An Analysis of *Cornus florida* Population Trends and Predicted Risk

William E. Jones[1], William D. Smith[2], Daniel B. Twardus[3], and Edwin K. Yockey[1]

[1]USDA Forest Service, Forest Health Protection, Asheville, NC; [2]USDA Forest Service, Southern Research Station, Research Triangle Park, NC;
[3]USDA Forest Service, Forest Health Protection, Morgantown, WV

Introduction

- Since its discovery in the late 1970's *Discula destructiva*, causal agent dogwood anthracnose, has resulted in severe but basically undocumented impacts to *Cornus florida*
- Early projections of >90% losses during epiphytotics extending from the mid 1970's to late 1980's
- Researchers began documenting reduced disease severity as early as 1988
- Interest waned by 1995

- Disease progression of dogwood anthracnose was known to be affected by various physiological and physiographic factors
  - Drought stress
  - Light level
  - Crown exposure
  - Host density
  - Topography
  - Timber harvesting practices
  - Acid rain (laboratory-only)

- Therefore, it was considered timely to assess:
  - Current population structure of *Cornus florida* based on FIA/FHM data
  - Tree health and condition of dogwoods from multiple forest types across it range
  - Report on two decades of annual monitoring of permanently-maintained dogwood plots

- **Goal**: Link three databases together to establish on a regional scale the effects of dogwood anthracnose after approximately 25 years since its discovery
  - Simplify or development new guidelines for forest managers for disease control

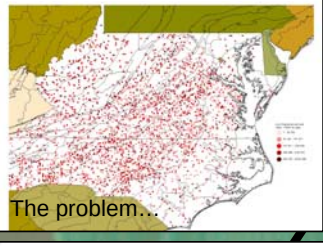
Component 1 Methods

- Given the wide geographic range of Cornus florida in North America, the only practical means of analyzing current and past population numbers was to utilize existing FIA and FHM databases
- The first approach generated the overall population structure of dogwood in the 1980's versus the 2000's FIA panels
- Effects of aspect, physiological land class, ecoregion sub-type, slope, and percent openness of forest cover were modeled

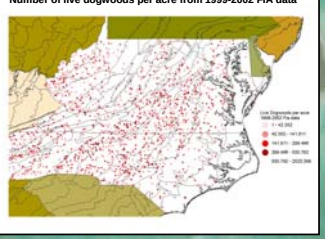
Component 1 Results

- Preliminary results using FIA plot data showed that the number of live dogwood trees per acre on forested land has declined by approximately 50% between the 1984 and the early 2000 panels

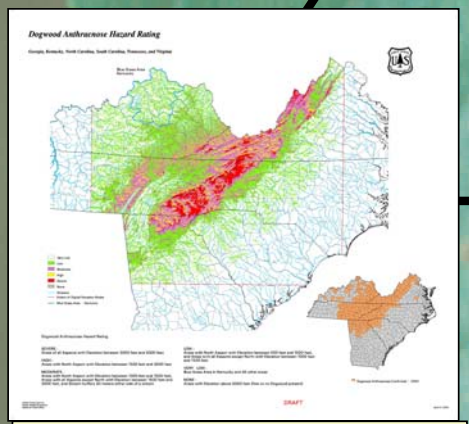
Number of live dogwoods per acre from 1984-1990 FIA data



Number of live dogwoods per acre from 1999-2002 FIA data



The problem...



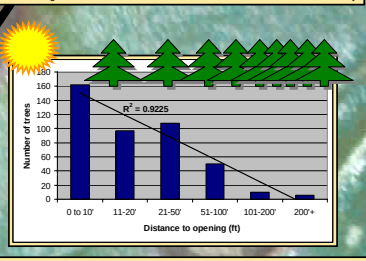
- Perceived risk to disease based primarily on aspect, elevation and distance to a stream

Component 2 Methods

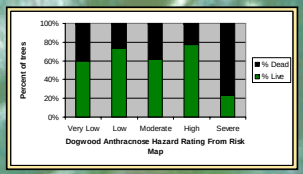
- 67 points in North Carolina and Tennessee
  - Each point consisted of four 6'-wide by 330' long transects (5 chains)
  - North, east, south and west cardinal directions
  - All live or dead dogwoods with pith falling on or within transects tallied
  - Aspect, elevation and tree data collected

Component 2 Results

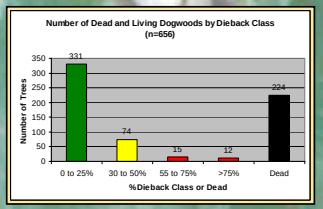
- A strong negative trend was discovered between the number of dogwoods and the distance to an opening
- As might be expected, the relative proportion of dead trees was found to be highest within the 'severe' hazard class but this was not the case for the other risk categories
- About 33% of dogwoods intersected on transects were 'dead' and 50% were 'healthy'



- Distance from live dogwood pith to a crown opening was a powerful predictor



- Except for trees in 'Severe' hazard areas, higher proportions of living versus dead trees were found as perceived risk to disease increased



- Dogwood may be less able to capitalize on their competitive advantage of shade tolerance in aging stands as the stem exclusion stage begins to influence stand dynamics

- Distribution of trees within dieback-classes for live and dead dogwoods
  - 34.1% of dogwoods were dead
  - Most surviving dogwoods in "good" to "fair" crown classes

Component 3 Methods

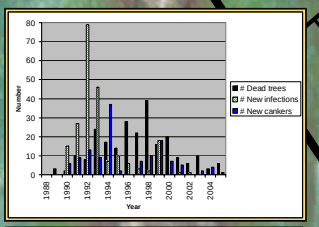
- From 1988 to 2005 the North Carolina Division of Forest Resources has maintained permanent monitoring plots to track the condition of Flowering dogwood
- Methods were previously published by Knighten and Anderson in 1993
- Results from 1993-2005 have not been formerly reported (NCDFR, unpublished data)

- Plots consisted of the closest ten dogwood trees on a random stratified 15-minute grid system
- Plots are were part of a larger regional project Involving 210 plots across seven states in the Southeastern U.S., but only North Carolina has maintained plots continuously since 1993 on a yearly basis

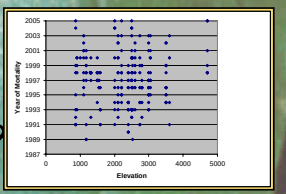
- The basic tree health information collected between 1993 and 2005 was dieback class, DBH, tree height, stem infections, and whether a leaf sample was obtained for laboratory confirmation of *Discula*
- Once a tree was laboratory-confirmed as being Discula positive, that tree was maintained as "positively infected"
- Crown ratings were based on a six-point scale from 0-to-5 based on the Mielke-Langdon dieback classes:
  0=Dead, 1= >75% Foliage affected, 2= 51-75% Foliage affected, 3= 26-50% Foliage affected, and 5 = Healthy

Component 3 Results

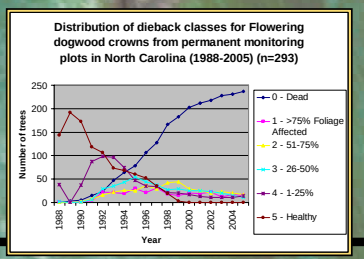
- **237 / 293** of the dogwoods were **dead** by 2005 (80.8%)
  - 55 were never found to be positive for *Discula* (23.2%)
  - 129 died without exhibiting signs of cankering (54.4%)
  - Trees continued to die each year from 1989 through 2005
  - Peak mortality occurred in 1998
- **215 / 293** trees tested **positive** for ***Discula*** between 1988 and 2005 (73.4%)
  - Peak year for positive new infections was 1992 with a smaller peak in 1999
  - 172 of the *Discula*-positive trees died (80.0%)
  - Mean time and SD between cankering becoming evident and mortality was 3.7 ± 3.1 years
- **130 /293** trees showed signs of **cankering** (44.4%)
  - 98 of the cankered trees died (75.4%)
- **56 / 293** of the dogwoods were still **alive** as of 2005
  - 44 were confirmed *Discula* positive (78.6%)
  - 32 had cankering (57.1%)
- **Mean crown rating** for living trees has remained relatively constant since 2000
  - Mean crown ratings ranging from 2.3 to 2.4 (2000-2005)
  - Prior to 2000 mean crown rating had declined steadily from a high of 5.0 in 1989 to a low of 2.3 in 2002
  - Since 2000, no trees were rated "healthy"



- Peak years of new *Discula* infections in 1992 and 1999
- Peak stem cankering lags behind leaf infections
- Mortality quickly followed cankering but lagged up to thirteen years after leaf infections



- No significant relationship was detected between mortality and elevation in permanent dogwood monitoring plots
- Upcoming risk map will take into account these new findings



- Distribution of the number of trees in Meilke-Langdon dieback classes from North Carolina permanent plots
  - Yearly mortality from 1989-2005
  - No trees rated "Healthy" after 2000

Discussion

- Almost unheralded in current scientific literature have been the apparently sweeping changes taking place for *Cornus florida* during the past twenty years.
- Readily apparent with the aide of FIA data, the population of dogwood has been reduced by approximately 50%
- This stands in stark contrast to early predictions of 90 to 100% losses
- Analysis of the FIA data indicated that slope and increasing percent openness of canopy cover explained a significant amount of where dogwoods occur
- This corresponded with results from transects which showed that most of the dogwoods occurred in proximity to crown openings
- Monitoring of 293 dogwood in North Carolina from 1988 through 2005 indicates that at least in mountainous regions, surviving dogwood numbers alone may not be enough to assess population trends as tree health may be poor

- Putting together information from these three databases, preliminary results showed that across its natural range Flowering dogwood growth habits have been significantly impacted
  - Dogwoods now have a very different environmental range across the landscape
  - Shifts from a small tree that thrived in shade-conditions to an impaired, short-lived tree found only in close relation to a significant canopy opening(s)

- Though incomplete, this project is already yielding novel findings relating to current and past conditions on the population structures of Flowering dogwood

An easier solution to disease management?

- Plant resistant trees
- Manipulate light via silviculture
- Irrigate yard trees during drought

Acknowledgments

- Funding was provided by Forest Health Monitoring-Evaluation Monitoring as part of FHM-EM Project ISA-08-31-05-FH-14

- Cooperation and fieldwork was performed by USDA Forest Service, Forest Health Protection staff in conjunction with Kristine Johnson, Bryan Wender, and Bambi Teague with the USDI National Park Service, Brian Heath and Don Rogers with the North Carolina Division of Forest Resources, and Jim Brown, USDA Forest Service

- Slide background photography and original risk map design by Dr. Robert L. Anderson

Environment

Host

Pathogen