Testing the Feasibility of Dendrogeomorphic Studies in the Southeastern U.S. on Mt. Le Conte, Great Smoky Mountains National Park, Tennessee, U.S.A.

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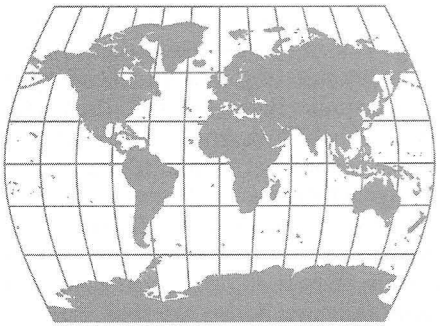

ABSTRACT

Dendrogeomorphic analyses of mass movement events have been sparingly conducted at sites in the western United States, and are especially uncommon in the eastern U.S. The goal of this study was to determine if southeastern tree species in Great Smoky Mountains National Park (GSMNP) record evidence of debris slides in their tree-ring record. Following initial reconnaissance on three debris slide scars on Mt. Le Conte in GSMNP, we performed preliminary dendrogeomorphic analysis on one of the slides, LC01. This slide is considered, although not thoroughly documented, to have occurred following a cloudburst on September 1, 1951. The identification of suppressed growth beginning in 1952 confirmed the correspondence of the debris slide at LC01 with the cloudburst event and, combined with the identification of accessible and discernable evidence of the impact of debris slides on trees, served as confirmation of current and future use of dendrogeomorphic methods on Mt. Le Conte and in GSMNP.

Key Words: dendrogeomorphology, tree rings, Mt. Le Conte, Southeast US, Great Smoky Mountains National Park

INTRODUCTION

Shroder (1978) outlined the impacts of mass movement events on trees and their subsequent responses. He described the Process-Event-Response approach for understanding relationships between landscape-modifying processes that lead to specific types of mass movement events that leave anatomical evidence in tree boles and the tree-ring record. The "event" describes what happens to the tree as a consequence of the geomorphic occurrence, such as tree tilting, corrosion, burial, exposure, inundation, and nudation. The "response" describes the biological response of the tree to the event, such as scarring, growth suppression or release,

tree death, basal sprouting, and formation of reaction wood. Secondary succession can also occur when trees reestablish on exposed slopes and deposits. Tree-ring evidence, observed as the "responses" listed above, can then be used to determine when the "events" occurred (Shroder 1978). The use of tree-ring evidence to analyze geomorphic events, such as debris slides, is known as dendrogeomorphology.

The term "debris slide" is defined by Easterbrook (1999) as the "rapid downward movement of predominantly unconsolidated and incoherent debris in which the mass does not show backward rotation but slides or rolls forward, forming an irregular hummocky deposit." Debris slides are most common in mountainous areas where thin layers of sediment collect on top of bedrock layers that dip in the same direction as the slope. Heavy rainfall often leads to saturation of these thin layers, which can break loose as masses of unconsolidated sediment and rock and slide over the top of the tilted planar bedrock surfaces (Easterbrook 1999). Debris slides are a common natural disturbance on Mt. Le Conte in Great Smoky Mountains National Park (GSMNP), where thin soil layers underlain by tilted Anakeesta Formation bedrock are prone to sliding after heavy rainfall events (Hadley and Goldsmith 1963; Moore 1988; Henderson 1997). We chose Mt. Le Conte for our study because of the high number of visible debris slide scars and efficient access to these scars from trails, roads, and drainage systems. Henderson (1997) performed an initial dendrogeomorphic analysis of debris slide susceptibility in the Mt. Le Conte-Newfound Gap area of GSMNP, but his focus was on secondary succession, using the establishment dates of trees to estimate the minimum dates of debris slides.

Despite high incidence of mass movement events in the Appalachian Mountains of the eastern United States, dendrogeomorphology has been used rarely in the region, especially in the southeastern United States and in GSMNP. Possible reasons for the scarcity of dendrogeomorphic studies, identified during our own attempts to perform dendrogeomorphic analyses in GSMNP, are accessibility and terrain. Accessibility was a determining factor when we chose our study sites on Mt. Le Conte, as vegetation in GSMNP, especially at lower elevations in summer, grows rapidly, and thick underbrush sometimes restricted access to slide scars and perimeter trees and made it difficult to identify trees for sampling. In the case of lower elevation slide scars, the rapid growth of vegetation made it challenging to even locate the slide scars. The three slides investigated for this study were primarily accessible via the slide scars themselves, which bisected trails, roads, and streams in the park. Because such research can require off-trail hiking and impacts to vegetation, finding access points while leaving minimal impact on the environment will be especially difficult in future studies of the slide scars in GSMNP. Where steep slopes and loose talus also occur, appropriate climbing gear and other safety equipment will be necessary to access and sample on some debris slide scars in the park. These two factors, vegetation and terrain, are limiting factors that preclude extensive dendrogeomorphic studies in GSMNP and are possible reasons for the deficiency of such work in the park.

Despite these limitations, debris slides still pose a threat to human life and property in GSMNP. Dendrogeomorphology can be used to not only determine the dates of these events in the park, but can also be used to identify debris slides and flows no longer visually evident or not reported in historical records. The addition of these events to the record can contribute to mass movement inventories and the improved identification of high-risk areas (Stoffel and Bollschweiler 2008). Because of the lack of dendrogeomorphic studies in the eastern United States and in GSMNP, we first sought confirmation of the ability of trees to record a debris slide signal before we performed a complete dendrogeomorphic analysis. A preliminary exploration of the visible impacts of debris slides on trees in GSMNP was needed to better understand the external evidence