

TITLE: Regional oak decline-related and regular oak mortality predictions of extent and severity: including factor identification, and probability modeling.

LOCATION: Ozark Highlands in Arkansas and Missouri (Ecological section 222A: Ozark highlands)

DURATION: 2 years

FUNDING SOURCE: Base

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PROJECT OBJECTIVES:

- Quantify historical rates of black, scarlet and northern red oak mortality in the Ozark Highlands (Ecological section 222A) as a baseline against which to evaluate current levels of oak mortality.
- Use classification and regression tree (CART) analysis and/or related classification techniques to determine the tree and plot factors that are the best indicators of oak mortality.
- Determine the relative importance of factors that are determined to be statistically significant indicators of oak mortality.
- Apply the CART model using the latest available data from the Arkansas and Missouri FIA state-wide inventories (Cycle 5) to identify risk levels (severity).
- Use the CART model to identify FIA plots measured in the most recent Arkansas and Missouri state-wide inventories that appear to show high risk (severity) of future oak mortality & map predicted extent.

JUSTIFICATION: In the Ozark Highlands of southeast Missouri and Northern Arkansas there is considerable concern about oak decline (Oak et al. 2004, Starkey et al. 2004, Spetich 2004). In the Ozark National Forest of Arkansas alone, at least 300,000 acres have been severely impacted (Starkey et al. 2004). Red oak group species (*Quercus* spp. L.; subgenus *Erythrobalanus*) appear to be particularly susceptible, especially those that are large or physiologically mature, in dense stands, and growing on droughty sites (Law and Gott 1987; Starkey and Oak 1989, Starkey et al. 2004, Johnson et al. 2002). A number of related agents such as the red oak borer are also involved in the decline and mortality complex (Voelker and Muzika 2004). Forests of the Ozark Highland ecoregion (Ecological section 222A) (Keys et al. 1995) are highly susceptible to oak decline in the coming decades (Lawrence et al. 2002). Approximately 98 percent of all scarlet oak volume, 83 percent of all black oak volume, 54 percent of all northern red oak volume in Missouri and Arkansas occurs in this ecoregion. There are statistical techniques and data available to identify the factors associated with oak decline. Those factors can be used to develop a range of models (simple to complex) that can be applied with FIA/FHM data (or other sources of data) to identify tree, stand, or site conditions and geographic subregions of concern for future mortality. The same suite of models can be applied by silviculturists and forest managers to mitigate oak mortality by identifying trees and sites where future mortality is likely to be unacceptably high.

DESCRIPTION:

a. Background: Recent research on oak mortality from the Missouri Ozark Forest Ecosystem Project (MOFEP) (Brookshire and Shifley 1997, Shifley and Brookshire 2000, Shifley and Kabrick 2002) has demonstrated that species, crown class, and tree size are significant indicators of the probability of oak mortality (Kabrick et al. 2004). Those results are based on a time period covering approximately 1991 to 2002. Oak decline is a periodic event and recent oak mortality rates may or may not be consistent for earlier decades. However there are historical data that can be used to test the temporal consistency of oak mortality rates. A number of analytical and modeling techniques can be used to identify the factors most associated with future oak mortality. Classification and regression tree analysis or CART (Breiman et al. 1984) has been shown to be particularly useful at identification of factors associated with oak Mortality (Kabrick et al. 2004). Additional unpublished analyses give preliminary indications that oak diameter growth rates are a particularly good indicator of future mortality rates. This is a logical outcome and consistent with some past models of tree survival (e.g. Buchman et al. 1983). For most forest management inventories, individual-tree diameter growth rates are not available (nor cost-effective to measure). However, diameter growth rates are regularly observed on FIA plots. Analyses based on a variety of data sources should identify threshold diameter growth rates that, in conjunction with other tree, plot, and/or climate variables, are indicative of high rates of future oak mortality. When such relationships are verified, they can be applied with current inventory data (e.g., FIA) to identify plots and regions that appear to be at comparatively high risk of future oak mortality.

b. Methods: Use CART and other statistical analysis tools to identify hierarchical relationships among tree, stand and/or site factors that are associated with varying levels of oak mortality.

- Evaluate data collected at different points in time from 1957 through 2002 to determine if the patterns are consistent over time.
- Specifically evaluate the relationship of a tree's recent diameter growth rate to its subsequent survival.
- Use CART analyses to create a probability based model of oak survival. Previous work indicates that models will most likely be based on tree species, crown class, and diameter growth rate (and possibly other factors). We will explore links between mortality and drought indices over the various plot remeasurement intervals found in the available data.
- Apply the model to current FIA data to identify (and possibly map) plots that have a high probability of future oak mortality.

c. Products:

- A ranked list of the factors that are the best indicators of oak mortality (or survival).
- An associated model of the mortality probability expected for each level (or value) of each significant factor.
- An evaluation of the model performance for historical data datasets with initial measurements dating back as far as 1952.
- Application of the best model(s) to current (cycle 5) FIA data for the Arkansas and Missouri Ozarks to identify and map regions (extent) where future oak mortality is expected by severity (risk) class.

d. Schedule of Activities:

Based on time from date of award receipt

Year 1

- Award + 6 months Data assembly and initial summary
- Award + 12 months Initial model development and factor identification

Year 2

- Award + 4 months Model testing across data sets
- Award + 7 months Application to Arkansas and Missouri cycle 5 FIA data
- Award + 12 months Mapping, final report Revision and draft publication.

e. Progress/Accomplishments: Not applicable, this is a new proposal

COSTS:

	Item	Requested Funding	Other-Source Funding	Source
YEAR 2006				
Administration	Salary and Benefits Research Associate (5 mo.)	27,907	Contributed salary (Spetich, Kabrick, Shifley, Moser; Moltzan, Lawrence) \$25,000	SRS, NCRS, and MO Dept. Cons.
	Overhead Univ of MO Southern Res, Stn	10,469 6,592		
	Travel	3,000	\$3,000	SRS, NCRS
Procurements	Supplies	500		
TOTAL YEAR 2006		\$48,468	\$28,000 (in-kind)	
YEAR 2007				
Administration	Salary and Benefits Research Associate (5 mo.)	29,302	Contributed salary (Spetich, Kabrick, Shifley, Moser; Moltzan, Lawrence) \$25,000	SRS, NCRS, and MO Dept. Cons.
	Overhead Univ of MO Southern Res, Stn	10,434 6,570		
	Travel	1,500	\$3,000	SRS, NCRS
Procurements	Supplies	500		
TOTAL YEAR 2007		\$48,306	\$28,000 (in-kind)	
TOTAL PROJECT		\$96,774	\$56,000 (in-kind)	

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