

A Preliminary Hazard Rating for Dogwood Anthracnose in the Southern Appalachians

Keith Langdon, Charles Parker, Mark Windham,
Sue Powell, Kristine Johnson

U.S. National Park Service/Great Smoky Mountains National Park
Resource Management and Science Division, Gatlinburg, TN

Completed through Interagency Agreement 5460-9-8016 with USDA
Forest Service, Forest Pest Management, Asheville, NC

Introduction

Background

In the mid-1970's, a new fungal disease was reported on dogwoods (*Cornus spp.*) in North America. First found near Chehalis, WA, on *Cornus nutalli*, the disease was found in successive years northward into the Puget Sound region and into British Columbia. (Daughtrey, et al. 1988). This disease caused lesions on leaves and defoliations but usually not the death of the tree. At about the same time, a new disease was found to be killing flowering dogwoods (*Cornus florida*) in the New York City area. This disease became known as dogwood anthracnose and was eventually identified as *Discula destructiva* Redlin. (Redlin, 1981). By the early 1980's, the disease was identified in Maryland and in 1987 in the southern Appalachians. A number of fundamental questions have arisen concerning dogwood anthracnose in general, such as, what is the disease's potential range? Are there climatic parameters that limit *Discula destructiva* to particular geographic areas or habitats? What are current effects of the disease on flowering dogwood, and what are likely long-term effects?

Excellent work on region-wide monitoring of the disease is being conducted by the Dogwood Anthracnose Work Group and coordinated by the USDA-Forest Service, Forest Pest Management. This project investigated the feasibility of assessing impact to flowering dogwood by *Discula* at a meso scale that is over areas of several to tens of kilometers.

This study will examine these specific, investigative questions:

1. Are there significant differences in dogwood anthracnose severity across a southern Appalachian landscape?
2. If there are differences, can these be modeled accurately enough to allow classification of sites into a hazard rating system?
3. If questions 1 and 2 above are possible, what insight into future impacts does this provide?

Methods

The methodology used focused on intensive mapping and ground truthing of both the dogwood resource and relative incidence severity of the anthracnose.

Three areas of the Great Smoky Mountains National Park, each 10 to 15 square kilometers in size, were aerially photographed during blooming season in 1989 and/or 1990 with a variety of films and at several scales.

Dogwoods in flower were mapped, and ground crews sent to rate dogwood stands continuously along transects. These transects were selected to coincide with the stands, bisect them and extend into putative non-dogwood habitats. The width of each transect varied from about 50 meters to approximately 75 meters, depending on survey party size and visibility in the stand. That portion of the stand visible was classified into one of six categories of anthracnose activity (see below) and carefully hand-drawn onto 1:24,000 topographic maps. Each category was color-coded on field maps, a total of 10 kilometers were rated:

1. Few or no dogwoods
2. Dogwoods present but little or no anthracnose apparent
3. Generally light infections (usually lower branches and seedlings) on up to 50 percent of visible trees
4. Moderate infection - more than 50 percent of trees with infection, but most not severely affected (loss of canopy, dying)
5. Severe infection - most infected and more than half with loss of canopy and usually some mortality
6. Dying - half or more dying or already dead.

This effect was expanded in later efforts to an additional 186 kilometers (115 miles) of trails mapped for dogwood infection. All trails were in natural zones; woods edge, and utility and transportation corridors were avoided.

Currently, several vegetation-related Geographic Information System (GIS) themes are available for full park coverage. They were tested for "best fit" with field results. The GIS themes below were developed or customized by Dr. Charles Parker at the Uplands Field Research Laboratory.

<i>Theme</i>	<i>Resolution</i>	<i>How Used</i>
Vegetation type	90m ²	Comparison of 13 vegetation types made dogwood and anthracnose maps
Aspect (from Digital Elev. Models)	90m ²	Compared northerly (WNW to ENE aspects) to southerly aspects
Proximity to streams	Line data from USGS quads	Searched out 1, 2, and 3 pixels from stream segments of various orders
Topographic sheltering	90m ²	Topographic exposure checked against anthracnose and dogwood distribution

Moisture

90m²

Two models with 9 and 13 classifications, based on topography, were used for comparison

Various combinations of these themes were tested for "best fit" after it became obvious that single themes under or over predicted either geographic extent or severity. Since each theme may have multiple attributes (e.g., streams may be either first, second, or third order, and may be searched out one, two, three, or more pixels), large matrices quickly developed. The largest matrix had 42 values to which low, moderate, and high were assigned, as general risk categories of anthracnose.

As each major theme combination was produced graphically, another transect was selected for ground truthing. Specific routes were selected to test the accuracy of the new GIS attributes used.

Finally, to improve our assessment of impact on flowering dogwood, additional surveys were undertaken to accurately determine the distribution of host. Sixty-five sites were subjectively selected to assay relative abundance of tree species. This information was combined with existing data to construct a range map of flowering dogwood on GIS. The range of dogwood was then overlain with the map of risks to anthracnose severity.

Results

The air photos taken were very useful in delineating blooming stands, although northerly slopes bloom later, and most small trees or younger stands do not produce enough of a floral display to be detected in aerial photography. The best results were obtained with large scale, natural color photos, taken in slightly overcast conditions. Shadowing by clouds provided much greater contrast between the bright white bracts of the dogwood and the underlying forest litter.

As expected, many theme attributes and some entire themes, such as the vegetation type, were found to be of little value, either singly or in combination. Also some themes encompassed disease extent well but had little sensitivity to severity of anthracnose.

The best results were obtained using the following GIS prescription:

Elevation and aspect - on northerly slopes, only elevations below 3,000 feet used due to scarcity of dogwood stands above that elevation. On southerly slopes, elevations below 3,500 feet were used. Dogwoods occur above that elevation, but *stands* are much more uncommon.

Stream proximity - southerly slopes were considered to be at moderate risk only for the pixel through which the stream flowed. Southerly slopes farther from streams were classified as of low risk. Northerly slopes were generally considered to be of moderate risk, unless within one pixel of first-order streams or two pixels of second-order streams, which were classed as high risk.

Field Survey of Stands
(196 Linear Kilometer)

Risk Prediction by Model

	High infection	Moderate infection	Light infection	No dogwood predicted (too high)
Dead or dying (black)	59%	19%	11%	11%
Severe (red)	50%	26%	22%	2%
Moderate (orange)	40%	38%	21%	1%
Light (yellow)	35%	34%	30%	1%
Little/no anthracnose (green)	32%	36%	19%	13%
No dogwoods (blue)	18%	28%	21%	33%

The risk prediction model shows general accuracy, especially for predicting worst impact areas. More difficulty is encountered in predicting where moderate and light infections are on the landscape. This is believed to be influenced by the fact that the park's infection is still "immature," having been first detected in 1988 and increasing in intensity yearly. (Windham, et al. 1993). Note that about 28 percent of the time the model predicted that it was too high in elevations where dogwoods were found.

To grossly estimate the total anthracnose effect on the park's dogwood resource, additional surveys of host range were undertaken and mapped via GIS. Several host range characteristics became evident in this preliminary distribution mapping effort.

1. Dense stands of *Cornus florida* mostly occur below 2,600 feet elevation, on slope of 20 degrees or less, within approximately 300 meters of streams - 59,408 hectares area.
2. Less dense stands occur higher along streams to about 3,000 feet elevation on southerly slopes - 3,168 hectares area.
3. Sparse stands occur away from streams on southerly slopes, especially in mesic oak stands, up to 4,000 feet elevation - 8,493 hectares area.

The dense stands of flowering dogwood (#1, above) on low elevation alluvial corridors, probably contain the vast majority of dogwood individuals in the park. Using the above stand distribution criteria, a conservative (and preliminary) range map for *Cornus florida* was produced for the first time. This map was then overlain with the anthracnose risk model.

This analysis showed that about 58 percent of the dense dogwood stands in the park are at high-to-moderate risk of mortality due to *Discula destructiva* infections in stands. Other stands are also at significant risk, but less so. If this is true, then the majority of the park's dogwoods on high productivity sites will perhaps be permanently lost. In addition, if the model is too conservative in predicting losses to stands, then the situation is very serious, with extirpation of the host over much larger areas than the sites currently known in the park.

Relating back to the investigative questions:

1. There are significant differences in dogwood anthracnose severity across the park landscape. Some of the differences seen may be temporary as the disease progresses into more severe status.
2. A model has been produced which is generally accurate for predicting the worst impacted sites. Further assessment of dogwood hazard may have to wait until the disease stabilizes.
3. The future of flowering dogwood in the park and similar areas is serious. A large number have already perished, possibly taking much of the genetic base with them. It is possible that low risk areas may avoid significant mortality until the disease incidence is reduced through host loss in high-to-moderate risk areas. This project indicates, however, that low risk sites are low-density stands of dogwoods and probably less productive. It is also reasonable to assume that population on more xeric sites may not be genetically similar to those on colder and/or moister sites.

Literature Cited

- Daughtrey, Margery, Craig Hibben, and George Hudler. Cause and control of dogwood anthracnose in northeastern United States. *Journal of Arboriculture* 14(6). June 1988.
- Redlin, Scott. *Discula Destructiva*, Sp. Nov., Cause of dogwood anthracnose *Mycologia* 83(5), 1991. pp. 633-642.
- USDA-Forest Service, Protection Report R8-PR20. Results of the 1990 dogwood anthracnose input assessment and pilot test in southeast United States. Compiled by Robert L. Anderson. Asheville, NC.
- Windham, M., M. Montgomery, and K. Langdon. 1993. Distribution of dogwood anthracnose in Great Smoky Mountains National Park and effects of proximity of water to plots and plot aspect on disease severity. Unpublished Report to National Park Service. Gatlinburg, TN.