RELATIONSHIP BETWEEN CROWN DIEBACK AND DROUGHT IN THE SOUTHEASTERN UNITED STATES

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Abstract.—Forest Health and Monitoring (FHM) and Palmer's Drought Severity Index (PDSI) data were obtained for 11 states in the southeastern United States to assess the relationship between drought and crown dieback. Correlation analyses were performed at the species group and ecoregion levels within the study area. The results indicate a negative correlation between drought and crown dieback within 3 to 5 years of the onset of drought conditions.

INTRODUCTION

Crown dieback, a crown health indicator collected during Phase 3 sampling by the Forest Health and Monitoring (FHM) Program of the U.S. Forest Service, provides an early indication of tree stress by estimating the amount of death that has occurred in a tree crown (Schomaker et al. 2007). We seek to use crown dieback as a first indication of the impacts of drought on forests in the southeastern United States. Regional differences in crown dieback such as elevated crown dieback in maple species (*Acer* spp.) throughout the northeastern United States and red oak species (*Quercus*, section *Lobatae*) in the Ozark Highlands (Fan et al. 2008, Randolph 2009) indicate that trees may react differently to sources of stress. Typically, hardwood species will shed leaves to avoid drought stress while pine species typically have less leaf area from the outset (Barnes et al. 1998). In the southeast, Randolph (2009) found that oak species had higher levels of crown dieback than pines. Further, denser oak stands exhibit a higher susceptibility to drought in some areas of Alabama, Georgia, and Virginia that could lead to an increase in mortality (Klos et al. 2009) or increased susceptibility to damage from fires or insects.

Monitoring the susceptibility to damage over a large scale is an important first step in understanding the interaction between climate and forests. To this end, we wanted to determine the relationship between crown dieback and drought within various species groups by forest type and ecoregion. Our hypothesis was that relationships will vary among the selected groups and give an overall impression of the impact of drought on southeastern U.S. forests.

METHODS

Crown dieback, plot location (i.e., latitude and longitude), and inventory year were extracted from FHM inventory data obtained from the U.S. Forest Service for all trees with a diameter at breast height (d.b.h.) greater than 5 inches for available states in the southeastern United States (Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, North Carolina, South Carolina, Texas, Tennessee and Virginia). PDSI data (Palmer 1965), a commonly used index for assessing drought, were obtained from the National Climatic Data Center of the National Oceanic and Atmospheric Administration to determine the severity and duration of drought across the southeastern United

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States. FHM and PDSI data were then displayed in a geographic information system (GIS) and joined so that PDSI values were extracted to the FHM plot. This allowed for a completed dataset of crown dieback and PDSI for each tree record in the dataset. The data were then extracted by species group within each forest type and then by ecoregion. It was then possible to assess the relationship between crown dieback and PDSI across forest types and ecoregions for each species group.

RESULTS

The pine species group did not yield any significant relationships with PDSI, forest type, or ecoregion. The red oak, white oak (*Quercus* section *Quercus*), and other hardwood species groups all exhibited significant relationships with forest type, with pine, oak/pine, and oak/hickory having elevated levels of crown dieback. PDSI and ecoregion were also significant explanatory variables for red oak and white oak species groups with the highest levels of crown dieback occurring in areas impacted by drought (Table 1). These preliminary findings can be used to further refine models to monitor crown health with indicators of drought.

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Table 1.—The most significant variables for assessing crown dieback in the southeastern United States by species group

Species Group	Significant Variables	Crown Dieback (%)
Red Oaks	Pine, Oak/Pine, and Oak/Hickory forest types	19.7
	Eastern Broadleaf Forest (Oceanic), Outer Coastal Plain Mixed Forest, Lower MS Riverine Forest, Ouachita Mixed Forest/Meadow Ecoregions	26.7
	3-Year Cumulative PDSI ≥1.28	36.8
White Oaks	Prairie Parkland Ecoregion	33.2
	Pine, Oak/Hickory, and Oak/Gum/Cypress forest types	39.6
	7-Year Cumulative PDSI < -1.802	64.8
Other Hardwoods	Pine, Oak/Pine forest types	42.6

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