RESEARCH REPORT

DENDROCHRONOLOGICAL FIELD METHODS FOR FIRE HISTORY IN PINE ECOSYSTEMS OF THE SOUTHEASTERN COASTAL PLAIN

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ABSTRACT

Few tree-ring based fire-history studies have been completed in pine ecosystems of the Southeastern Coastal Plain, in part because of difficulties in finding old fire-scarred material. We propose specialized field methods that improve the likelihood of locating fire scars in dead trees (i.e. stumps, snags, and logs). Classic fire-history field methods developed in the southwestern United States involve targeting only trees with evidence of repeated external scarring, but we have found this approach to be less effective in our region given that trees without any external scarring may contain an abundance of buried scars. The buried scars occur primarily near the ground surface and can be sampled by collecting full cross-sections from the bases of old dead trees. We hope our insights foster further fire-history research in the Southeastern Coastal Plain.

Keywords: Pinus palustris, longleaf pine, Southeastern Coastal Plain, fire history, fire scars, dendroscopy, field methods.

INTRODUCTION

Dendrochronological techniques allow researchers to reconstruct the frequency, seasonality, and sometimes extent and severity of past fires (Arno and Sneck 1977; Falk et al. 2011). In pine ecosystems of the U.S. Southeastern Coastal Plain (SCP), few tree-ring-based reconstructions of fire have been completed (but see: Huffman et al. 2004; Henderson 2006; Huffman 2006; Stambaugh et al. 2011; Harley et al. 2012; White and Harley 2016). Although these and other sources of information indicate that low-severity fire occurred frequently in this region, additional research is needed to elucidate key aspects of historic fire regimes. Prescribed fire is a widely used land-management tool in the SCP (Melvin 2015), and tree-ring based fire histories can provide important insights regarding burning practices that are best aligned with ecological restoration goals.

In this report, we explore why tree-ring based studies are generally lacking in pine ecosystems of the SCP, address how standard field techniques are sometimes inappropriate, and present alternative methods that should improve the likelihood of locating old, fire-scarred material. Most importantly, we emphasize the need to sample trees near the root-shoot interface to locate buried scars, which are scars that are completely healed over and not externally visible prior to sampling. We also advocate for sampling only dead trees given that removal of partial cross-sections from living trees may make them more susceptible to mortality.

METHODS

Locating Fire-Scarred Material

One of the greatest challenges of conducting fire-history research in the SCP is finding samples that contain abundant fire scars. Traditionally, dendrochronologists target trees that appear to be old and show external signs of repeated scarring in the form of an inverted v-shaped wound (Arno and Sneck 1977; Falk et al. 2011). However, in pine ecosystems of the SCP, this approach is relatively ineffective. Previous work in longleaf pine...
(Pinus palustris Mill.) and slash pine (Pinus elliottii Engelm.) indicated that external fire scarring often occurs in trees that were originally injured by anthropogenic activity, such as deliberate 19th or 20th Century wounding for turpentine or timber purposes (Huffman et al. 2004; Huffman 2006). A fire-history record that extends deeper in time requires obtaining wood that contains buried scars, which may occur in trees with or without external scarring (Figure 1). Thus, in addition to targeting trees with external scarring, researchers should target old trees with no obvious signs of scarring. We are finding that some of the oldest fire scars are from stumps of trees that exhibited no external scarring. We cannot say with certainty why buried scars appear to be more common than external scars in southern pines of this region, but factors including relatively thick bark that insulates well except at fissures, low fuel loads (and associated low fire intensity), increased susceptibility to mortality when open (external) wounds do form, limited topographic relief, and rapid growth over wounding may help explain this pattern.

**Sampling Fire-Scarred Material**

We have developed specialized methods for sampling fire-scarred material from the bases of pines of the SCP (Figure 2). These methods differ notably from the classic approach where the sawyer removes a cross-section or partial cross-section from aboveground, aiming to collect the maximum number of external fire scars (sensu Arno and Sneck 1977). Although this method is useful for collecting recent fire-history information, for longer fire histories it is necessary to collect material from near the base of the tree, where buried scars are typically concentrated. For snags and stumps, cutting slightly below the ground surface requires that the soil first be excavated from around the specimen. The exact location of scars varies and may be just above or below the current soil surface. In our experience, the lowest cut on stumps and snags should be made about 10–20 cm below the current soil surface. Unless there are external scars that are also being collected, only approximately 30–50 cm of aboveground material is needed. In the case of...
tip-ups (from tree falls), no excavation is needed, but it is necessary to estimate the former location of the soil surface and therefore collecting a larger sample may be advantageous. In all cases, the full specimen is later sliced into many cross-sections (of ca. 2.5 cm thickness), and a subset of those samples are selected for analysis. In addition to analyzing one or more samples from near the base of the tree, which contain buried scars, it is useful to use a section taken from higher up in the sample to aid with crossdating because distortion around the scars and near the roots can add difficulty to the process. Not all trees contain buried scars and therefore some sampled material may not be useful for reconstructing fire history. Our approach is relatively time- and labor-intensive compared to traditional methods, especially in wetter sites where pines often produce extensive lateral roots.

**Live-Tree Sampling**

Another consideration for conducting tree-ring work in pine ecosystems of the SCP is whether sampling of live trees is appropriate. Many tree-ring based fire-history studies have included the collection of partial cross-sections from living trees. However, our experience working on prescribed fires in the SCP indicates that trees with significant wounding (both of anthropogenic and natural origin) are more susceptible to mortality from fire. We have frequently observed the flammable, resinous wounds of injured trees ignite during a prescribed fire (Figure 3) and continue to burn the trunk for days, ultimately resulting in the death of the tree. There is some published support of higher vulnerability of sampled trees (i.e. trees for which partial cross-sections were removed) to prescribed fire from a study of ponderosa pine trees (Pinus ponderosa Dougl. Ex Laws.) in Oregon (Heyerdahl and McKay 2008), where researchers attributed significant differences in mortality rates for sampled vs. control trees to prescribed fires. Pine ecosystems of the SCP require frequent fire to maintain their basic character (i.e. species composition and structure) and more prescribed burning occurs in the Southeast than anywhere else in the United States (Melvin 2015). Given the rarity of old living pines in the SCP and the increased likelihood of mortality in prescribed fires following removal of partial cross-sections, we strongly advocate against sampling live trees, except in rare cases where tree mortality is an acceptable or desired outcome. Fortunately, there are often detailed records of recent prescribed fires and wildfires, and sampling exclusively dead material is generally sufficient from a research perspective.
DISCUSSION

We conclude that although there are many challenges to developing tree-ring based fire histories in pine ecosystems of the SCP, this type of research is feasible using modified field methods. Rather than targeting only trees with external scarring, we encourage researchers to collect samples from the bases of dead old trees (whether external scarring is present or not) with the goal of finding buried scars. Other researchers have collected cross-sections from the bases of trees for fire-history purposes (e.g. Henderson 2006; Stambaugh et al. 2011; White and Harley 2016), but this paper is the first to discuss this methodology in detail.

Additional research is needed to aid with the interpretation of fire-scar data from pines in the SCP. Although details are beyond the scope of this paper, we do highlight two considerations. First, research is needed to document how fire-scar position is related to season of burning, especially given how important fire seasonality may be in influencing vegetation patterns in this region (Fill et al. 2012; Robertson and Hmielowski 2014). In order to associate a certain scar position (e.g. within the latewood of a tree ring) to a specific time of year, researchers must first document when trees typically put on earlywood vs. latewood and the timing of dormancy in a given study area. This information could come from monitoring tree growth patterns (e.g. Huffman and Platt 2014) or analyzing the location of scars with known fire dates within annual rings. Second, in the SCP and elsewhere, the interpretation of fire-scar data would be greatly improved by research that examines the mechanisms behind fire-scar formation, including assessment of the fire conditions (fuel, weather, topography), fire behavior, and tree physiology characteristics that might result in scarring.

Valuable wood for fire-history work in pine ecosystems of the SCP is rapidly disappearing from numerous causes including: conversion of pine ecosystems to other uses (e.g. housing developments), natural decomposition processes, prescribed fire and wildfire burning up stumps, and the practice of stump harvesting or “stumping,” which is the deliberate removal of stumps after logging for resin (Gamble 1921), and more recently for mulch, bioenergy, or to make the land more traversable. We hope that other researchers will join in our efforts to collect fire-scarred wood from these systems before the opportunity is lost. Although researchers and land managers understand that pine ecosystems of the SCP are maintained by frequent low-severity fire, direct evidence from tree rings is needed to develop a better understanding of...
historic fire regimes. Our experience is limited to sites in the SCP, but it is possible that these methods may also be applicable to other areas where low-severity fires occur but external scars are rare or absent.

ACKNOWLEDGMENTS

We would like to thank Bill Platt and Kevin Robertson for their essential support and encouragement of this work, Neil Jones for his unflinching help and hard work cutting stumps over many years, and Steve Morrison who has helped develop and refine our stump collection and processing methods. Also thank you to the two anonymous reviewers whose feedback improved this manuscript.

REFERENCES CITED


Received 10 February 2016; accepted 1 November 2016.