# Characterization of Forest Fragment Structure in Northeastern Indiana

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## Abstract

Northeastern Indiana's geography consists mainly of agricultural fields and small, scattered forests, most of which are privately owned resulting in disjunct management strategies and equally isolated end goals for the forests. The purpose of this study was to identify differences and similarities in forest overstory composition and physical structure within fragments across a regional landscape. By understanding species and structural distributions across the region, forest management strategies to maximize diversity may be developed at the regional scale. Because of similarities across counties in many of the compositional and structural forest characteristics, there may be benefit in management recommendations to land owners that could be applied as a regional strategy. A deeper analysis is needed to fully understand and identify implications of forest size and shape in regards to maximizing species richness and occurrence.

## Introduction

Forest Foundations:
- Retreating of the Wisconsin glacier provided much of the parent material for soil development in Northeastern Indiana [1].
- Current forests may have similar structure due to historic connections.

Forest Fragmentation:
- As the need for more cultivated land increases, the size and shape of forests are altered to meet the new spatial demands, often bisecting large forests [2].
- Increases in urbanization also leads to forest fragmentation [3].

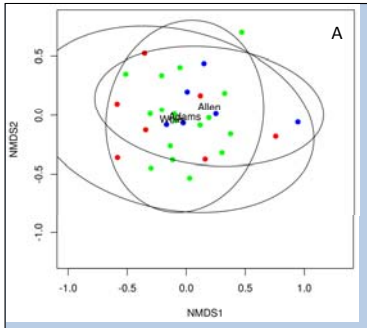
Forest Characteristics:
- Soil moisture, canopy cover, density and forest age all play an important role in determining forest type and species diversity [4]

Objectives:
- Identify Northeastern Indiana forest types by species and size.
- Determine the effects of forest fragmentation on overstory diversity and species richness.

## Methods

- Forest fragments (N = 30) were selected in Adams, Allen, and Wells Counties, IN.
- Based on forest size, plots were randomly located on a 12.62 m grid, with larger forest fragments (> 16 ha) containing more individual plots than the smaller fragments (< 4.5 ha).
- At the center of each plot, 500 $m^2$ circular plot was established and all overstory trees were identified to species.
- DBH (> 4 cm), soil moisture, canopy cover, basal area, and the density of forest stocking for each species were recorded using established forestry protocols for each plot.
- Using increment borers, the largest trees per plot (excluding species identified by land owner) were selected and cores were collected to estimate the age of each forest surveyed.
- Nonmetric multidimensional scaling (NMDS) ordination was used to identify species relationships with external factors.

## Results




- There was substantial overlap between counties in relation to forest composition.
- Because of this overlap, we did not conduct county level analyses.

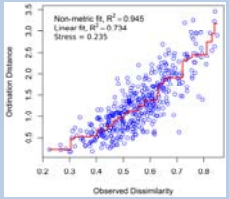
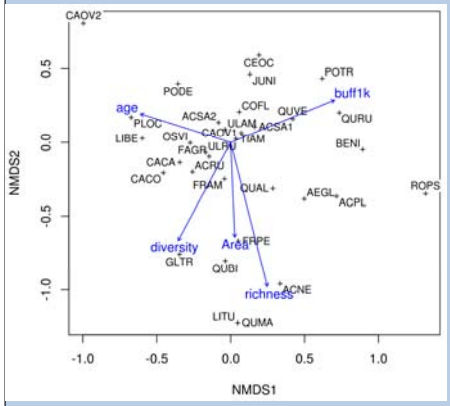
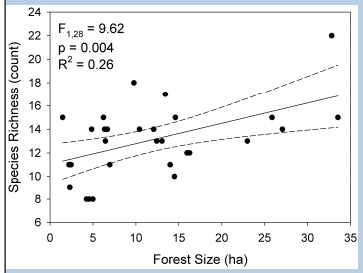



Figure 1. NMDS ordination of forests with 95% confidence ellipses for counties (A) and stressplot for NMDS ordination (B).




- Common midstory species were recruited into the overstory in older forests (American hornbeam [CACA], spice bush [LIBE], hophornbeam [OSVI]).
- Norway maple (ACPL) and Ohio buckeye (AEGL) were found in younger forests.
- Increases in forest density within 1 km buffer (buff1k) resulted in increased abundance northern red oak (QURU) and trembling aspen (POTR).

Figure 2. NMDS ordination of species with joint vectors of external factors.




- Overstory species richness was significantly related to forest size.
- Species diversity was not significantly related to forest size.
- Additionally, density of overstory trees (basal area or stems/ha) were not related for forest size.
- Richness was negatively related with perimeter:area ratios ($F_{2,28}$ = 9.91, p = 0.004, $R^2$ = 0.26).

Figure 3. Simple linear regression of species richness and forest area.

## Results continued

Table 1. Importance values for the top-10 overstory tree species.

| Common Name | Relative Frequency | Relative Density | Relative Dominance | Importance Value |
|---|---|---|---|---|
| American Elm | 0.90 | 0.17 | 5.58 | 6.65 |
| Sugar Maple | 0.83 | 0.28 | 5.20 | 6.31 |
| Red Maple | 0.49 | 0.10 | 1.61 | 2.20 |
| Ironwood | 0.55 | 0.07 | 1.30 | 1.92 |
| Shagbark Hickory | 0.50 | 0.05 | 1.21 | 1.75 |
| American Beech | 0.53 | 0.06 | 1.11 | 1.70 |
| Basswood | 0.31 | 0.05 | 0.79 | 1.16 |
| Cottonwood | 0.27 | 0.03 | 0.72 | 1.02 |
| Muscle Wood | 0.27 | 0.03 | 0.43 | 0.73 |
| Silver Maple | 0.18 | 0.03 | 0.45 | 0.66 |

- American elm (ULAM) and sugar maple (ACSA2), the clearly most important species, were clustered together in Figure 2 close to the vector center.
- Abundance of these two species was not influenced greatly by the external factors.

## Conclusions

- Forest fragments in Adams, Allen and Wells Counties Indiana can be considered one Northeastern Region based on similar forest characteristics.
- This could be expanded to several surrounding counties in Indiana and Ohio because similar ecological, geological, and physiographic characteristics.
- There is a positive relationship between richness and forest size.
- A deeper analysis is needed to fully understand and identify implications of forest size and shape in regards to maximizing species richness and occurrence.

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