ASSESSMENT OF THE 1998–2001 DROUGHT IMPACT ON FOREST HEALTH IN SOUTHEASTERN FORESTS: AN ANALYSIS OF DROUGHT SEVERITY USING FHM DATA

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INTRODUCTION

Analyses of forest health indicators monitored through the Forest Health and Monitoring (FHM) program suggested that weather was the most important cause of tree mortality. Drought is of particular importance among weather variables because several global climate change scenarios predicted more frequent and/or intense drought in the Southeastern United States. During the years of 1998-2001, extensive forest areas within the Southeastern United States experienced severe drought conditions (defined by the Palmer Drought Severity Index (PDSI)). In this study, we used FHM data to examine the effect of drought induced moisture stress on forest growth, mortality and changes in crown condition at a regional scale.

OBJECTIVES

Our objective was to investigate changes in growth, mortality, and crown condition across the Southeastern United States under various drought conditions using 1991 to 2005 FHM plot data. Specifically, we examined how drought severity influenced the rates of annual growth, mortality, and change in crown condition using PDSI as an indicator of drought severity. Drought effects were examined for three species groups (pines, oaks, and mesophytic species).

METHODS

FHM plot data from 1991 to 2005 for 307 plots located in AL, GA, and VA were used in this study. Tree data were obtained at the subplot level from a total of 936 subplots. Within each subplot, all trees with diameter at breast height greater than 5 inches were measured. Annual relative growth rate and annual rate of change for crown density, crown dieback, and foliage transparency crown condition indicators were calculated for each tree re-measurement. Annual mortality rates within a subplot were calculated for each species and were expressed as percent removed per year. Monthly PDSI values during the study period were obtained for each of the plots from NOAA. Drought conditions were assigned to each interval of plot measurements based on the minimum growing season (May to September) PDSI using a classification similar to that used by NOAA: 1) no drought, 2) mild drought, 3) moderate drought, and 4) severe drought. Three species groups were identified for analyses: 1) pine (*Pinus*), 2) oak (*Quercus*), and 3) mesophytic species. The mesophytic species group includes maple (*Acer*), birch (*Betula*), beech (*Fagus*), sweetgum (*Liquidambar*), yellow-poplar (*Liriodendron*), and magnolia (*Magnolia*). The mixed model procedure PROC MIXED in the SAS/STAT software was used to examine the relationship between the dependent variables (i.e., the rates of relative growth, mortality, and change in crown condition) and drought severity and stand condition variables. Five stand condition variables were included in the analyses to account for varying stand conditions: total basal area, total tree density, tree species richness, slope, and stand age. The means were calculated for each dependent variable by drought class and species group. The LSD test was used to determine differences among the drought classes for each of the dependent variables.

RESULTS AND DISCUSSION

A general decrease in mean relative growth rate was observed with increasing drought severity. However, mean relative growth rates were not significantly different among drought classes for the oak species group, indicating that oaks exhibit drought tolerance and can maintain growth rates during drought episodes, regardless of drought severity. The pine and mesophytic species exhibited a significant reduction in growth rate when exposed to mild and moderate drought. These findings suggest that oaks can maintain growth rates during drought episodes but pine and mesophytic species cannot. A general increase in mean mortality rate was observed with increasing drought severity for the pine and mesophytic species groups. Mean mortality rates within the no drought class were significantly lower than those within the other three drought classes, among which no significant differences in mean mortality rate were observed, for both the pine and mesophytic species groups. The pine and mesophytic species groups appear to be sensitive to drought and suffer higher mortality rates during drought episodes, regardless of drought severity. However, mean mortality rates were not significantly different among drought classes for the oak species group, indicating that oaks exhibit drought tolerance and can avoid mortality during drought episodes, regardless of drought severity. Our analyses failed to show any negative effect of drought on the change of crown conditions, suggesting that detecting changes in crown condition indicators over a relatively short plot measurement interval using visual measures at 5 percent increments may be unrealistic.

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Citation for proceedings: Stanturf, John A., ed. 2010. Proceedings of the 14th biennial southern silvicultural research conference. Gen. Tech. Rep. SRS-121. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station. 614 p.

CONCLUSIONS

(1) Pines and mesophytic species exhibited a significant reduction in growth rate and increase in mortality rate with increasing drought severity, suggesting they are sensitive to drought.

(2) Oaks exhibited no significant change in either growth or mortality rates with increasing drought severity, suggesting that they are tolerant of drought (even under the most severe drought class).

(3) No realistic change in crown condition was observed. Therefore, change in crown condition in relation to drought severity may require different data and/or analyses.

(4) The observed differential growth and mortality rates among different species groups in response to drought severity may alter the composition of Southeastern United States forests if drought episodes become more frequent and/or intense due to climate change. The potential shift in forest composition should be considered in current forest management in order to sustain these forests in the future.

ACKNOWLEDGMENTS

This work was funded by the U.S. Forest Service. We thank Dr. James Reick for his statistical advice.