

TITLE: Assessment and etiology of hickory (*Carya* spp.) decline in the mid-west and northeastern regions

LOCATION: MO, IA, IN, IL, WI, OH, WV, NY

DURATION: 3 year project **FUNDING SOURCE:** Base EM

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PROJECT OBJECTIVES: 1. Conduct field evaluations to: a) determine frequencies of decline and mortality of *Carya cordiformis*, *C. ovata* and other species in appropriate forest cover types where deviations from expected levels of mortality have been observed, b) quantify relationships between decline incidence and pathogen and/or insect pest presence, and c) quantify relationships between decline incidence and prior land use, fire history, soil fertility and/or drought. 2. Determine the role of two newly described *Ceratocystis* spp. (*C. smalleyi* and *C. caryae*) in decline and mortality of *Carya* spp. in trees from which these fungi can be isolated.

JUSTIFICATION: Our proposed project addresses the selection criteria as follows.

1. The project is directly linked to FHM detection monitoring, where recent widespread hickory decline is indicated by off-plot survey data in parts of the two regions which is an unexpected deviation from earlier published FHM grid plot reports for the species.
2. Geographic scale: Bitternut hickory is the most abundant and uniformly distributed *Carya* spp. in the two regions; however, shagbark hickory and other species are also common. Deviations from expected levels of decline have been reported in Iowa, Minnesota, New York, Ohio, and Wisconsin.
3. Biological impact and/or political importance: Hickories are an important component of many forest associations in the eastern United States, particularly various oak-hickory cover types. Hickories are important sources of hard mast for wildlife and have the potential to produce valuable timber. They are also important in the biological diversity of stands threatened by numerous other stressors and damage agents. Sites impacted by hickory decline and mortality have been reported to lose a high proportion of the hickory over a very short period of time (3 to 5 years), causing a significant adverse impact to wildlife, timber value and diversity on the sites.
4. Feasibility/probability of success: Early success has been achieved in preliminary work conducted with state cooperators on a very limited scale in WI and MN in 2006. This work has included determination of presence of *Ceratocystis* spp., several insect pests/damage agents, and other pathogens associated with affected trees. Thus, a high probability of success is likely.

DESCRIPTION:

- a. *Background:* Hickory decline, particularly of bitternut hickory and shagbark to a lesser extent, has recently been noted in Iowa (Johnson et al. 2005), in Missouri, Maryland, New York, Pennsylvania and West Virginia by FHM (USDA Forest Service 2003 and 2004), and Wisconsin (Wisconsin DNR, 2005). Widespread mortality of hickory has historically been attributed to outbreaks of the hickory bark beetle (*Scolytus quadrispinosus*) during extended periods of drought (USDA Forest Service 1985). The insect is considered the most important pest of the species group (Solomon and Payne, 1986). In 1994, a newly discovered fungus was reported in discolored wood and sunken bark cankers associated with beetle attacks (USDA Forest Service, 1994). This fungus, *Ceratocystis smalleyii*, and a new sister species (*C. caryae*) were recently described (Johnson et al. 2005). Both species were pathogenic on 2-y-old *Carya* spp. in greenhouse studies. The researchers suggested that *C. smalleyii* might play a significant role in hickory mortality. Past land use and soil fertility were shown to indirectly determine outbreaks of the bark beetle (Dale, et al. 1990). Phomopsis galls, *Armillaria* root rot and a flatheaded woodborer (*A. otiosus*) have also been associated with declining trees (Wisc. DNR 2005). A re-examination of affected ecosystems is needed to determine and/or clarify the importance of hickory decline and mortality in relation to these damaging agents as well as climatic, edaphic and cultural factors.

- b. *Methods:*

Field Evaluation – Multiple decline-affected stands in at least six states will be identified by state cooperators for evaluation. Information on site history, stand and site conditions, and recent episodes or drought or other stresses will be recorded. Standard tree and stand information such as tree size class, area of stand, species present, will be recorded for each site. Transect survey methodology will be used to obtain estimates of decline and mortality frequencies. One to two trees in several decline foci will be closely examined for evidence of insect pest and/or damage presence, and for disease damage and/or pathogen presence. Samples will be collected and forwarded to the processing lab for insect pest identification or rearing plus identification and for pathogen isolation and identification. Relationships between i) insect pest and/or pathogen presence; ii) historical site and climate information; and iii) soils and stand condition information and decline and mortality frequencies will be investigated.

Role of *Ceratocystis* species – A) Field and laboratory studies will be conducted in selected stands with active hickory decline to determine the role of *Ceratocystis* spp. in tree decline and mortality. i) Isolations will be attempted from hickories with and without a) hickory bark beetle colonization, b) *Agilus* spp. colonization, and c) open wounds, to determine the frequencies of *C. smalleyii* and *C. caryae* associated with each. B) Field inoculations of apparently healthy pole-sized trees of the predominant hickory species will be inoculated with isolates of both *Ceratocystis* species to confirm pathogenicity suggested by seedling tests (Johnson et al. 2005) and to investigate whether systemic spread of the organisms occur within infected trees. C) The contamination frequency of hickory bark beetles with *C. smalleyii* dispersing in the stand and/or emerging from colonized trees will be determined.

- c. *Products:* This project will produce 1) maps of states showing locations of evaluated stands and key findings, 2) quantitative summaries and predictive understanding of the relationships between decline and mortality probabilities and the factors investigated,

3) qualitative and quantitative summaries relating to the role of two *Ceratocystis* species in the decline process.

d. *Schedule of Activities:* Year 1 – i) conduct field evaluations in ≥ 3 states (6 to 10 stands per state) and process samples in lab, ii) conduct studies on role of *Ceratocystis*– a) intensively sample and isolate from hickories with specified conditions for ≥ 4 stands, b) initiate first year inoculation study, and c) test and finalize insect trapping procedures in preparation for year 2 study.

e. *Progress/Accomplishments:* see above for accomplishments anticipated for year 1

COSTS:

For Year 1 -

Category	Item	Requested FHM EM Funding	Other Source Funding	Funding Source
Administrative	Salary and Benefits	\$20,000	\$34,000	University of Minnesota
	Travel	\$5,000	\$ 5,000	NRS
	Overhead	\$2,500		
Procurement	Field Equipment	\$1,000		
	Lab Supplies	\$3,500		
	Mailing Costs	\$ 500		
TOTAL		\$32,500	\$39,000	

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