Dendrochronology as a Proxy for Reconstructing Midwestern Forest Gaps and Spring Ephemeral Composition Change

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Introduction

Temperate deciduous forests, occupying most of the eastern and some of the Mid-western United States, rely on natural and anthropogenic disturbances. Natural disturbances include: windfall (Pickett and White 1985), fire (Frissell 1968), insect outbreaks (Speer *et al.* 2001), natural plant invasions (Gysel 1951), exotic plant invasions (Collier *et al.* 2002), and deer browsing (Rooney and Dress 1997). Examples of anthropogenic disturbances include: foot traffic and vehicle compaction (Dzwonko and Loster 1997), grazing (Donkor *et al.* 2002), and logging (Capellotto Costa *et al.* 2002). All of these disturbances could either impede forest regeneration or enhance it, and disturbances can either operate separately or en masse. Because an understanding of disturbance regimes is a critical component of understanding forest dynamics, a variety of techniques have been used to assess disturbances.

Plants (herbaceous and woody) often respond to regular disturbances which constantly produces new micro-habitats (Pickett and White 1985). Assemblages of plants compose different forest types. Gap dynamics is a natural part of old growth forests and I expect that this process maintains high species diversity. High species diversity could indicate a productive forest. The literature suggests that spring ephemerals (short lived plants that grow in the spring) may not be affected by disturbance frequency (Moore and Vankat 1986). This is contrary to the function of disturbance and could possibly cause us to re-examine the role of disturbance in these forests or to find out more about what spring ephemerals can tell one about forest composition.

Methods

Study Sites

Kieweg Woods is located west of the Wabash river about two kilometers east of the Indiana / Illinois state line. This land is mostly a beech-maple dominated old forest (16 hectares) along with two fields that are succeeding to forest. Kieweg is one of many mesic forests in Indiana (Jackson unpublished data). Forest Park formerly known as Hulman Park Woods is located in the Rosedale quadrangle. Approximately 26 of 81 hectares is older growth beech-maple forest including oak and hickory. The flat upland was farmed and is in old-field succession. No stumps were observed by Lindsey (1969) indicating no major recent logging events.

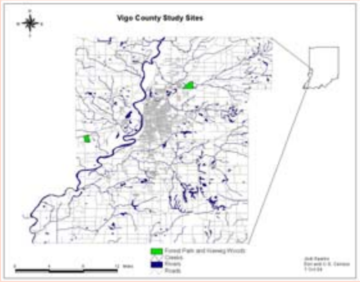

Figure 1: Study sites located in Vigo County, Indiana

Long-Term Data
- ISU Professor, Dr. Marion Jackson's Plant Taxonomy classes
- Up to 30 years of data
- Data contains herbaceous and woody specimens

Vegetation Diversity
- Plots re-established in 2004
- One representative of herbaceous and woody plants
- Species identified, mounted and deposited in ISU herbarium
- Plot area (Kieweg) 0.08- 0.27 hectare
- Plot area (Forest Park) 0.09- 0.16 hectare
- Majority of plots are 0.09-0.10 hectare

Dendrochronological Techniques
- Two cores taken at the base of tree with Haglof (5.15mm) borer
- Cores were prepared for analysis (mounted and sanded)

Figure 2: *Sanguinaria canadensis* (Bloodroot)

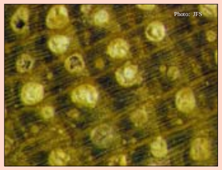

Figure 5: Sassafras (*Sassafras albidum*) wood structure

Figure 14: Large canopy gap

Methods (cont'd)

Stand-age Structure
- Two plots (highest and lowest diversity)
- Sampled all dead and living trees

Targeted Gap Sampling
- Five plots
- Ten closest trees (DBH > 10 cm) were cored
- Crossections or cores taken from the gapmakers
- Coordinates were taken for all trees
- Five saplings (DBH < 4 cm) from within each plot were harvested
- Gap measurements (length and width) follow Runkle (1982)

Figure 3: *Cardamine bulbosa* Cardamine

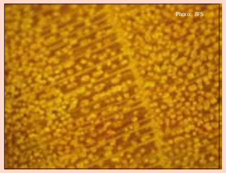

Figure 6: Tulip Poplar (*Liriodendron tulipifera*) wood structure

Results

- Overall, we found a decrease in herb diversity
- Three genera of trees were poor recorders of gap dynamics while one (*Acer*) recorded gaps well
- Trees typically demonstrate a suppression event before a release

Herbaceous Results

- A decrease in herb diversity from initial setup to 2004

Forest Park, Kieweg	1981-2004
Total # of Families	69
Total # of Genera	118
Total # of Species	180

Gap Results

- Fifteen gaps were identified in 7 plots
- Area ranges from 100 m^2 to 900 m^2
- Most were caused by one treefall

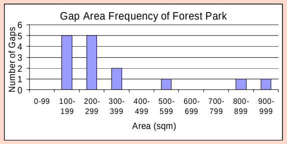

Figure 8: Gap area and abundance

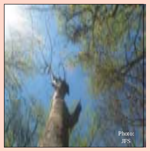

Figure 9: Canopy gap

Figure 4: *Claytonia virginica* Spring Beauty

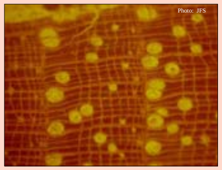

Figure 7: Hickory (*Carya ovata*) wood structure

Figure 15: Small canopy gap

Dendrochronology Results

- *Quercus* cores dated to 1891
- *Carya* cores dated to 1864
- *Sassafras* cores dated to 1925
- *Acer* cores dated to 1909
- *Fagus*--unconfirmed core dated to 1879
- Fifteen more genera still in process
- *Quercus* and *Carya* grew slowly when young
- *Quercus* and *Carya* rarely respond to additional light from nearby canopy gaps
- *Acer* responded to canopy gaps when young and old

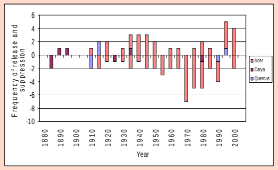

Figure 10: Release and Suppression for Forest Park Plot Ritzi

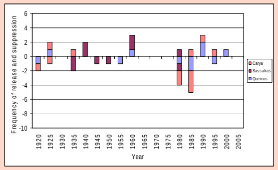

Figure 11: Release and Suppression for Forest Park Plot Adam

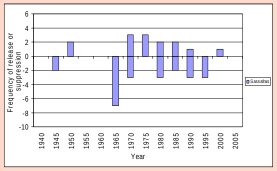

Figure 12: Release and Suppression for Forest Park Plot Duchamp

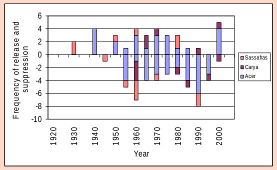

Figure 13: Release and Suppression for Forest Park Plot Crane

Conclusion

We have found that *Quercus, Carya,* and *Sassafras* rarely respond to canopy gaps as they grow older, but showed small periods of slow growth when they were young. It has been stated that many gaps close laterally instead of horizontally and this could be a factor on how older trees respond to canopy gaps. Our findings with Acer has demonstrated that it responds to canopy gaps more than the other species analyzed and our future work with *Fagus* could yield a similar response to canopy gaps since they take advantage of additional light.

Future Work

These data will also be used to determine intensity and frequency of thunderstorms (damaging winds) throughout the area over the term of the study period (1970-2004).
Climatic data (mean temperature, palmer drought severity index (PDSI), total precipitation, and storm events) were used to control for potential climate responses in the tree cores

Acknowledgements

- I would like to thank my field and lab assistants: Rob Jean, Chris Ritzi, Brenda Farrell, Graham Bishop, Jim Hayes, Dale Sparks, Chris Gentry, Vijay Lulla, Hua Lui, ISU Plant Taxonomy class, Paleoclimate class, Dendro class, Dr. Jim Speer, and Dr. Marion Jackson
- I would like to thank the Indiana Academy of Sciences for funding the Winona Welch Botanical Award, and the Indiana State University graduate school for internal grants.

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