TITLE: Drought Impact on Forest Heath in the Southeast – An Analysis Based on FHM/FIA data
[SECOND YEAR FUNDING]
LOCATION: Southeastern US

DURATION: Year one of two-year project

FUNDING SOURCE: Base

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PROJECT OBJECTIVES:
Based on analyses of FHM/FIA data between 1990 and 2002, the proposed study will address the following two questions: (1) how did drought affect forest health indicators? (2) Did the drought effect vary with stand condition?

JUSTIFICATION:
Results from current analyses of forest health indicators tracked through the FHM program indicated that weather was the most important cause of tree mortality in the Southeast US, more than insect, disease and animal effect combined. Among possible weather variables that affect forest health, drought or deviation from normal precipitation and its effects are of particular interest to FHM programs. The proposed project will assess drought effect on forest health based on analyzing FHM plot data. It will cover a large geographic area, the southeast US, where a severe drought occurred in 1998-2001 over an extensive forest area and yet its impact on forest ecosystems, including on forest health indicators, has not been assessed. Drought has been an important regulator of forest ecosystems. It can act directly on trees by reducing their growth and vigor or resulting in mortality. It can also act indirectly by predisposing trees to damage from other abiotic (e.g., fire) or biotic (e.g., insect) agents. Consequently, understanding how drought affects trees of different species and size classes on different sites under different stand conditions is essential to successfully mitigate its negative impact on the sustainability of forest ecosystems.

In the Southeast US, it is predicted that drought will become more frequent and intense under several global change scenarios. Furthermore, the proposed study will determine if poor stand conditions resulted from long-term fire suppression and timber management have affected the ability of forest stands to cope with stress such as drought, which is especially significant as it would provide direct evidence to support the President's Healthy Forest Initiative. Because of the cost associated with implementing experimental approach, most published studies that assess the effect of drought on natural forest were based on retrospective analysis of permanent sample plots monitored over a period of time including severe drought years. These studies have proven useful in evaluating the effect of drought on tree mortality and growth. The proposed project will benefit from these established methodologies. Unlike previous studies, however, the proposed project will use a much more extensive data (the network of FHM plots)

and, therefore, provide a regional perspective on the impact of drought in forest health.

DESCRIPTION:

a. Background:

In recent history, extensive forest areas of the Southeast US have experienced several severe droughts (1954-1957, 1986-1989, and 1998-2001) as indicated by the Palmer Drought Severity Index (PDSI) (Palmer 1965). The droughts of the 1950's and 1980's significantly affected tree mortality and growth (Buell et al. 1961, Small 1961, Elliott and Swank 1994, Olano and Palmer 2003) although the effect of the 1998-2001 drought has not yet been documented. Change in climate, especially global warming due to continuing increase in greenhouse gas concentrations, has raised concerns about potential impact of increased drought frequency and/or intensity on forest ecosystems throughout the USA (Neilson et al. 1989). Under most climate change scenarios, more frequent and/or intense drought is expected in the Southeast US, where potential evapotranspiration is predicted to increase and exceed future summer precipitation (e.g., Smith and Tirpak 1990). Therefore it is important to understand the effect of drought on forest health.

Since the implementation of an active fire suppression program in the early 1900, forests in the Southeast US have become much denser than under previous fire regimes. It is well known that fire suppression has resulted in dense forest and dense forests and greatly increased fuel accumulation, increasing the risk of catastrophic fire. It is not clear if dense forests are more susceptible to health problem induced by stress such as drought. The past emphasis on timber management has simplified species composition of many forest stands across the Southeast US with reduced tree species diversity. It is possible that decreases in tree species diversity may exacerbate the drought effect. Knowing if and how forest response to environmental stress changes with stand condition is pre-requisite for prescribing silvicultural treatments to enhance the sustainability of forest ecosystems. By utilizing the extensive network of permanent sample plots established by FHM program, it is possible to assess the effect of drought and stand condition on tree growth, mortality and other health indicators at regional scale.

b. Methods:

All FHM plot data in the Southeast will be acquired and examined. Only those plots with at least one re-measurement will be used in the study. After compiling the study dataset, climatic data for each plot will be obtained from the nearest climatic station for the entire monitoring period. Based on climatic data, PDSI will be calculated for each plot in each year. Number of years (0 to 4) in severe (PDSI > -3.0) drought will be determined and maximum and average PDSI will be calculated for each study plot. Stand conditions including stand type, age, and density, basal area, and tree species richness will be compiled from the FHM data for each study plot. Tree species diversity (based on proportion of basal area of individual species) will be calculated, and % mortality, changes in growth and crown condition will be quantified.

Regression analyses will be used to relate drought variables to growth, mortality and crown condition variables. Based on drought variables, plot will be classified into three groups (no drought, moderate drought and severe drought) using K-MEAN cluster analysis (Wang 1997). Within each group, regression analyses will be used to relate stand variables to growth, mortality and crown condition variables. All statistical analysis will be conducted using SYSTAT version 10.2 (SYSTAT Software Inc. 2002).

c. Products:

Soon after funding approval, outline of the research project will appear on website. By the end of the project, a MSc. thesis will be completed by the graduate student working on the project, a manuscript will be submitted for publication at a refereed journal, and a summary of research findings will be published on website.

d. Schedule of Activities:

The proposed project is for two years starting in January, 2004 and ending December 2005. Each major activity and its starting date are listed below:

01/2004	Acquiring FHM/FIA plot data	05/2004	Compiling study dataset
08/2004	Acquiring climatic data	12/2004	Analyzing data
06/2005	Writing thesis	10/2005	Writing manuscript

e. Progress/Accomplishments:

N/A

f. References

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Elliott, K.J. and W.T. Swank. 1994. Impact of drought on tree mortality and growth in a mixed hardwood forest. J. Veg. Sci. 5: 229-236

Neilson, R.P., G.A. King, R.L. DeVelice, J. Lenihan, D. Marks, J. Dolph, B. Campbell and G. Glick. 1989. Sensitivity of ecological landscape to global climatic change. US Environmental Protection Agency, Environ Res. Lab., EPA-600-3-89-073, NTIS-PB-90-120-072-AS, Washington, DC, 103 pp.

Palmer, W. C, 1965: Meteorological Drought. Res. Paper No.45, Dept. of Commerce, Washington, D.C. 58 pp.

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Smith, J.B. and D.A. Tirpak. 1990. The potential effects of global climate changes on United States. Hemisphere Publishing Corp., New York. 689 p.

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COSTS (Requested FHM EM funding)

	Year 1	Year 2
Graduate student stipend	18,000	18,000
Summer salary for G. Wang (one month)	6,400	6,400
Fringe benefit	1,716	1,716
Materials and supplies	500	500
Travel	1,500	1,500
Total direct cost	28,116	28,116
Overhead (40%)	11,246	11,246
Total	**39,362**	**39,362**