Assessment and Etiology of Hickory Decline (NC-EM-07-01)

Preliminary Results

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**RESULTS**

A decline or dieback of hickories (Carya spp.), particularly of “smoothbark” hickories, has recently been reported in several sites across the midwest (USDA Forest Service 2003 and 2004, Johnson et al. 2005, WIDNR 2005) (Fig. 1). Site survey

**Objectives**

- Conduct field evaluations to determine the frequency and severity of decline and incidence of hickory mortality.
- Quantify relationships between decline incidence and severity and pathogen and/or insect presence.
- Quantify relationships between decline incidence and severity and stand basal area, soil type, elevation, land use, and drought history.

**Site and Tree Data**

- 14 sites in 13 counties across three states (IA, MN, and WI) were surveyed and sampled in the summer of 2007 (Fig. 2).
- Total live stand basal area and number of hickory stems across four size classes were recorded at 9 fixed radius plots (~1/15 acre) at each site.
- Frequencies of hickory decline and mortality (“decline” is defined as >20% crown dieback), decline severity based on crown ratings, and availability of damage on most from fungi, insects, fire, or mechanical damage, were gathered at 30 plot points per site.
- Soil, topographical, and climatological data were gathered through use of GIS.
- At each site, four 2-ft log sections were taken from each of three declining trees for insect and pathogen evaluation.

**Insect Data Collection**

- Two log sections from each declining tree were placed in insect emergence chambers.
- Total number and type of insects that emerged were recorded weekly over six weeks (Fig. 3).
- After six weeks, the bark on each log was removed and presence and type of galleries recorded (Fig. 4).

**Pathogen Data**

- Small cubes of discolored wood underneath cankers were taken from each 2-ft log section (Figs. 5 & 6) and used to isolate for fungal pathogens.
- Isolation protocol:
  - **Ceratocystis spp.**: small wood cubes were placed in moist chambers for 10 days. Ascospore masses produced by perithecia sporulating on cubes were plated onto MEA + SS, and pure cultures obtained from the resulting isolates.
  - **Fusarium spp. and Phomopsis spp.**: wood cubes were surface-sterilized with alcohol and flaming, small wood chips removed, and then placed into petri dishes containing APA. Cultures with characteristics of Fusarium and Phomopsis spp. were purified, identified to genus, and stored at 40°C until species identification is made.

**Insects Associated with Declining Trees**

- HBB and/or their galleries were found at all sites (Fig. 10).
- Oak bark beetles (Pseudotylophloeus assectans) were obtained from logs collected on the 25th of May in WI.

**Fungi Associated with Declining Trees**

- **Ceratocystis spp.** and **Fusarium spp.** were isolated from logs from declining trees infested with the hickory bark beetle.
- **Fusarium**—positive log sections were commonly from trees infested with the hickory timber beetle.
- **Phomopsis**—more frequently obtained from sunken cankers on logs than trees.
- Both fungi were obtained, in similar proportions, from annual, diffuse cankers.

**Site survey**

- Oak-hickory-maple northern hardwood stands were found at all sites. Bitternut hickory (Carya ovata) accounted for 75% of the hickories, the remainder were shagbark (C. glabra). Soils were sandy or silty loams, slopes of the sites ranged from 0 – 20%, and elevation from 600 – 1861 ft.
- BA ranged from 51 – 114 ft²/acre-1 (10 out of 14 sites considered “overstocked” with BA > 80 ft²/acre-1).
- Decline severity (based on crown dieback) was found to increase linearly with BA (r² = 0.45) while incidence of mortality was highest at sites with extremely low and high BA (Fig. 8). Average decline frequencies for MN and IA were similar (45%) and higher for WI (65%) (Fig. 7).
- Similar levels of hickory mortality were found in IA and WI, ranging from 4 – 20%; higher levels were found in MN sites (6 – 89%) (Fig. 7).
- Severity of decline ranged from 21 – 95% across all sites; highest average values were recorded in MN (53%) and lower in WI (40%) and IA (30%) (Fig. 8).
- 12 out of 14 sites had adequate to high levels of hickory regeneration (200 – 2400 stems/acre for stems < 1-ft tall).

**Fungal Infections**

- **Gibbsia gall** was the most common type of damage found (Fig. 9).
- **Hickory bark beetle galleries** were the most common types of damage found (Fig. 9).
- **Similar levels of hickory mortality were found in MN and IA; ranging from 4 – 20%; higher levels were found in MN sites (6 – 89%)**.
- **Severity of decline ranged from 21 – 95% across all sites; highest average values were recorded in MN (53%) and lower in WI (40%) and IA (30%)**.
- **12 out of 14 sites had adequate to high levels of hickory regeneration (200 – 2400 stems/acre for stems < 1-ft tall).**

**Pathogen Data**

- Several different types of damage were found on declining hickories (from inoc to leaf curling). Insect holes (associated with HBB, flatheaded woodborer, and ambrosia beetles), sunken annual and diffuse cankers, **Phomopsis** galls, black leaf spotting, sapsucker and woodpecker damage, decay fungi, mechanical and fire damage, broken tops, and human-induced girdling.
- **Incidence and severity of decline** were positively correlated with basal area in our stands, but all sites were similar.
- Decline mortality affected trees > 5 inches dbh. Levels of regeneration observed at most sites were adequate for stand replacement.
- **Hickory bark beetles** and/or their galleries were found at all sites, exceeding occurrence of other damage on declining trees.
- **Ceratocystis** and **Fusarium spp.** were both obtained from log sections from declining trees with hickory bark beetles and/or galls.
- **Ceratocystis** was more often obtained from sunken, annual cankers than **Gibbsia gall**, but both fungi were similarly obtained from logs with diffuse cankers.

**Ongoing Work**

- Additional sites will be surveyed and sampled mid-May to late July, 2008. There will include 2 more sites each in WI and IA, 3 sites in IN and OH, and 6 in NY.