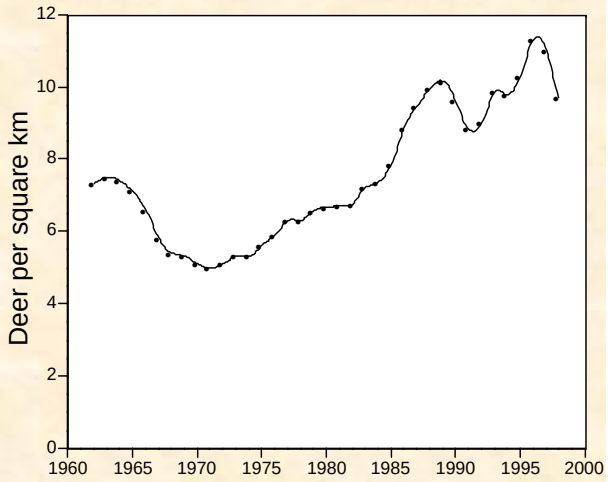
History of Deer Population in Indiana

- early 1900s: Essentially all deer in Indiana killed by hunting and habitat destruction
- 1930s: Deer reintroduced to state
- 1950s: Populations re-established and modern hunting programs begun
- 1990s - present: Historic high deer populations
- Forest vegetation in Bloomington area more affected by deer than other nearby areas

Causes of High Deer Populations

- Current deer numbers in U.S. can be 15 – 50+ / mi^2
- Believed to be higher than before Europeans
- Primary causes of deer increase
  - improved forage from agriculture
  - elimination of natural predators
  - increase in edge habitat preferred by deer
  - supplemental feeding
  - warm winters (recent decades warmest on record
  - hunters (and regulations) often favor bucks



Deer per square km of deer range in the **northern forest**. Each data point is derived from WI DNR SAK population estimate, and represents an average density for the entire region. Values are smoothed using a 5 year moving average to better reveal long-term trends.

Images from Fairfield County, Conn. Deer Management Alliance. www.deeralliance.com

Shifts in large mammal fauna

Moose

Before European settlement:

Predators:

cougar, wolf, wolverine

Ungulates:

Moose, Woodland Caribou
Elk, and White-tailed Deer

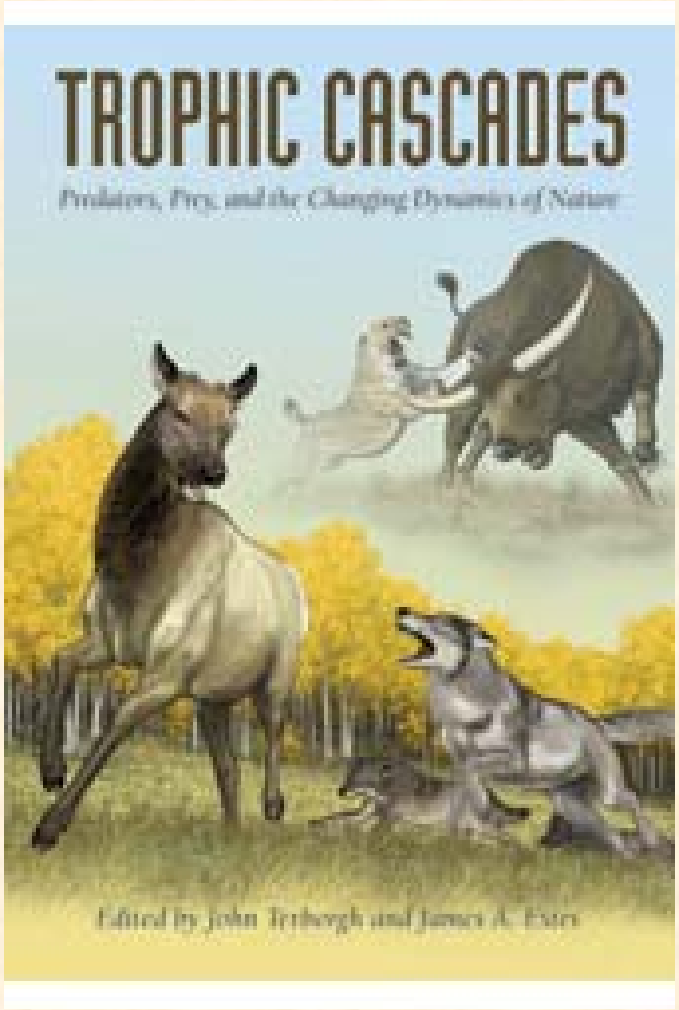
Elk

Woodland caribou

Deer

Importance of Predators

- Trophic cascades are often drastically disrupted by human interventions—for example, when wolves and cougars are removed, allowing deer and beaver to become destructive—yet have only recently begun to be considered in the development of conservation and management strategies.



John Terborgh & Jim Estes. 2010. Island Press.

Deer Overpopulation is Not New

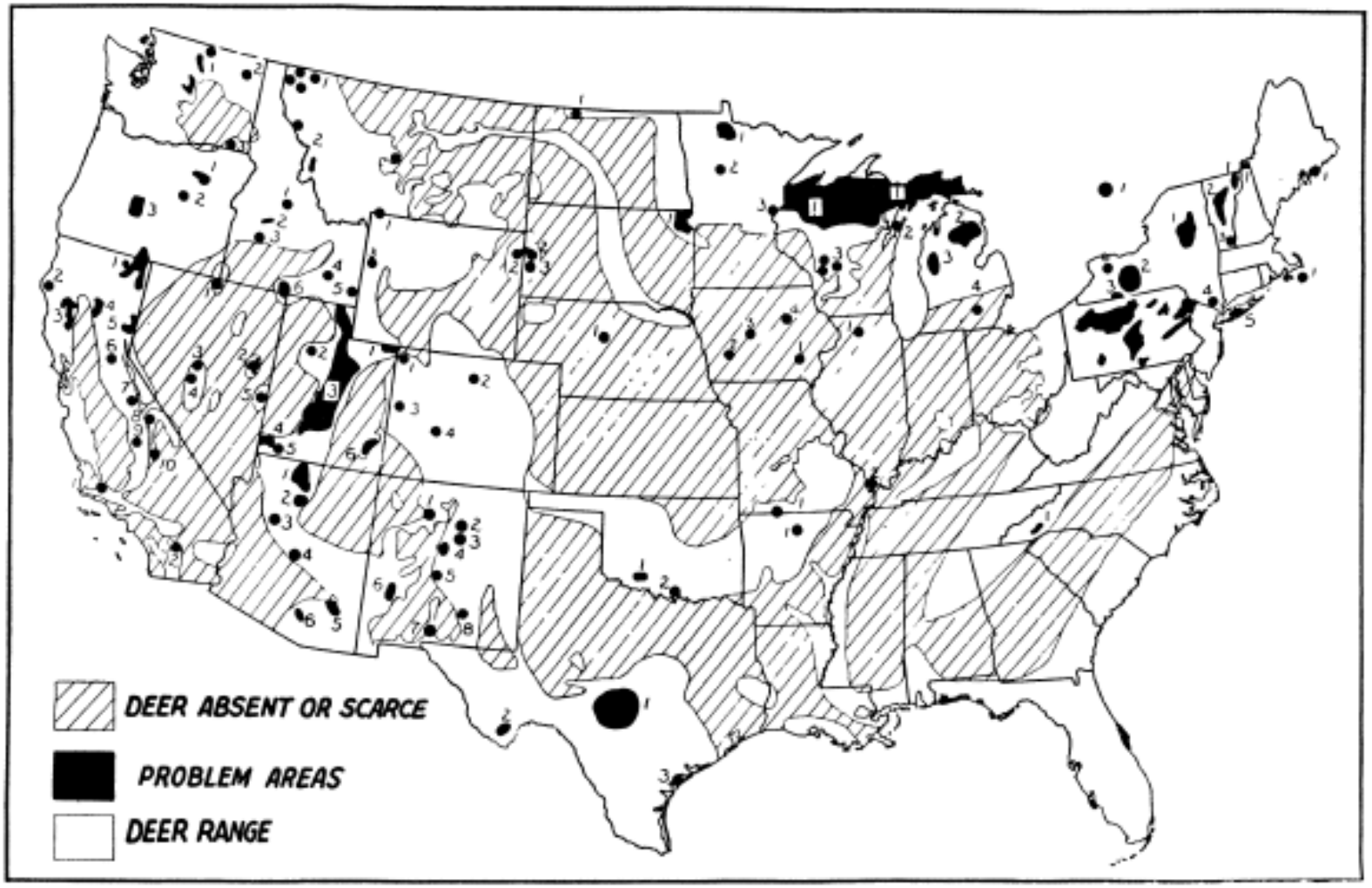


FIG. 1.—Areas in which over-populations of deer now exist or have existed in the recent past. Numbers refer to case histories.

Aldo Leopold 1947. J Wildlife Mgmt 11: 162

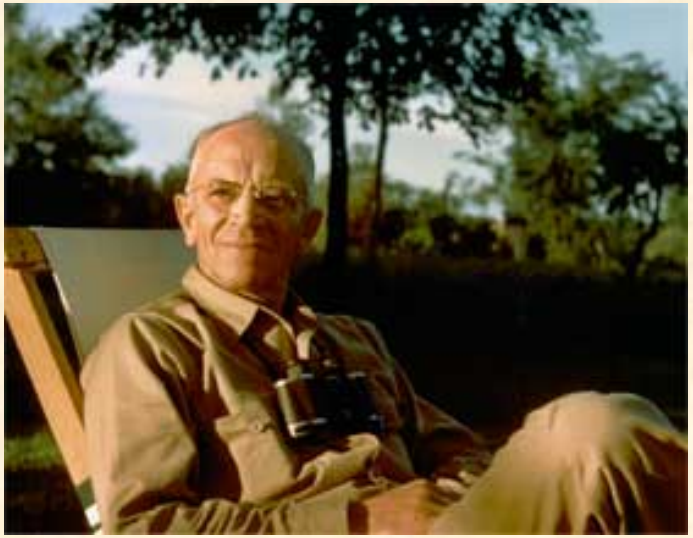
Deer Overpopulation is Not New

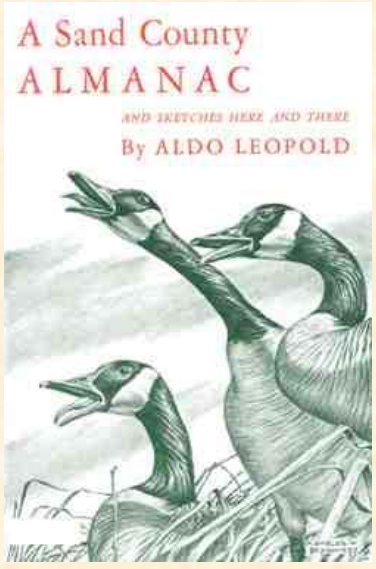
quoted from Aldo Leopold et al 1947 (J Wildlife Mgmt 11: 162)

(1)delay in reduction of overpopulated deer ranges means ultimate shrinkage of both the herd and the range;

(2)reduction is the only remedy, nothing else works;

(3)to accomplish a reduction, female deer must be killed.





How do we assess deer impacts?

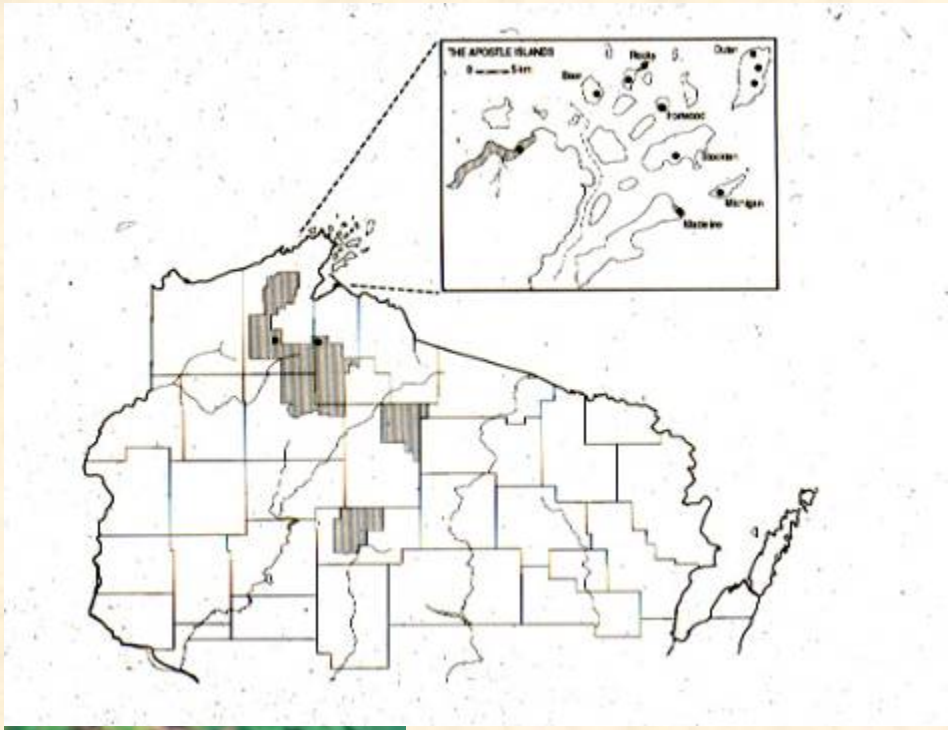
1. Anecdotes . .
2. 'Natural experiments'
   e.g., compare islands with and without deer
3. Exclosure studies
4. Compare regions with different deer densities
   Webster and Parker's study comparing Indiana State Parks to nearby hunted properties
   Look at demographic size structure (e.g. Kalisz & Knight's work on Trillium)
5. Changes in plant community composition
   Which species are declining? Which are increasing? Where?

Approaches to monitoring deer impacts

1. **Anecdotes**:
   - ‘sandwich’ trees
   - browse lines

2. Natural Island Experiments

- Compared islands that vary in deer densities
- Deer reduced:
  - *Taxus canadensis*
  - *Acer spicatum*
  - *Betula allegheniensis*
  - *Sorbus decora*
  - *Clintonia borealis* →
  - *Aralia nudicaulis*
- Declines persist for several decades



Apostle Islands (Lake Superior)

3. Exclosures

The ‘gold standard’?

Pro’s:

- Allows **controlled** comparisons
- Often show clear effects
  - Can be quantified
- Visually dramatic - **educational**

Con’s:

- **Extreme** comparison:

  Zero vs. high deer density
- **Local** to one area (unless replicated)
- **Expensive** to construct & maintain

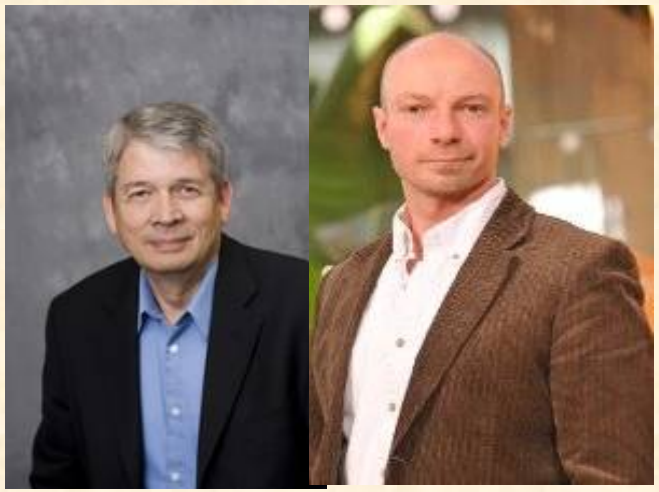
Dairymen’s Club

Fould’s Creek

Exclosures Show Dramatic Effects

4. Compare areas with and without hunting

Study of Effects of Deer on Indiana State Parks Compared to Nearby Hunted Areas (George Parker & Christopher Webster 1996)



- Hunted (control) areas had
  - more small woody plants (50-200 cm high)
  - higher % cover of herbaceous species
  - lower cover of unpalatable species
  - little difference in species diversity
- Before hunting many parks were dominated by only a few plant species
- In Wisconsin, several state parks without hunting lost over 50% of plant species

5. Change in Plant Communities over Time

- Which plants have increased over the past 50 years?
  - Sugar maple (*Acer saccharum*)
  - Grasses, sedges, ferns
  - Exotics

- Which plants have declined?
  - Hemlock, yellow birch and pines are declining
  - Lillies, orchids, & smaller native herbs
  - Overall species richness down 14%

Indicator Species to Assess Impacts of Deer

- Webster & Parker identified 3 indicator species for Indiana. These species tend to be smaller in areas with high deer densities.

Jack-in-the-pulpit
(*Arisaema triphyllum*)

sweet cicely
(*Osmorhiza claytoni*)

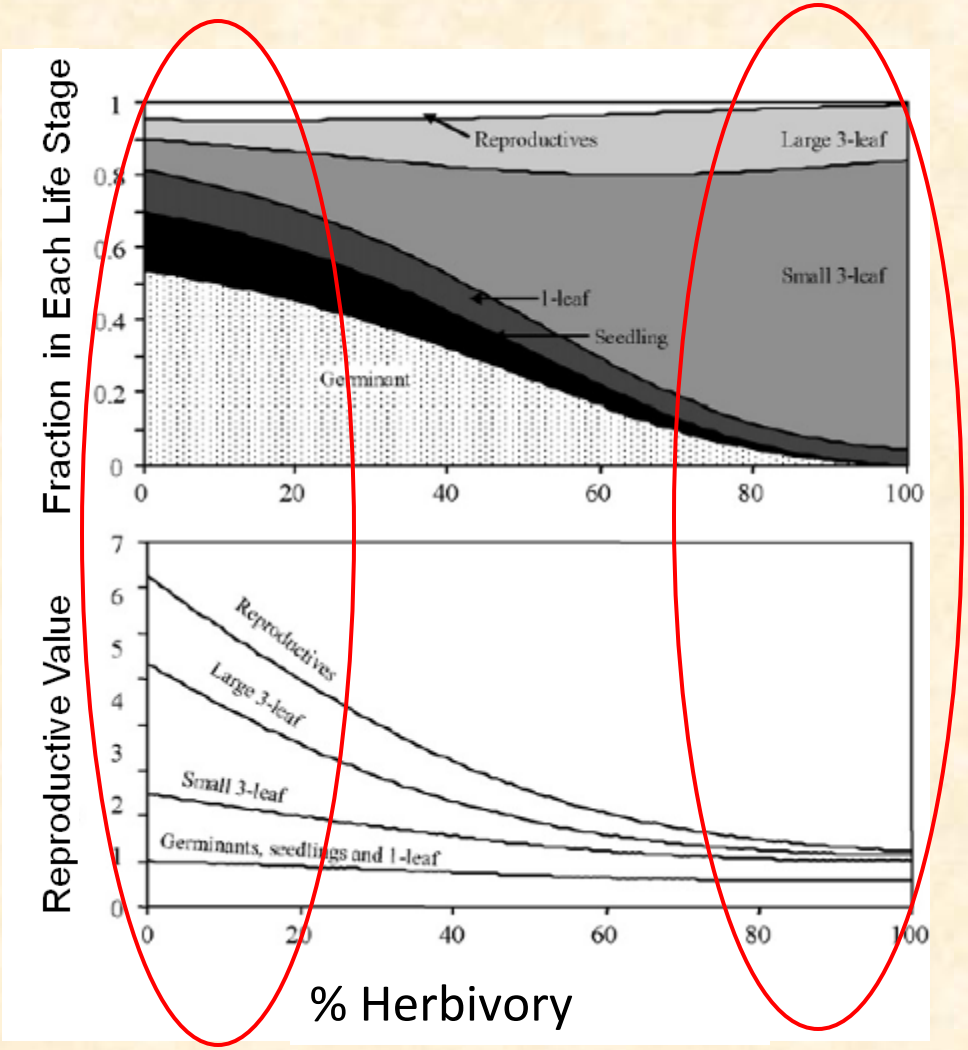
white baneberry
(*Actaea pachypoda*)

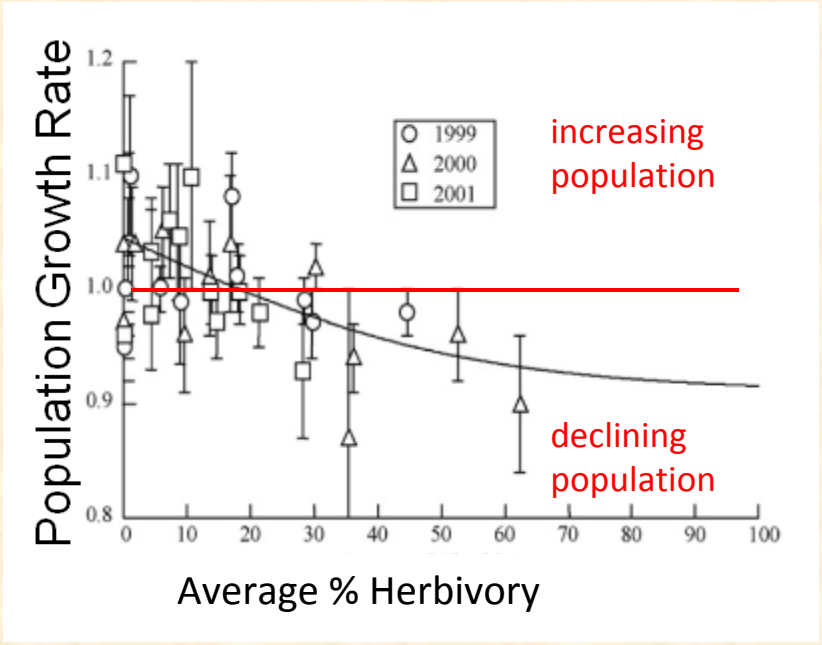
Effects of Deer Browsing on Forest Herbs

Research in Pennsylvania by Susan Kalisz

Effects of Deer Browsing on a Forest Herb

Large-flowered Trillium, *Trillium grandiflorum*



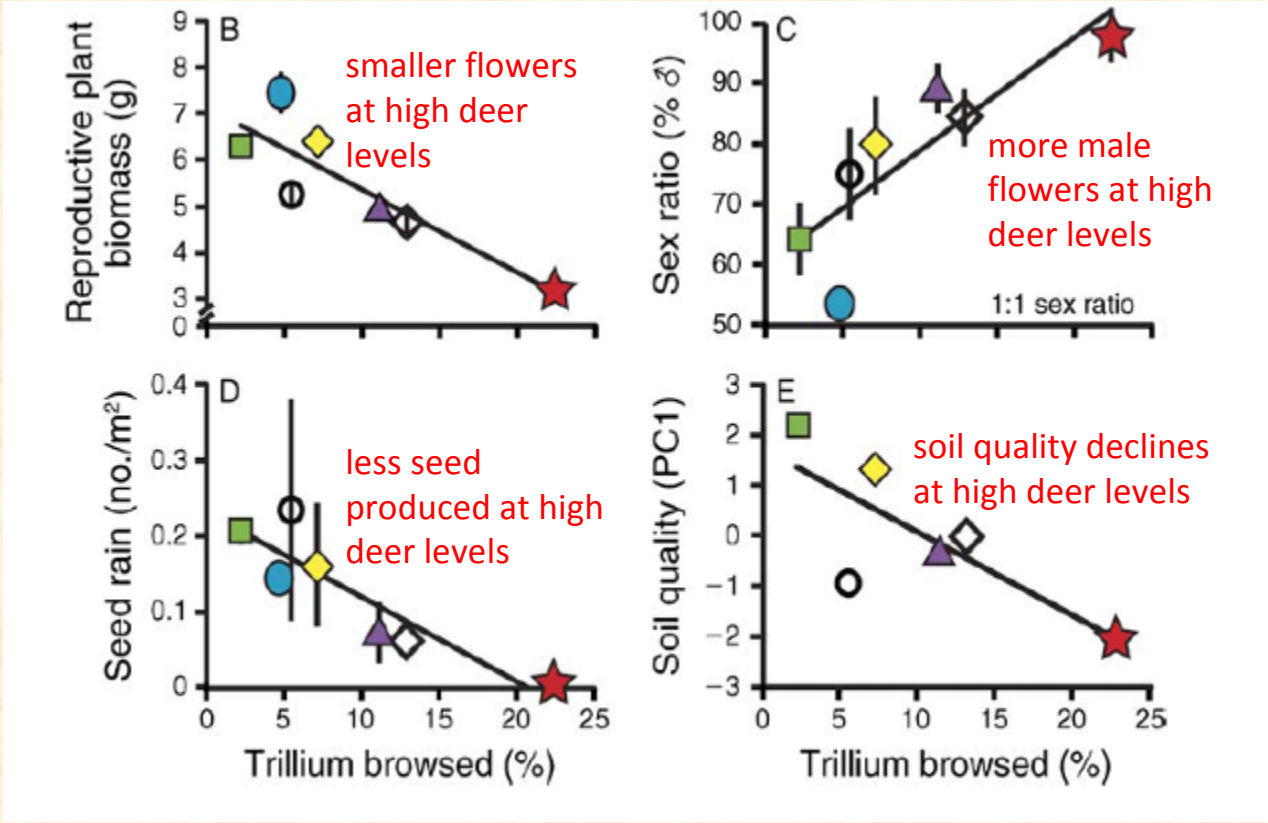


Knight, Caswell, and Kalisz. 2009. Forest Ecology and Management 257: 1095.

Deer Even Affect Plants They Don't Like to Eat

- Jack-in-the-pulpit is rarely eaten by deer (0.6% browsed)
- But plants are smaller and make fewer seeds when deer populations are high.
- In Griffy Woods, plants are small and most flowers are male

Effects of Deer on Jack-in-the-pulpit



Deer Intensity

Heckel, Bourg, McShea, and Kalisz. 2010. Ecology 91: 319-326.

Deer Can Facilitate Invasions and Alter Community Structure

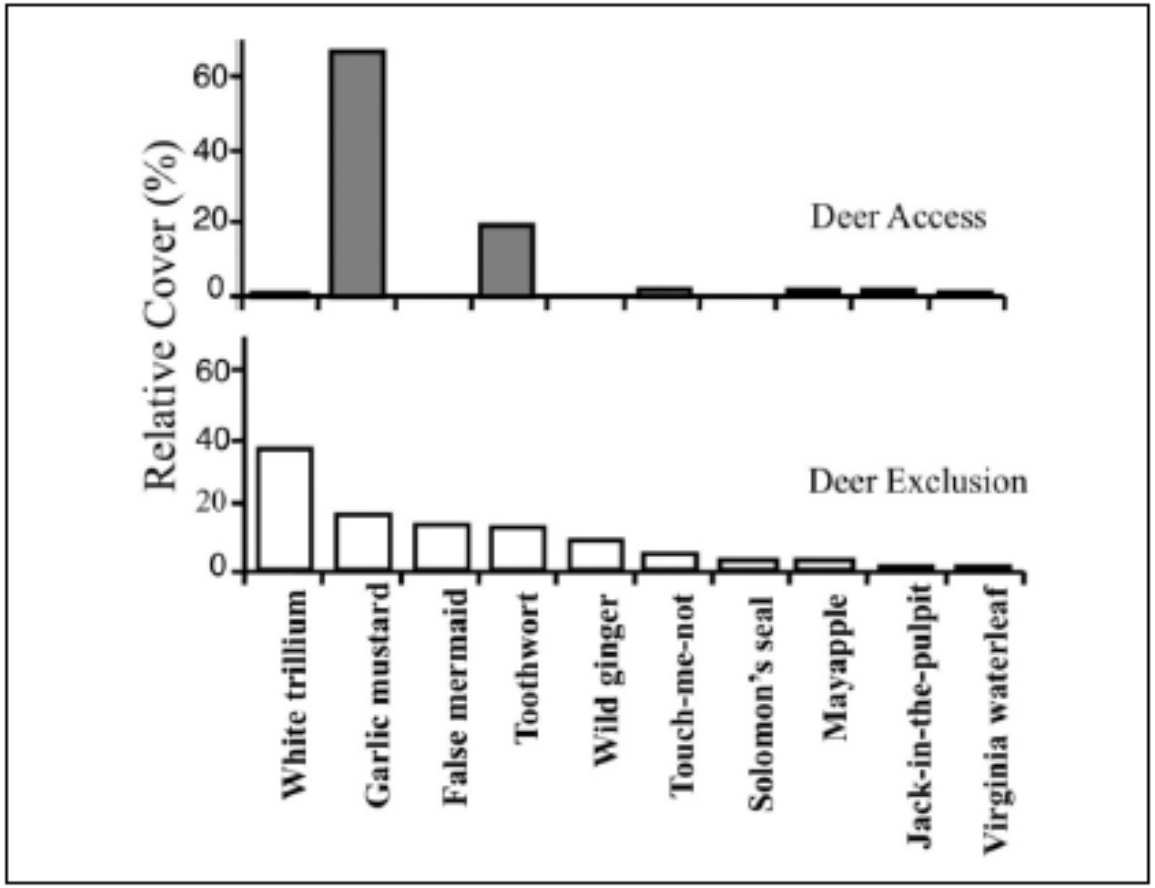


Figure 2. The relative percent cover of the ten most abundant plant species in our deer exclusion and control plots. All plant species are native, except garlic mustard. After five years of deer exclusion, community composition significantly diverged between treatments (Kruskal-Wallis rank test; $P = 0.001$).

Knight et al. 2009. Natural Areas Journal 29: 110.

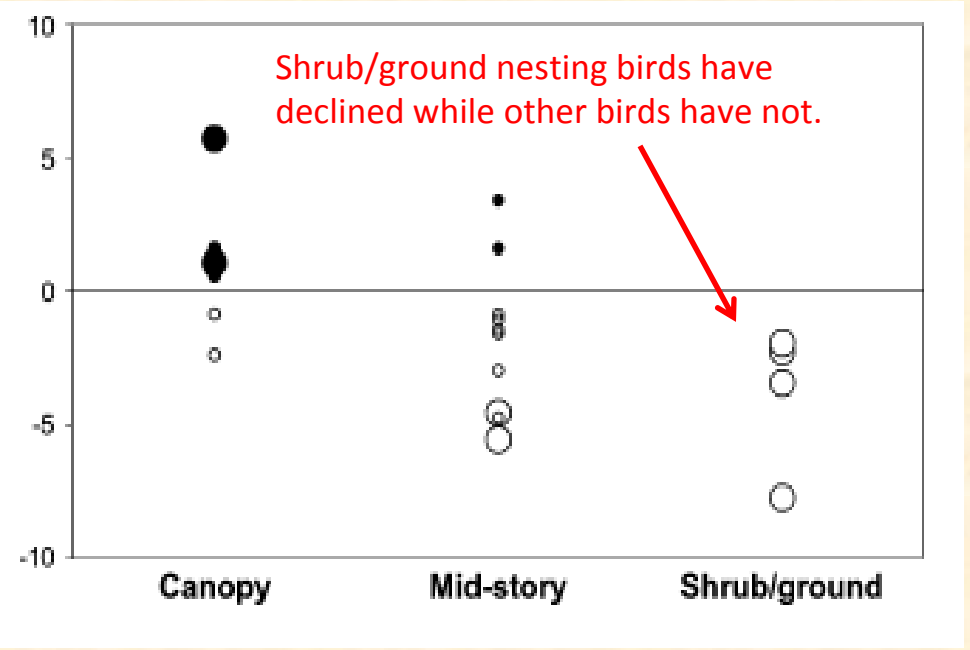
Deer Don’t Just Affect Plants

1976 – few deer. intact understory

2005 – understory dominated by invasives

2005 – barren understory

Change in Bird Population Abundances for 21 Forest Breeding Species in Hutcheson Memorial Forest (NJ)



open understory has little cover for bird nests

Baiser, Lockwood, Puma, and Aronson. 2008. Biological Invasions 10: 785

Long-term impacts of browsing

Griffy Woods is dominated by plants deer don't eat:

- pawpaw
- spicebush
- white snakeroot
- mayapple
- jack-in-the-pulpit
- plus invasives (Japanese stiltgrass, garlic mustard)

Few tree seedlings or saplings

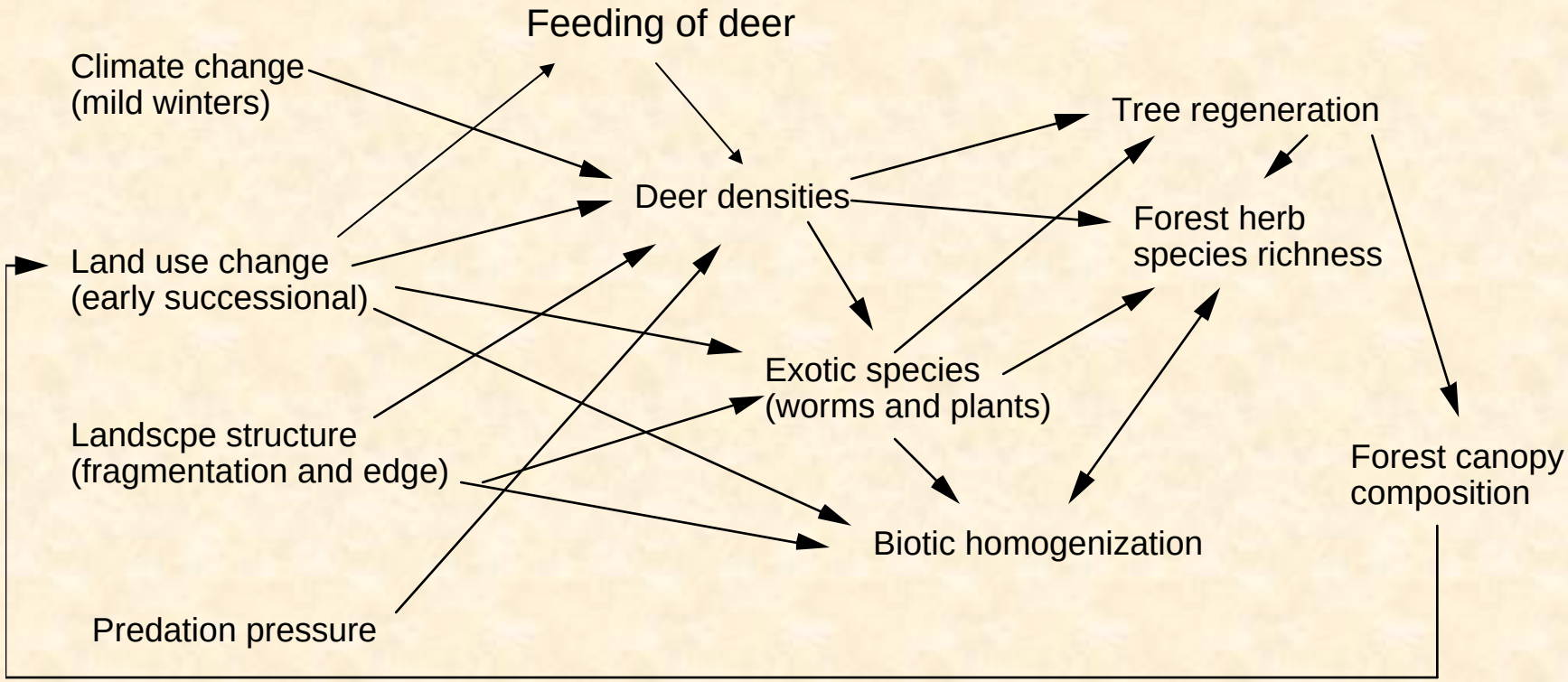
Black cherry trees and hay-scented fern dominate Pennsylvania's Allegheny National Forest. They are among the few plant species that can persist in the face of uncontrolled deer populations. Photograph: Alex Royo.

Ecological Effects of Deer Overpopulation

- increases plant invasions (Vavra et al 2007, Baiser et al 2008,)
- reduces size of eaten and uneaten plants (Heckel et al 2010)
- increases soil compaction (Heckel et al 2010)
- inhibits natural succession and tree regeneration (Côté et al 2004, Rooney & Waller 2003)
- causes shift to alternative community types (Webster et al 2008, Augustine et al 1998, Waller & Alverson 1997)
- reduces habitat for birds, small mammals, other animals (McShea & Rappole 2000)
- reduces food resources for other herbivores (Côté et al 2004)
- reduces litter depth (Heckel et al 2010)
- increases bare soil → erosion and sediment runoff
- increases disease in deer populations (Côté et al 2004)

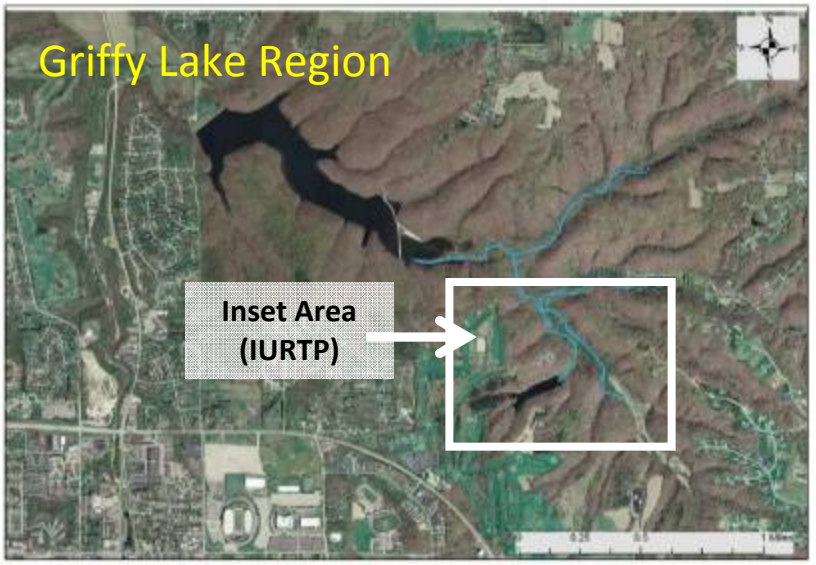
- Not to mention the effects on humans!

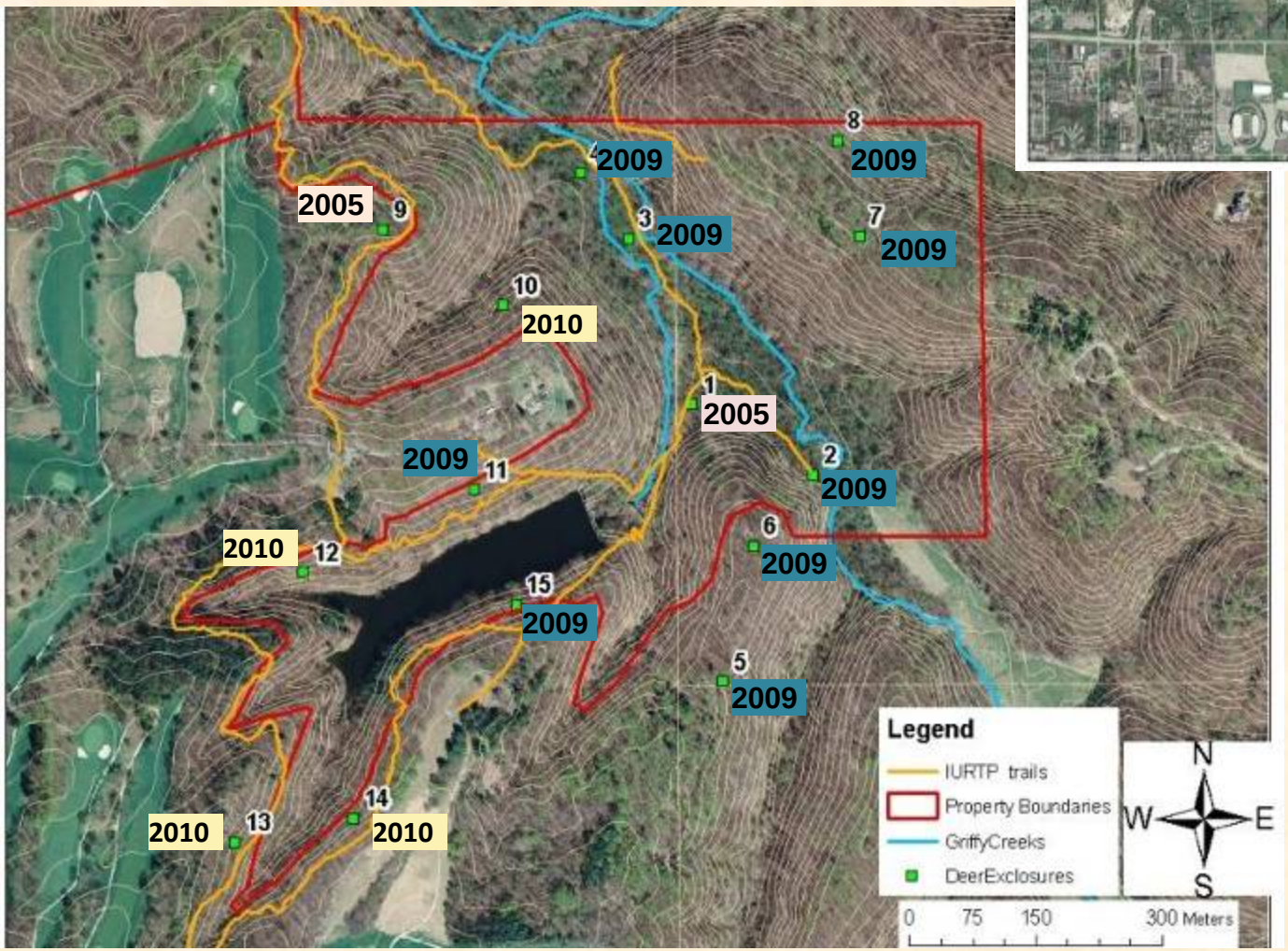
Deer and forests are a coupled system



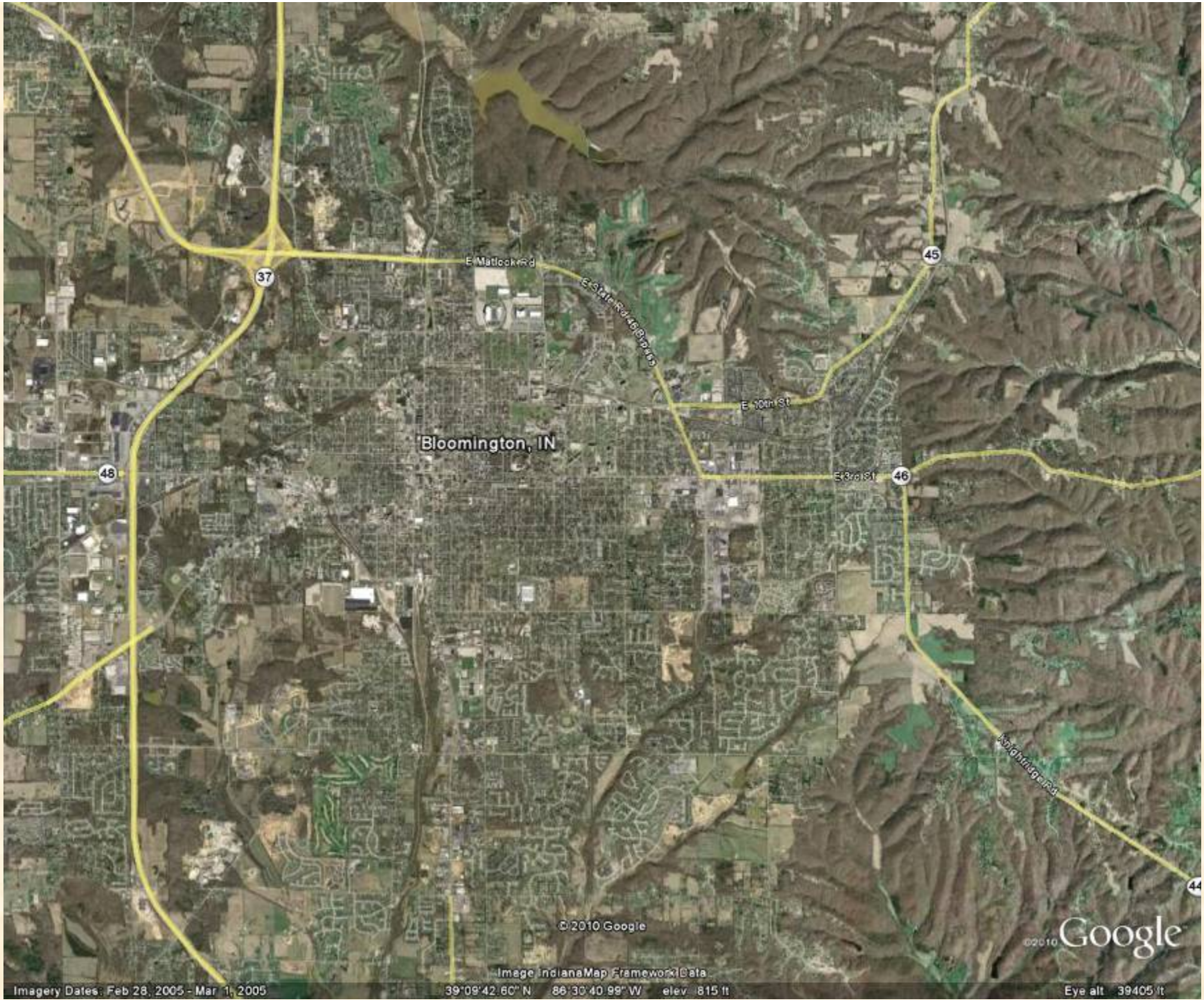
Griffy Woods Deer Exclosures at the Indiana University Research & Teaching Preserve

Deer Exclosures at IURTP Griffy Woods





- 15 exclosures and paired controls
- Fences constructed between 2005 (n=2) and 2010.
- Fences are 15 m x 15 m
- Herbaceous vegetation sampled in spring
- Woody vegetation sampled in winter


E Matlock Rd
37
45
E State Rd 46 Bypass
E 10th St
Bloomington, IN
48
E 3rd St
46
Northridge Rd
44
© 2010 Google
©2010 Google
Image IndianaMap Framework Data
Imagery Dates: Feb 28, 2005 - Mar 1, 2005
39°09'42.60" N 86°30'40.99" W elev 815 ft
Eye alt 39405 ft

IU Golf Course next to University Lake. Summer 2010. Photo by Angie Shelton.

IURTP Griffy Woods Deer Exclosure #6. Spring 2010. Photo by Angie Shelton.

IURTP Griffy Woods Deer Exclsoure #2. Late Summer 2010. Photo by Angie Shelton.

IURTP Griffy Woods Deer Exclsoure #4. Late Summer 2010. Photo by Angie Shelton.

Outside the Fence:

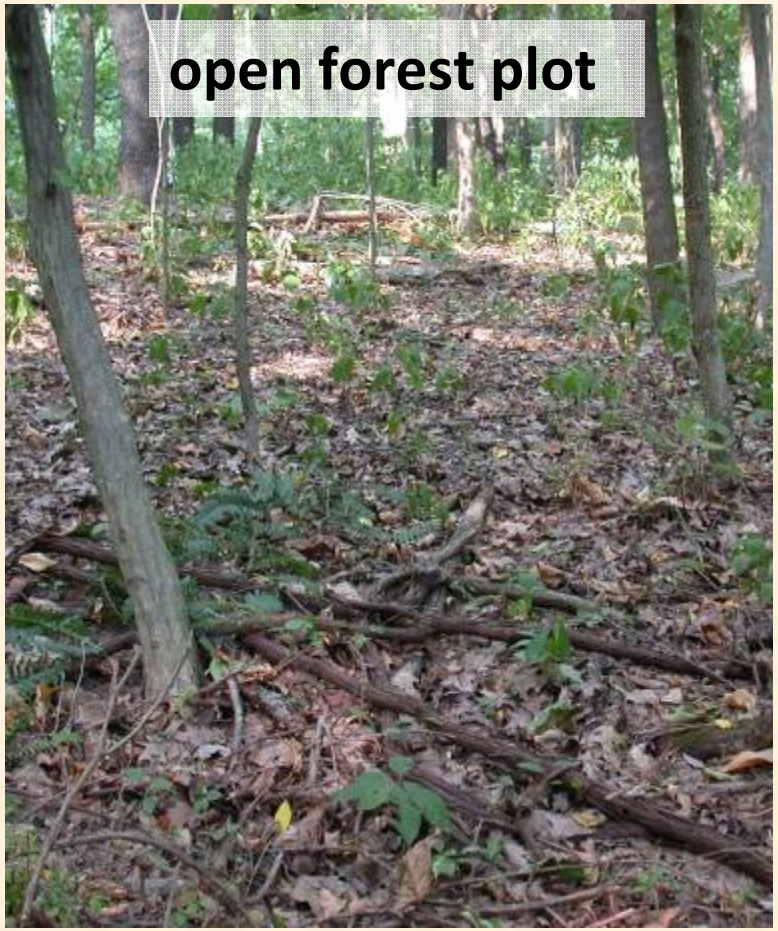
Dominated by Invasive Stiltgrass

Inside the Fence:

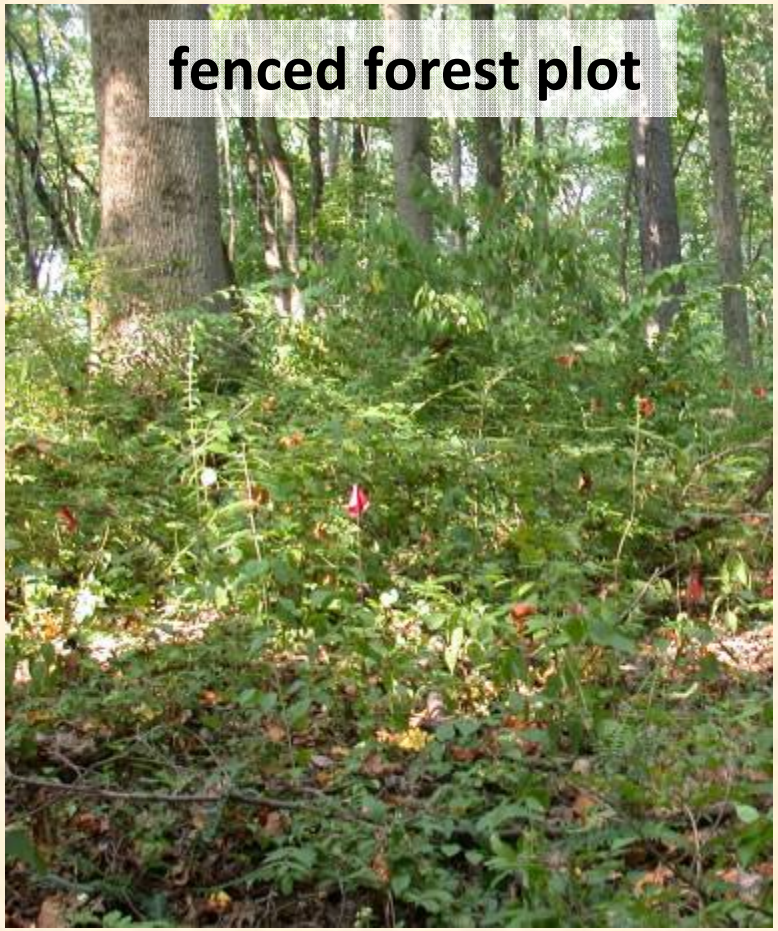
Stiltgrass present, but dominated by tall native plants

IURTP Griffy Woods Deer Exclosure #3. Late Summer 2010. Photos by Angie Shelton.

Vegetation Differences After 5 Years of Fencing



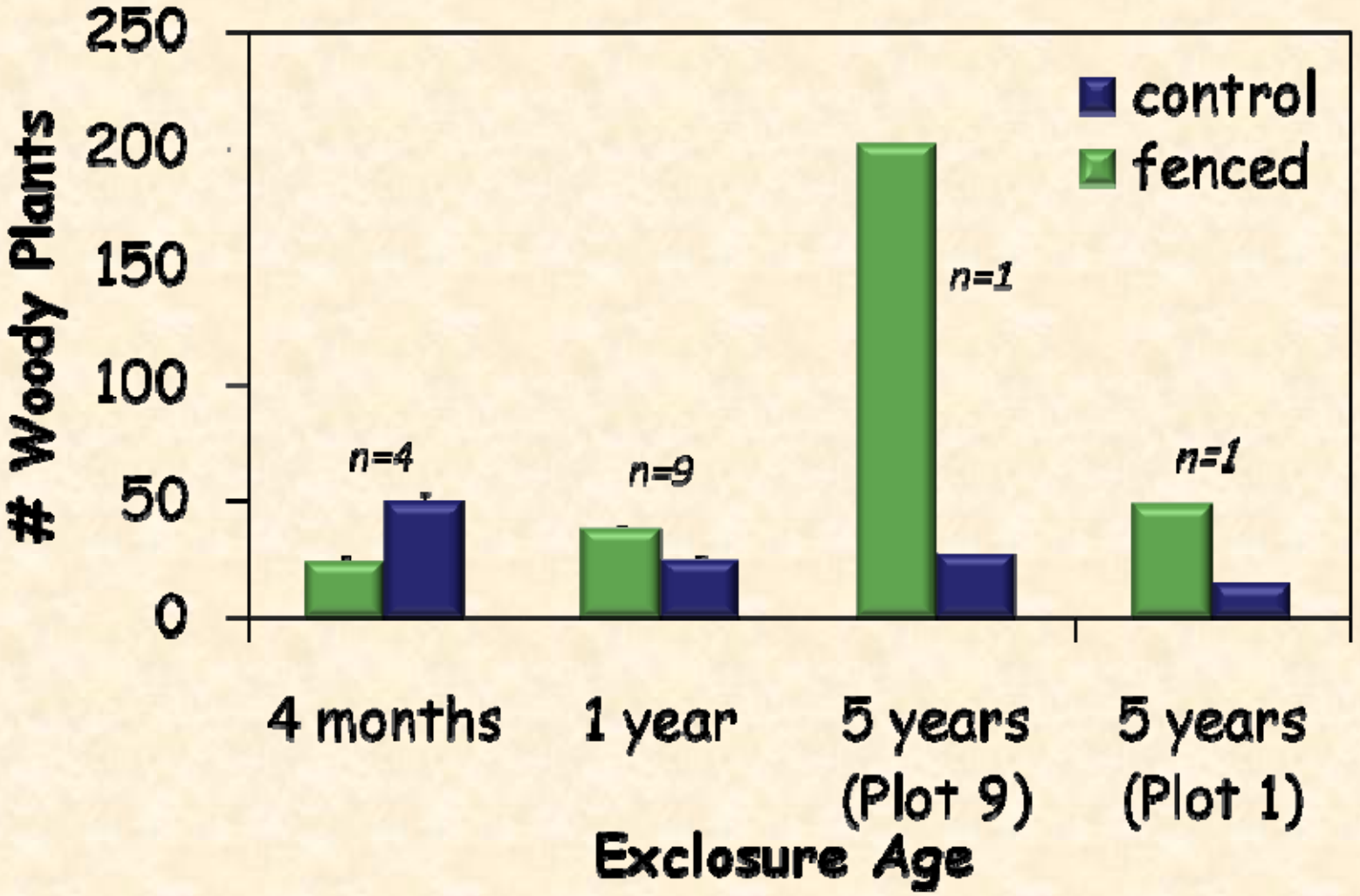
28 woody plants



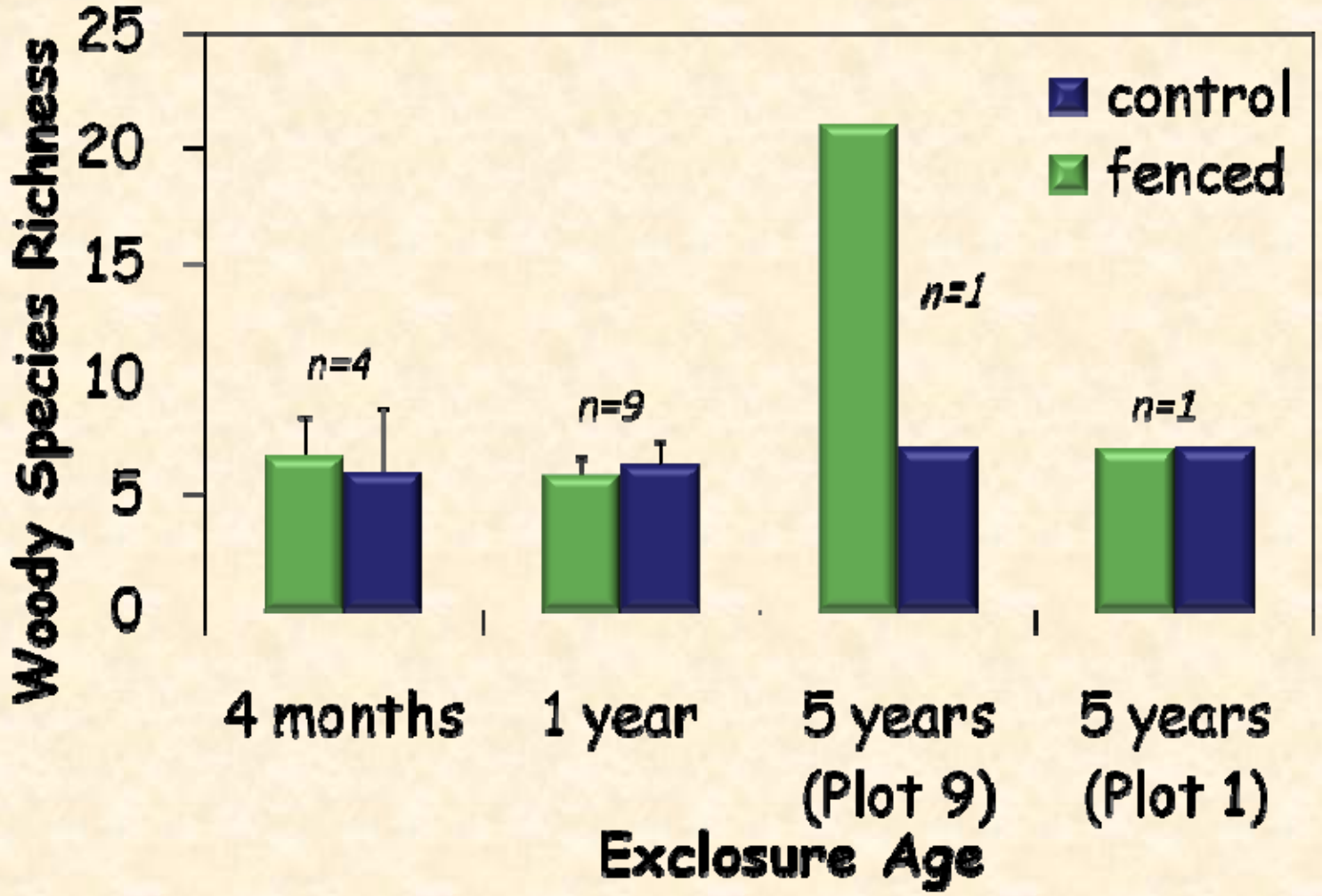
204 woody plants

IU Research & Teaching Preserve – Griffy Woods (Plot 9)

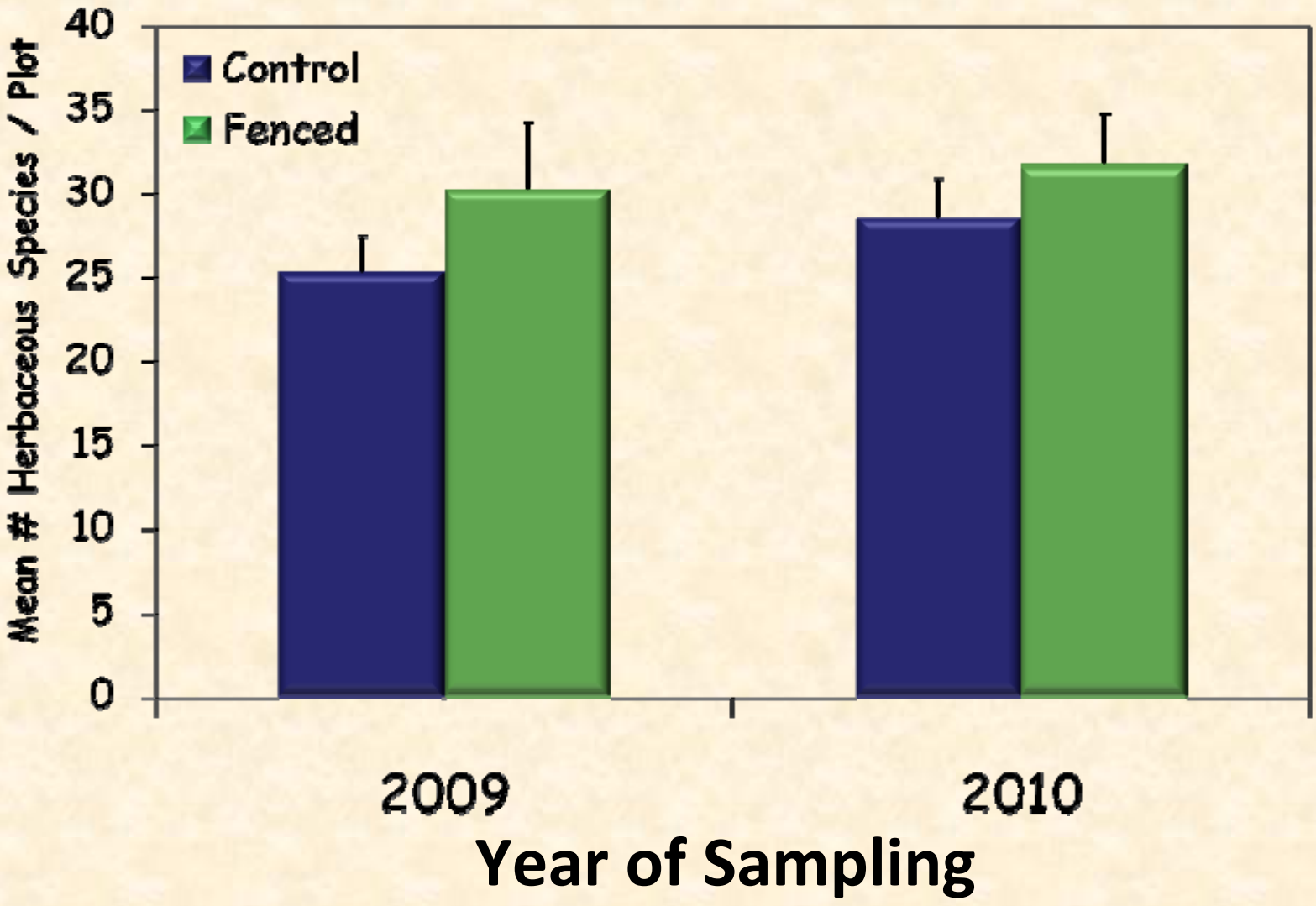
Change in **Number of Woody Plants** by Duration of Fencing



Change in **Woody Species Richness** by Duration of Fencing

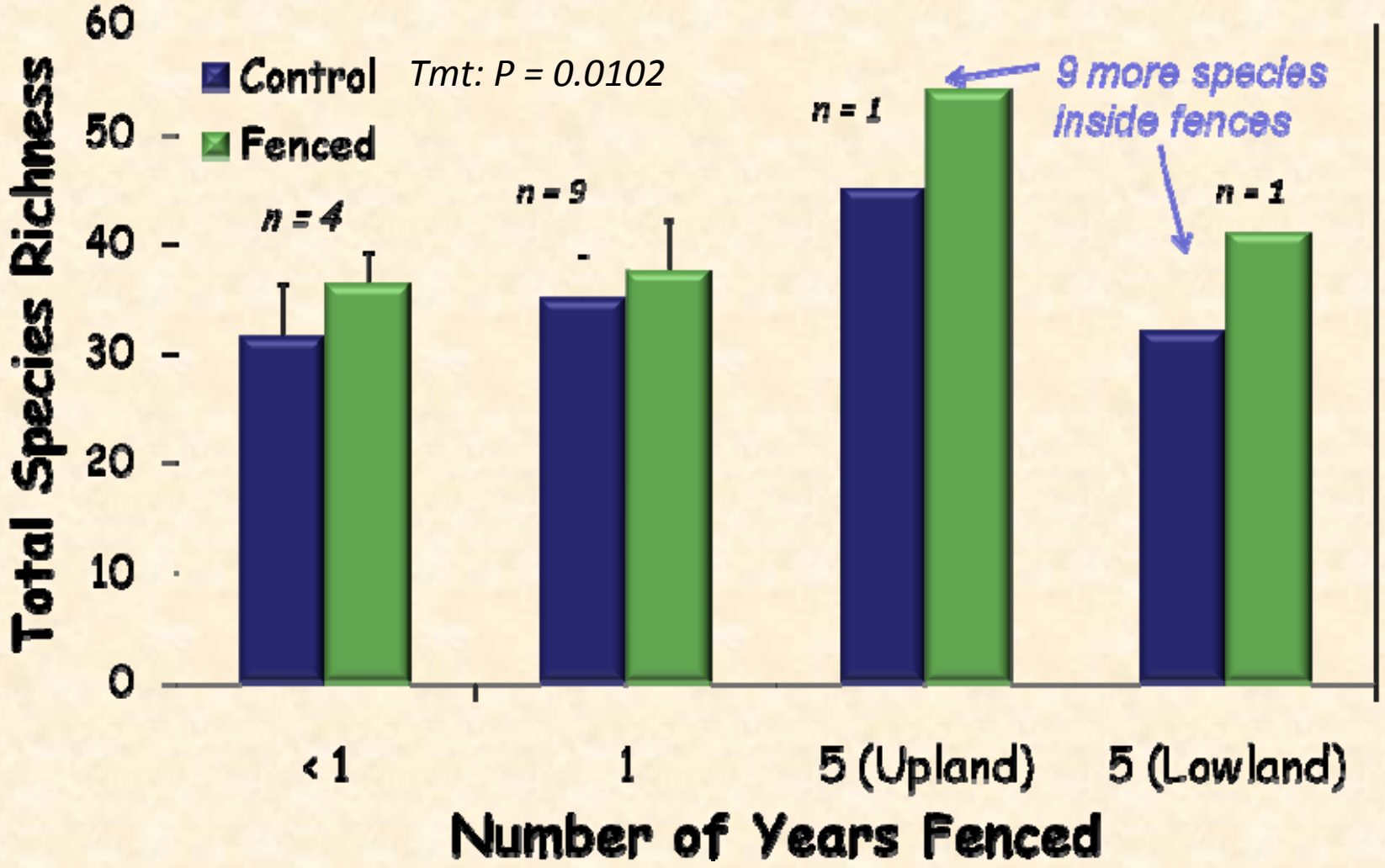


Number of Herbaceous Species

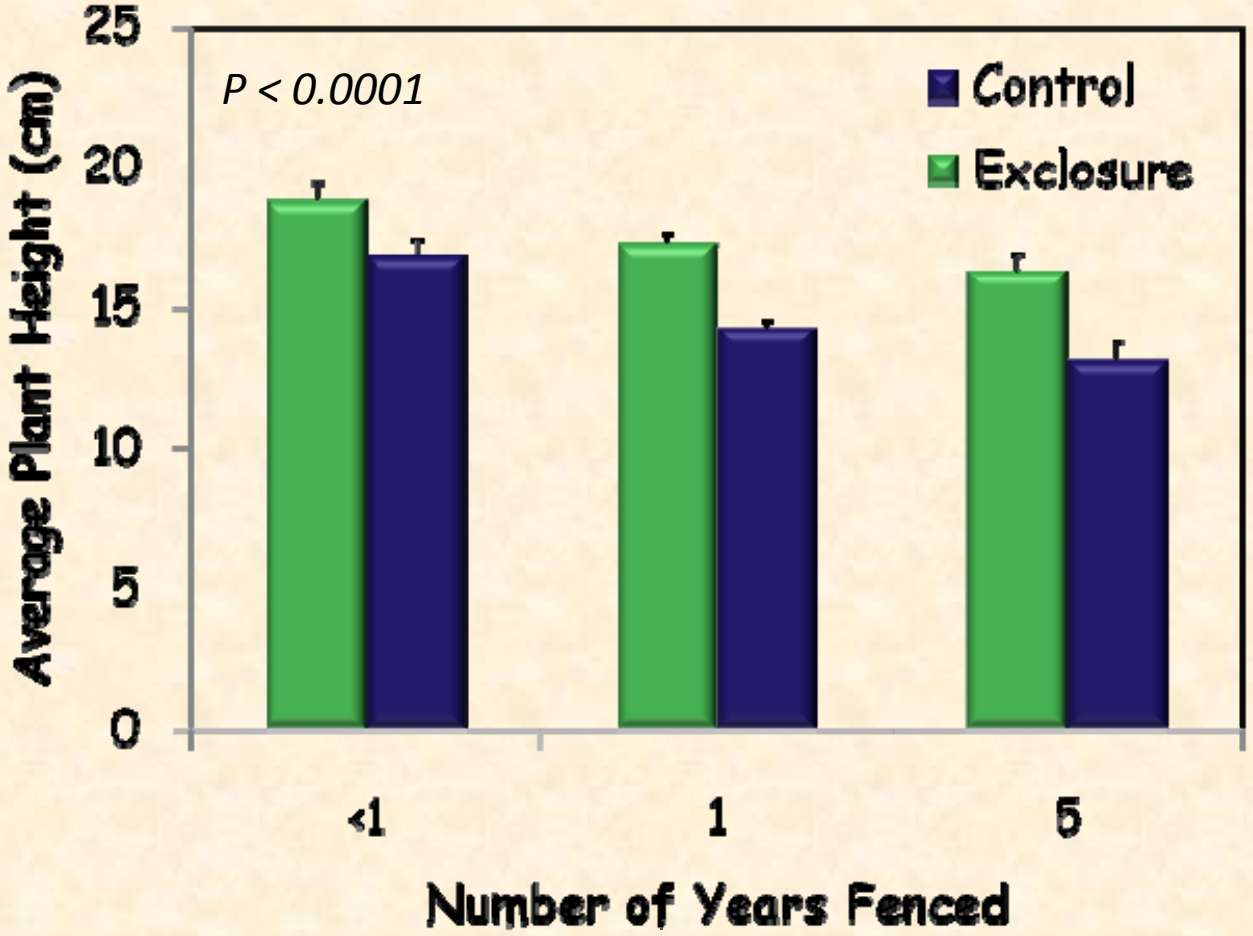


Total Number of **Species**

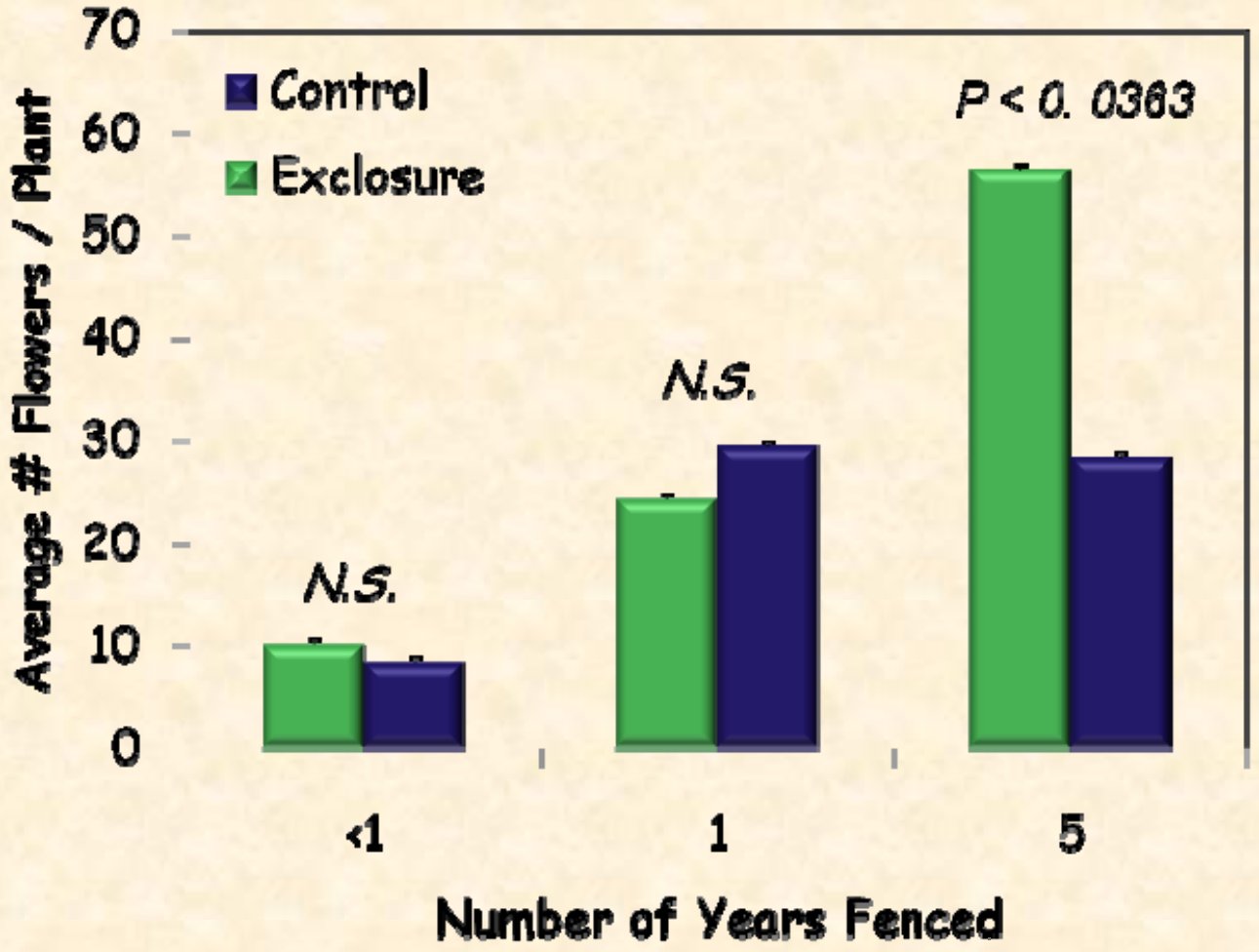
(woody and herbaceous combined)



Plants are Already Taller Inside Exclosures



Oldest Exclosures Have More Flowers Per Plant



Indicator Species to Assess Impacts of Deer

- Webster & Parker identified 3 indicator species for Indiana. These species tend to be smaller in areas with high deer densities.

Jack-in-the-pulpit
(*Arisaema triphyllum*)

sweet cicely
(*Osmorhiza claytoni*)

white baneberry
(*Actaea pachypoda*)

Status of Webster and Parker's Indicator Species in Griffy Exclosures

	Numbers		Average Height (cm)	
	control	fenced	control	fenced
jack-in-the-pulpit	47	45	10.6	14.0
sweet cicely	0	5	-	14.7
white baneberry	4	5	10.3	20.5

- Jack-in-the-pulpit tends to be taller inside exclosures
- Sweet cicely was only found inside exclosures
- White baneberry was taller inside exclosures
- Only 10 jack-in-the-pulpit flowers recorded. 7 were in exclosures.

Summary of Effects of Fencing

Fenced plots have:

- taller herbaceous plants (*P < 0.0001*)
- more flowers *(oldest exclosures only. P = 0.0363)*
- more woody plants *(P = 0.0190)*
- no difference in overall herbaceous species cover

  (but total cover of woody and nonwoody plants higher inside fences)
- non-significant trend for greater species richness

  (9 more species in each of two plots)

The Deer Dilemma . . .

- A local or temporary problem?
  - **No** - chronic over much of E. North America
  - Effects persist for decades
- A minor problem?
  - Not affecting one or a few species, but whole guilds & communities
  - Has begun to pose health & safety risks
- Simple impacts?
  - **No** - complex and often indirect
  - May be causing major and irreversible ecological effects