

EVALUATING WHITE OAK DECLINE AND MORTALITY IN SOUTHERN OHIO

FHM Evaluation Monitoring Progress Report for FY06

R. Long, Y. Balci, W. MacDonald, and D. Balsler

The primary objectives of this project are to investigate the factors associated with declining and non-declining white oaks on state forests in southern Ohio and to develop tools for land managers to identify stands potentially vulnerable to decline. Preliminary data indicated the possible role of *Phytophthora cinnamomi* in this oak decline based on recovery of the organism from soil samples taken in association with living, but moderately declining, white oaks in affected stands.

FY06 Accomplishments:

Field work in FY06 initially focused on collection of soil and root samples to test for the presence of *Phytophthora* organisms at Scioto Trail State Forest. Trees in declining and non-declining stands (total 103 trees) were sampled at a lower slope and then a second plot (occasionally a third plot) was established upslope. One white oak showing light to moderate crown dieback (decline scale described below) was sampled at each slope position. At the sampled oak, four 12 inch deep soil pits were dug in cardinal directions but within 2 m of the bole. Soils and roots were sampled from each hole and composited by tree. Each week the samples were transported to WVU for storage under controlled conditions and samples were prepared for processing and isolations. All *Phytophthora* sampling was done from 14 June through 19 July. An additional 24 trees were identified and geolocated at Zaleski State Forest in August, but will not be sampled until June 2007.

Phytophthora Sampling Results:

The 103 soil samples collected at the Scioto Trail State Forest were baited for *Phytophthora* spp; 67 samples yielded isolates of *Phytophthora*. Of the 67 positive recoveries, 50 isolates (74.6% of all isolates) were recovered during the first baiting routine. When the negative soil samples were re-baited, an additional 17 isolates (25.3% of all isolates) were recovered. Sixty-five isolates were identified as *P. cinnamomi*; one as *P. citricola* and one as *P. cambivora*. Two isolates remain unidentified.

The presence of *Phytophthora* in relation to white oak crown health status and slope position is presented in Table 1. No significant relationship existed between crown health and the presence of *Phytophthora* species. Likewise no significant relationship could be established when lower slope sites were compared to upper slope sites. However, *Phytophthora* generally was isolated at higher frequencies from declining trees than those that were scored as healthy (Table 1).

Table 1. Isolation frequency of *Phytophthora* spp. in relation to elevation and crown condition of sampled white oaks. Fischer's exact test was used for statistical analysis.

	Lower slope sites		Upper slope sites		All elevations	
	healthy	declining	healthy	declining	healthy	declining
<i>Phytophthora</i> present	17	15	9	26	26	41
<i>Phytophthora</i> absent	10	10	8	8	18	18
	p= 1.000		p= 0.115		p= 0.301	

Root samples collected from individual trees were washed with pressurized water and those with a diameter <3mm (fine roots and small woody roots) were collected and dried at 60°C. Dry root weights from *Phytophthora*-infested and *Phytophthora*-free trees were compared for lower and upper slope sites. A significant relationship was found in the average amount of roots of *Phytophthora*-infested trees when lower and upper slope trees were compared (Table 2). The average dry weight of roots from *Phytophthora*-infested trees at lower slope sites was less than those located at upper slope sites. Although a similar trend existed for *Phytophthora*-free (absent) trees when those in the healthy crown class were compared to those in a declining class, no statistically significant relationship could be established. No significant relationship was found for the average amount of roots in relation to crown status of *Phytophthora*-infested or *Phytophthora*-free trees.

Table 2. Mean dry root weight (gr) of sampled trees (root diameter <3mm). Comparison of root data was conducted using ANOVA.

	Lower slope	Upper slope	Healthy trees	Declining trees
<i>Phytophthora</i> present	77.5	93.8	89.4	81.9
	p= 0.03		p= 0.345	
<i>Phytophthora</i> absent	81.7	91.9	91	82.6
	p= 0.244		p= 0.337	

Vegetation Sampling:

One fifth acre circular vegetation plots (52.7 feet in radius) were established at each sampled white oak. Plot centers were usually within 16 feet of the sampled tree and were geolocated. For each plot the aspect (degrees), slope (%), and distance to the nearest stream or drainage were measured. Elevation will be determined from GPS locations plotted on topographic maps. Within each fifth acre plot, all trees ≥ 3.9 inches (10 cm) dbh were recorded by species and crown class (dominant, codominant, intermediate, suppressed), and dbh was measured to the nearest 0.25 inch (5 mm). All standing dead trees were measured. All oaks present in the plot were rated for crown vigor condition using a 5 class system:

- Vigor class 1: ≤ 10% fine twig dieback
- Vigor class 2: 11-25% fine twig dieback
- Vigor class 3: 26-50% fine twig dieback
- Vigor class 4: > 50% fine twig dieback
- Vigor class 5: Dead

Trees used for soils and root sampling were usually in vigor classes 2 and 3.

In addition to overstory vegetation, a sapling tally in 1- inch size classes was conducted on a nested circular 0.05 acre circular plot (26.2 feet radius) for all stems greater than 4.5 feet in height. Standing dead saplings were also tallied separately.

In addition to the 103 plots sampled at Scioto Trail State Forest, 24 plots were established and measured at Zaleski State Forest in September. A potential sample tree was identified and tagged in each plot for soil and root sampling in 2007.

Mortality Transects:

In order to better characterize mortality in the most severely affected portions of the forest, seven transects, one per stand, were established in stands with high levels of mortality, but where no or very limited salvage was conducted. A total of 34 plots was established in these seven stands (3-7 plots/stand). Total stand basal area of living and standing dead trees ≥ 3.9 inches dbh ranged from 96 to 163 ft² a⁻¹. White oak was the dominant species in these stands, and total white oak basal area ranged from 61 to 113 ft² a⁻¹. Standing dead white oak basal area averaged 75% of the total white oak basal area and white oak mortality ranged from 57% to 83% of the total white oak basal area. Volume loss was not estimated, but was clearly very substantial in these severely affected stands.

Integrated Moisture Index Maps:

The integrated moisture index (IMI) was developed by Iverson et al. (1997) for use in southern Ohio to characterize moisture regimes based on topographic and soil characteristics. This GIS index incorporates hillshade, flow accumulation, curvature of the landscape and total available water capacity of the soil in order to model moisture levels across the landscape. The IMI map for Scioto Trail State Forest is included at the end of this document. The higher the IMI score the moister the site. IMI maps and associated scores have been developed based on a 30 X 30 m cell for Scioto Trail, Brush Creek, and Pike State Forests. Portions of Zaleski State Forest with white oak decline have also been incorporated into an IMI map. IMI scores for each sampled plot will be determined from the developed maps and used for additional statistical analyses.

Aerial Survey:

We hoped to quantify and map the extent and severity of white oak mortality at Scioto Trail and Shawnee State Forests in 2006. Previous efforts in 2005 using fixed wing aircraft were unsuccessful in being able to clearly delineate the mortality. Instead of using a fixed-wing aircraft, we planned to use a helicopter to assess the mortality. However, due to weather conditions and scheduling problems we were unable to test this method in 2006. We plan to complete this portion of the project in 2007.

Future Studies and Data Analyses:

During the summer study period we investigated the presence of *Phytophthora* species at Scioto Trail State Park. Root analysis provided some evidence for greater root mortality at bottom land sites. Given the common occurrence of *Phytophthora* throughout the study site and lack of strong relationships with tree crown condition, additional studies of the severity of root mortality in bottom lands where *Phytophthora* is present seems warranted, especially by making comparison to sites from which *Phytophthora* was not isolated. Therefore more detailed investigations of specific locations will be initiated to further evaluate the role of *Phytophthoras* in white oak decline.

The vegetation data will be used to classify stands more rigorously with regard to decline status and to re-analyze the data based on revised classifications. Additionally, the IMI scores derived for each plot will be used to test the association of decline and moisture status and presence or absence of *Phytophthora* spp.

In FY07, we will expand sampling at Zaleski State Forest and potentially at Brush Creek and Pike State Forests. Pending a more thorough review of the FY06 data, we will consider additional collections at Scioto Trail if warranted. Aerial surveys will be conducted to determine the extent and severity of the mortality at selected locations. The IMI maps in combination with the vegetation data from Scioto Trail and Zaleski State Forests will be used to develop protocols and guidelines for land managers to use in managing white oak stands or for developing strategies to salvage areas with overstory white oak mortality.

Integrated Moisture Index Scioto Trail State Forest

