurrence more likely.

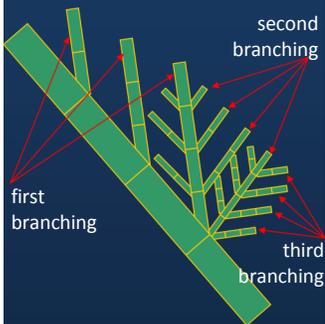
### Study Goal

I reviewed historical literature for evidence of fires in bottomland hardwood forests to place my ongoing research of fire effects on canebrakes in historical and evolutionary context. Colleagues and I have shown that cane can be quite flammable, and that under the right conditions it responds to burning with vigorous regrowth. Historical sources would have important implications for ongoing restoration efforts if they indicated that fires occurred periodically in bottomland hardwood forests.

## THERE IS EVIDENCE OF FIRES IN BOTTOMLANDS DATING BACK MANY THOUSANDS OF YEARS

### Determining Age of Cane Stems:

It is possible to age stems of cane because they flush new leaves at regular intervals. A new cane stem (called a *culm*) typically sprouts during early to mid summer and reaches its full size within just a few weeks, then lives for several years. It generally produces one to two branchings in its first year (see diagram below). Thereafter, the newest branching will itself branch every spring. This means that the number or order of branchings will indicate the approximate age of that culm in years.



By using order of branchings to estimate culm age, I established accurate demographic models of cane culms and thereby determined how many new stems had been produced in particular cane stands in the recent years prior to my censuses.

### Study Area

My experimental research took place in the heart of canebrake country, in the Buckhorn Wildlife Management Area (WMA) in Tensas Parish, NE Louisiana, in the lower Mississippi River alluvial valley (Fig. 3). This area is near the site of James Tanner's (1942) study of the ivory billed woodpecker. It was once famous because of a nearby hunting trip by Teddy Roosevelt; the story goes that he chose not to shoot a particular Louisiana black bear cub (the original "Teddy Bear"). This area produced canebrakes of impressive height and stem density, as shown in Figure 2. Today the Buckhorn WMA is surrounded by agricultural fields; it includes approximately 3600 hectares of forest and another 1200 hectares of reforesting agriculture fields.



Figure 3. Main study site

In November 2000, a large F2 tornado passed over the entire Buckhorn WMA traveling from southwest to northeast. The storm completely removed the forest canopy in a swath approximately 1 kilometer wide, and caused major damage to the forest for an additional 500 m on either side of its central path (Fig. 4). Cane occurred in



Figure 4. Typical view of forest understory at the Buckhorn WMA (left), and of the central blowdown four years after the large tornado of 2000.

the understory before the storm, and stands of cane were subsequently present both within the central zone (a large and virtually complete blowdown), and on either side under intact forest canopy.

### Methods

At my main study site at the Buckhorn WMA, I set up 30 research plots wherein I tagged and tracked every bamboo stem annually for six years beginning January 2002. Ten of these plots were within the central tornado blowdown, 10 more were in small stands of cane under adjacent forest canopy, and 10 were in large, expansive stands of cane also under adjacent forest canopy. After two years (in April 2004), I burned half (15) of the cane stands containing my plots. I then monitored bamboo regeneration. From the data I collected, I built population models to determine the extent to which stands of bamboo stems grew or shrank depending on whether they were burned or unburned and in the tornado blowdown or forest.

To put my experimental findings in historical and evolutionary context, I reviewed ecological literature and numerous sources from environmental history pertaining to fire in bottomland hardwood forests. These contained information about fire in pre-historic, historic and recent (20th century) times. I synthesized this information with major findings from my own and other ecological research on canebrakes to suggest if and how fires might have occurred in these forests.



**FIRES WERE MOST LIKELY WHEN DROUGHTS RENDERED DENSE, REGENERATING VEGETATION FLAMMABLE IN LARGE FOREST GAPS — GAPS ORIGINALLY CAUSED BY VIOLENT WINDSTORMS**

## Findings

There is evidence of fires in bottomlands dating back many thousands of years. Thickets of *Arundinaria* first appeared there in the pollen record around 9,500 years ago, and records of light-loving herbaceous species date back to the last glaciation (approximately 12,000 years ago), indicating that not all locations in the bottomlands were forested. Fire may have enabled these species to persist in place of forest trees. The current climate in the Southeast was essentially established by 5,000 years ago, and high frequency of lightning strikes (like today) has been likely since.

Native Americans would have additionally increased fire frequency; they left evidence in the bottomlands beginning around 12,000 years ago. Their use of bottomland resources increased between 9,000 and 5,000 years ago as the climate warmed and the bottomlands dried. The first major Native American settlement (Poverty Point) that depended on bottomlands for agricultural resources rose to prominence about 3,600 years ago. Between then and European contact, Native American agricultural practices intensified in river bottoms; this agriculture was reliant on fire to clear land for fields. The first Europeans brought diseases that are thought to have killed 80-90% of Native Americans in the Southeast and caused their large societies to collapse.

There is both direct and circumstantial evidence of fire in southeastern bottomlands during European exploration and

settlement. For example, various explorers documented numerous grasslands on high ground within the lower Mississippi River alluvial valley – these “prairies” were likely fire-dependent because trees would have otherwise dominated such areas. Bartram, Nuttall and Audubon, among others, mentioned canebrakes prominently in their various accounts. European settlers systematically targeted canebrakes as growing on the best soils for crops, and the fires they used to clear land commonly escaped.

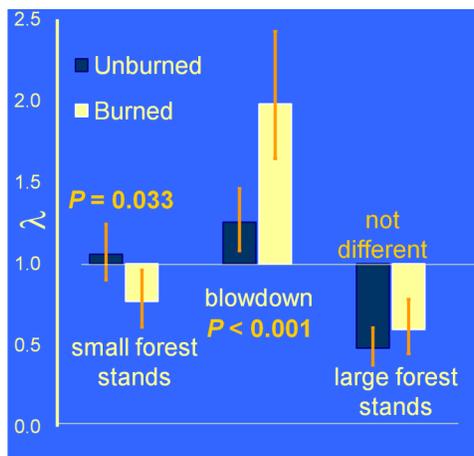
A couple of early foresters left accounts in the literature of fire in bottomland hardwood forests. They noted that fires were a

serious and recurrent risk to timber. G.H. Lentz describes fires occurring in the bottomlands during periodic droughts, when the sloughs and bayous went dry and did not act as fire-breaks. He noted that there were fires both in cut-over and intact forest at these times. F.H. Kaufert did a study of fire-scars on bottomland hardwood trees and documented fires every 5-13 years dating back to before the Civil War.

## Significance

Historical accounts indicate that at least in some locations, fires likely occurred periodically in bottomland hardwood forests. Fires were most likely when droughts rendered dense regenerating vegetation flammable in large forest gaps. Abundant lightning would have served as a source for these fires. By their land management practices, Native Americans and then European settlers increased the number of fires. Many burned areas undoubtedly revegetated with dense stands of native bamboo (canebrakes) and served as prime wildlife habitat.

Anyone interested in restoring canebrakes as a component of fully functioning bottomland hardwood forests should consider using fire as a management tool. But beware that while fire can be beneficial for cane stands, it can harm timber. An integrated study of cane phytoliths (precipitating plant silica bodies), macroscopic and microscopic charcoal might best determine the extent to which fires occurred in bottomlands over ecological time.



**Figure 5. Growth of cane stands after four years at the Buckhorn WMA, modeled as populations of culms, both burned and unburned growing in the tornado blowdown and under nearby forest canopy.  $\lambda = 1$  indicates population stasis,  $\lambda > 1$  indicates growth, and  $\lambda < 1$  indicates population shrinkage.**

## Additional Information

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## About the Author

Paul Gagnon is currently a Post-Doctoral Researcher in the Department of Wildlife Ecology & Conservation at the University of Florida, where he investigates effects of forest fragmentation on populations of an Amazonian understory plant (*Heliconia acuminata*). Prior to that he studied the influence of different fire characteristics on bunchgrass dynamics in species-rich longleaf pine savanna. His dissertation at Louisiana State University focused on the disturbance ecology of giant cane. His main research interest is in how plant populations and communities respond to ecological disturbances. He first became interested in fire as a management tool when he accidentally burned down his back yard as a boy growing up in rural Texas.



Photo by C. E. Timothy Paine

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