

Herbaceous Species Productivity in an Historically Altered Landscape

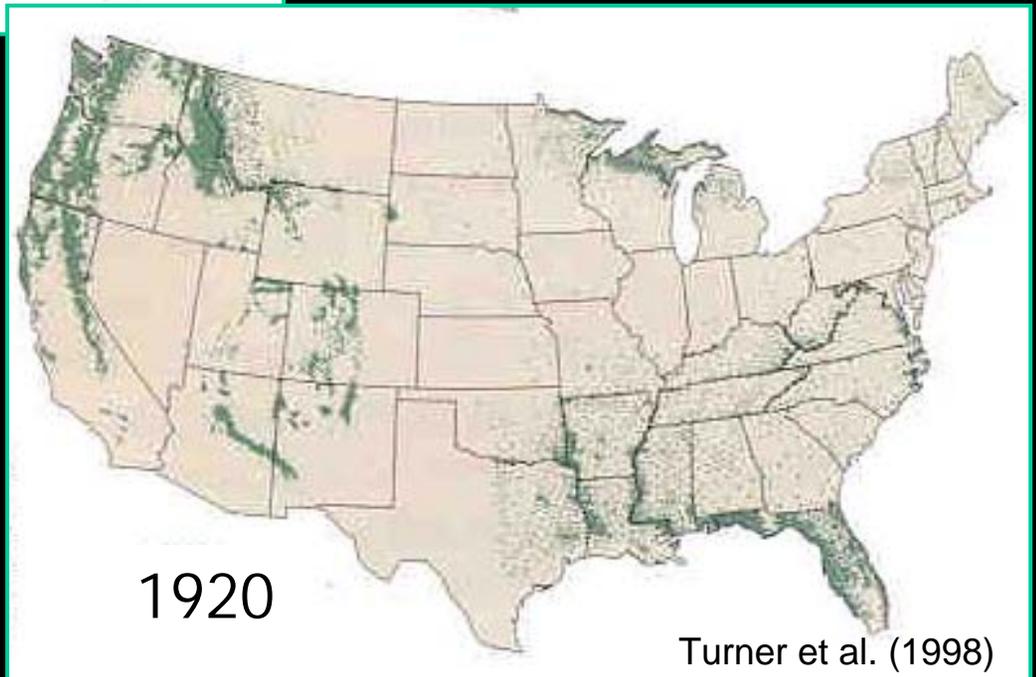
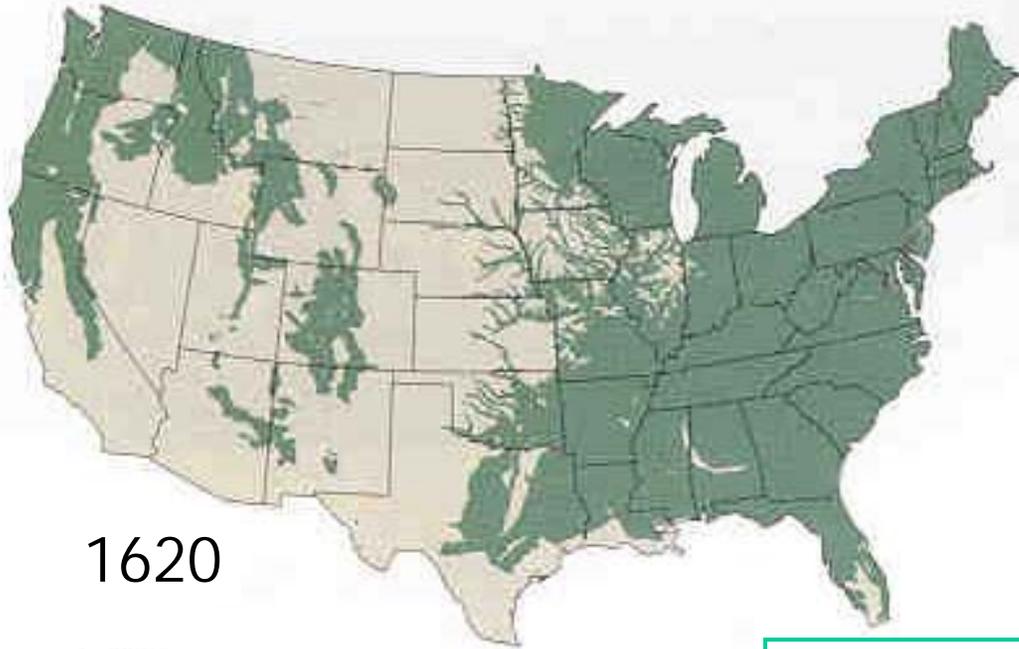


DOE End-of-Summer Workshop, 2004

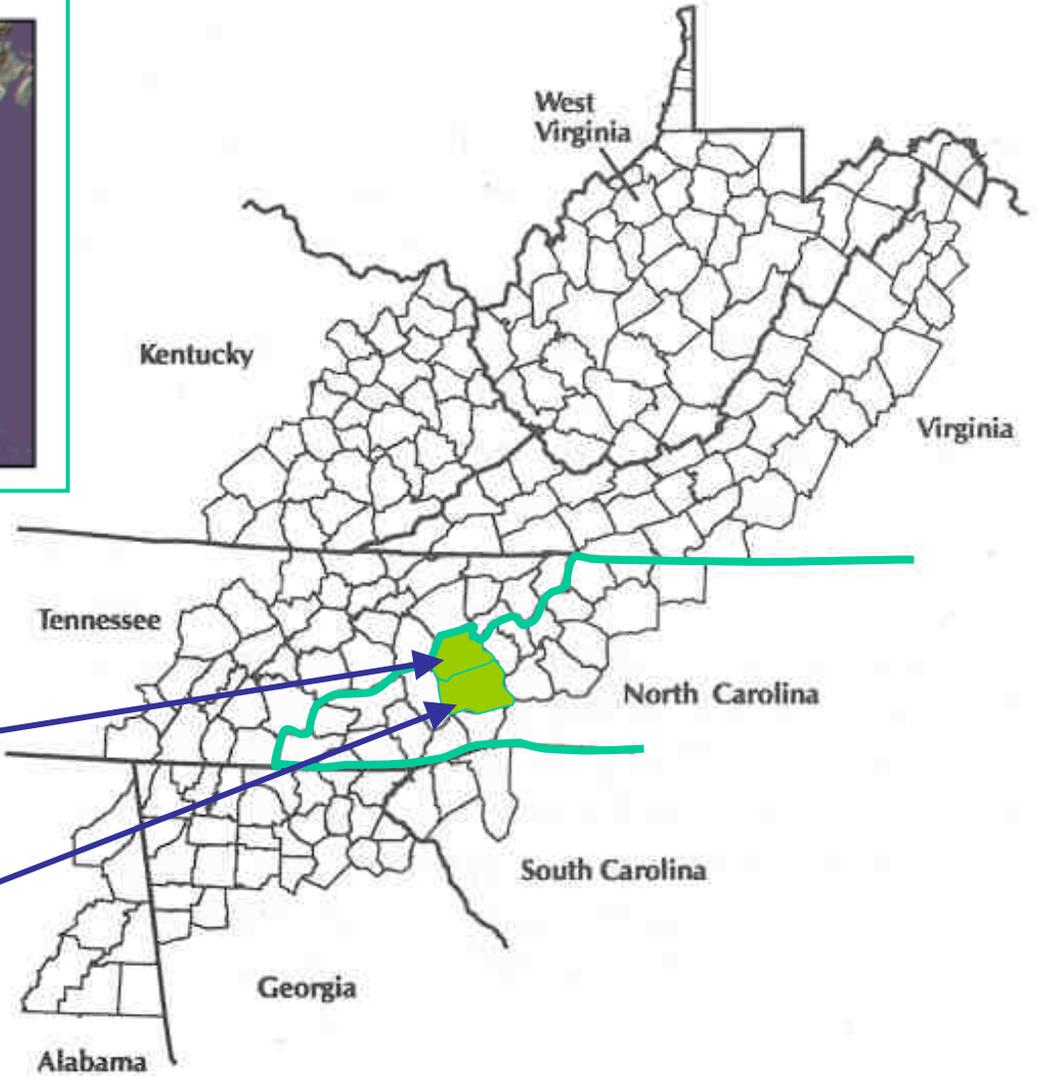
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Historical Land Conversion in the U.S.



Southern Appalachians

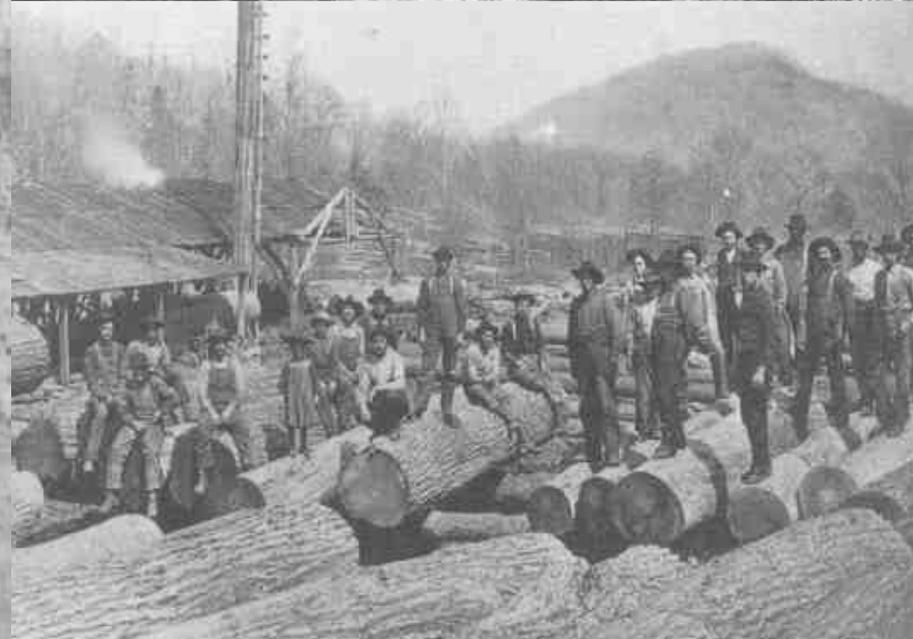


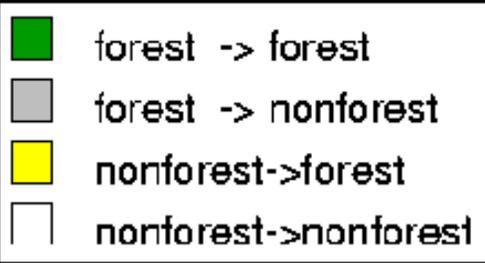
Madison County

Buncombe County

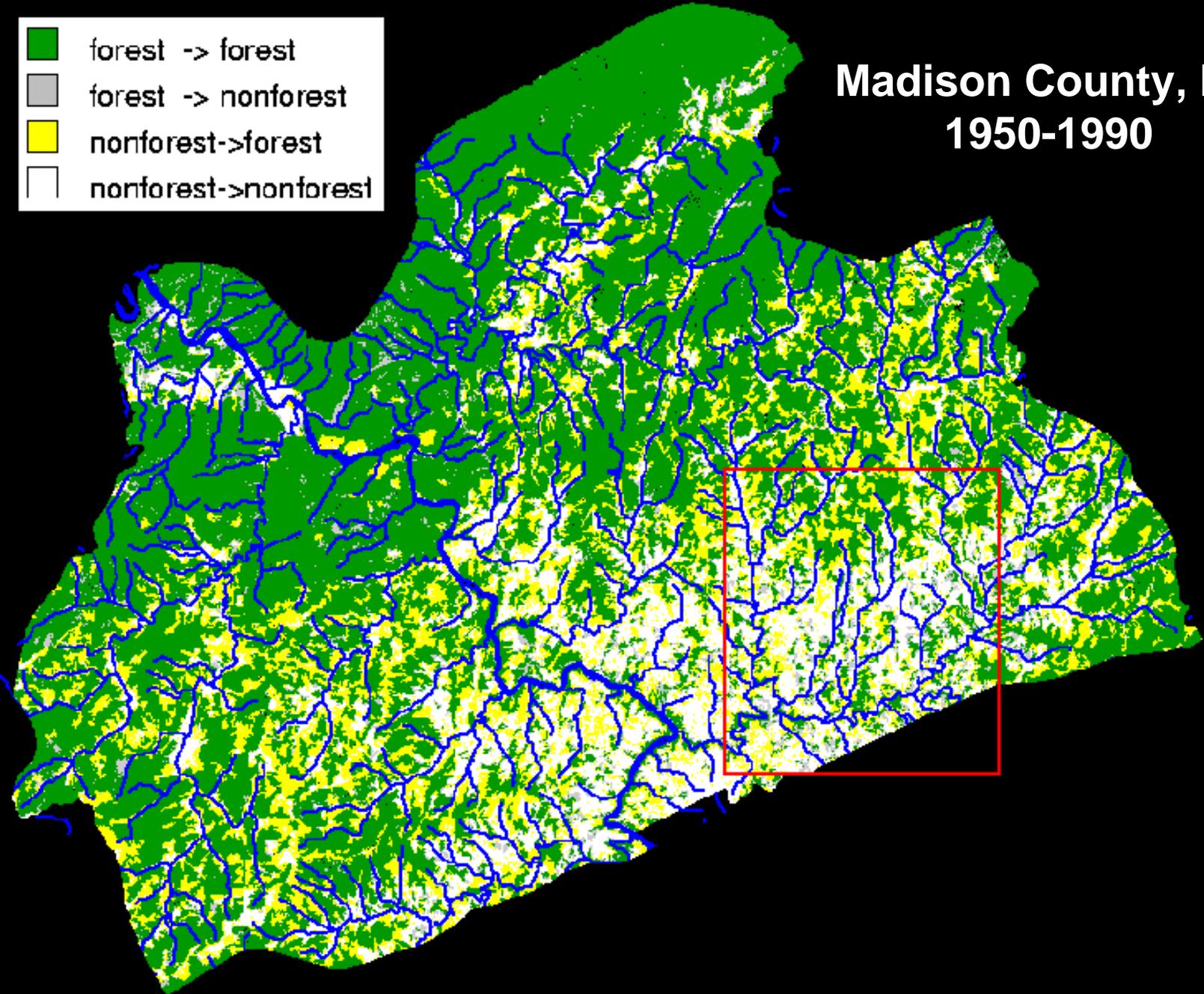
Southern
Appalachians
ca. late-1800s

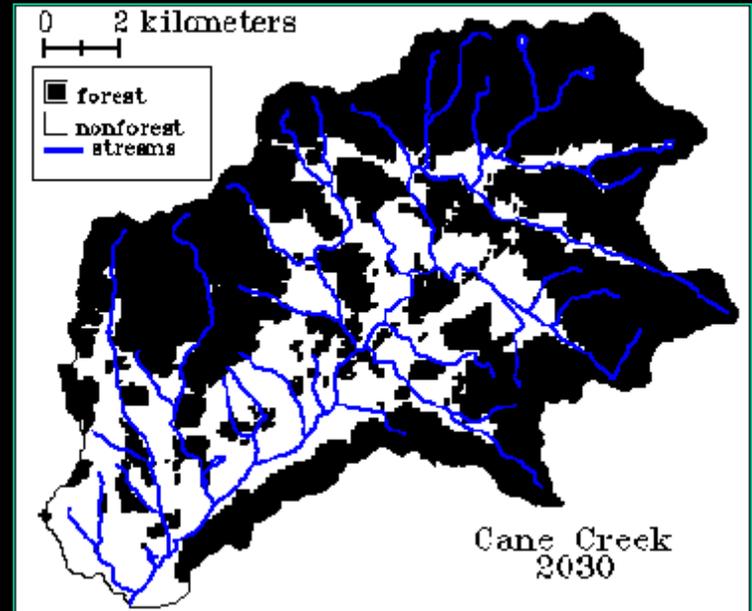
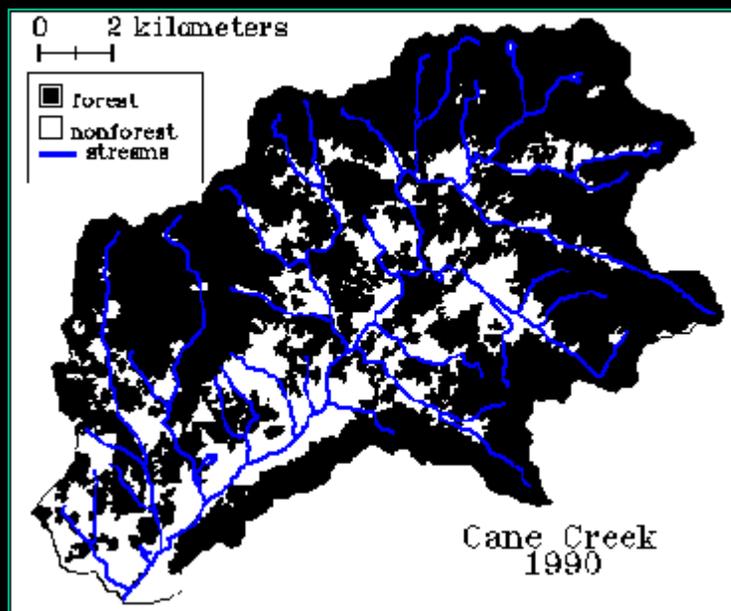
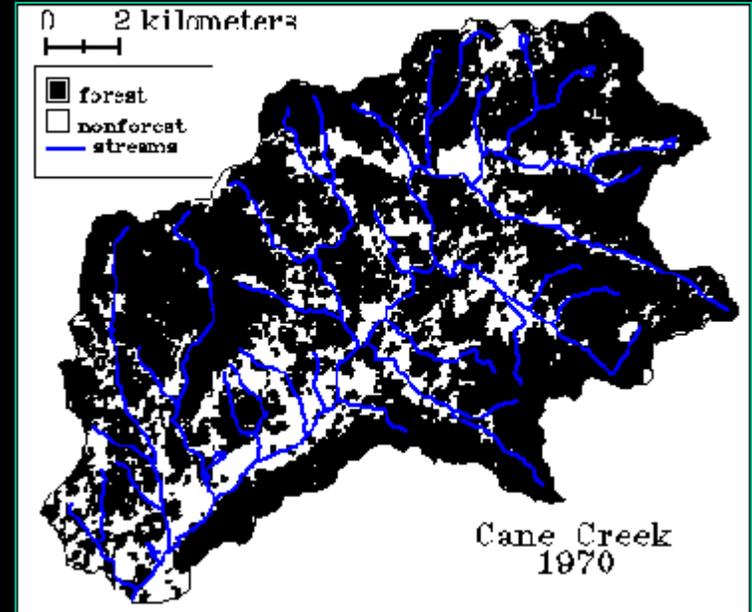
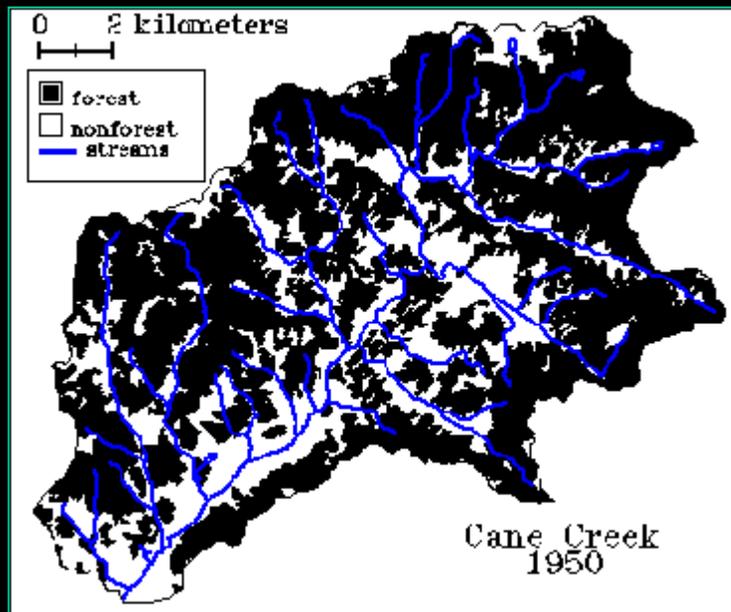






Madison County, NC 1950-1990



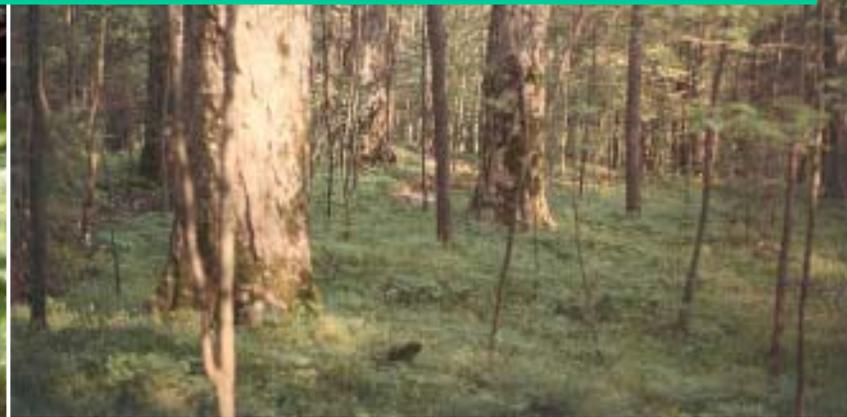




Paradoxical Landscapes:

Contemporary land cover is uniform, but histories are heterogeneous

- **Agriculture/Pastures (1900 farms - 2000 forest)**
- **Logging (logged twice in 20th century)**
- **Reference (least disturbed, not logged in past 75 yrs)**



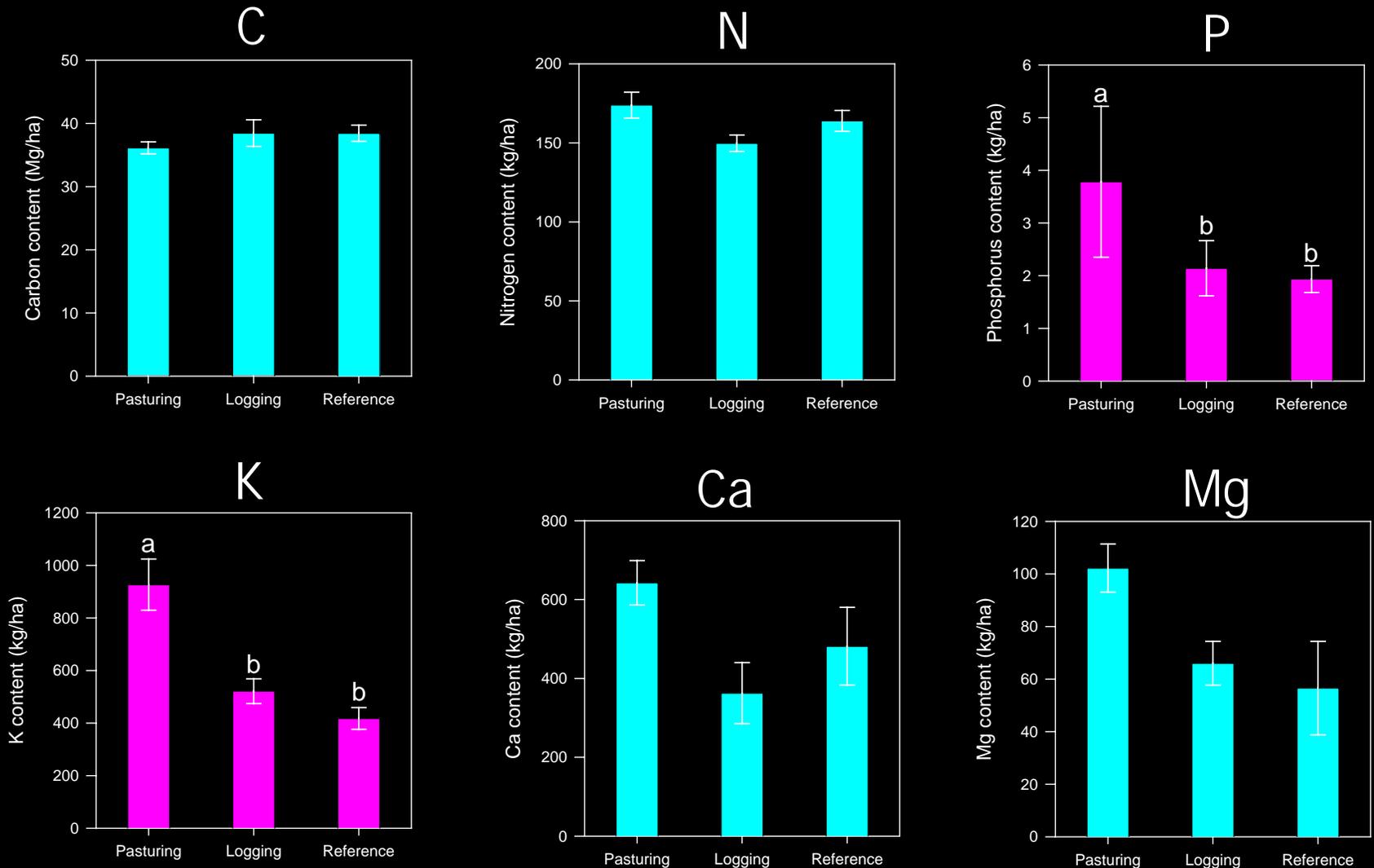
What is the response of terrestrial systems to changes in land use?

How does prior land use influence the availability and distribution of soil nutrients?

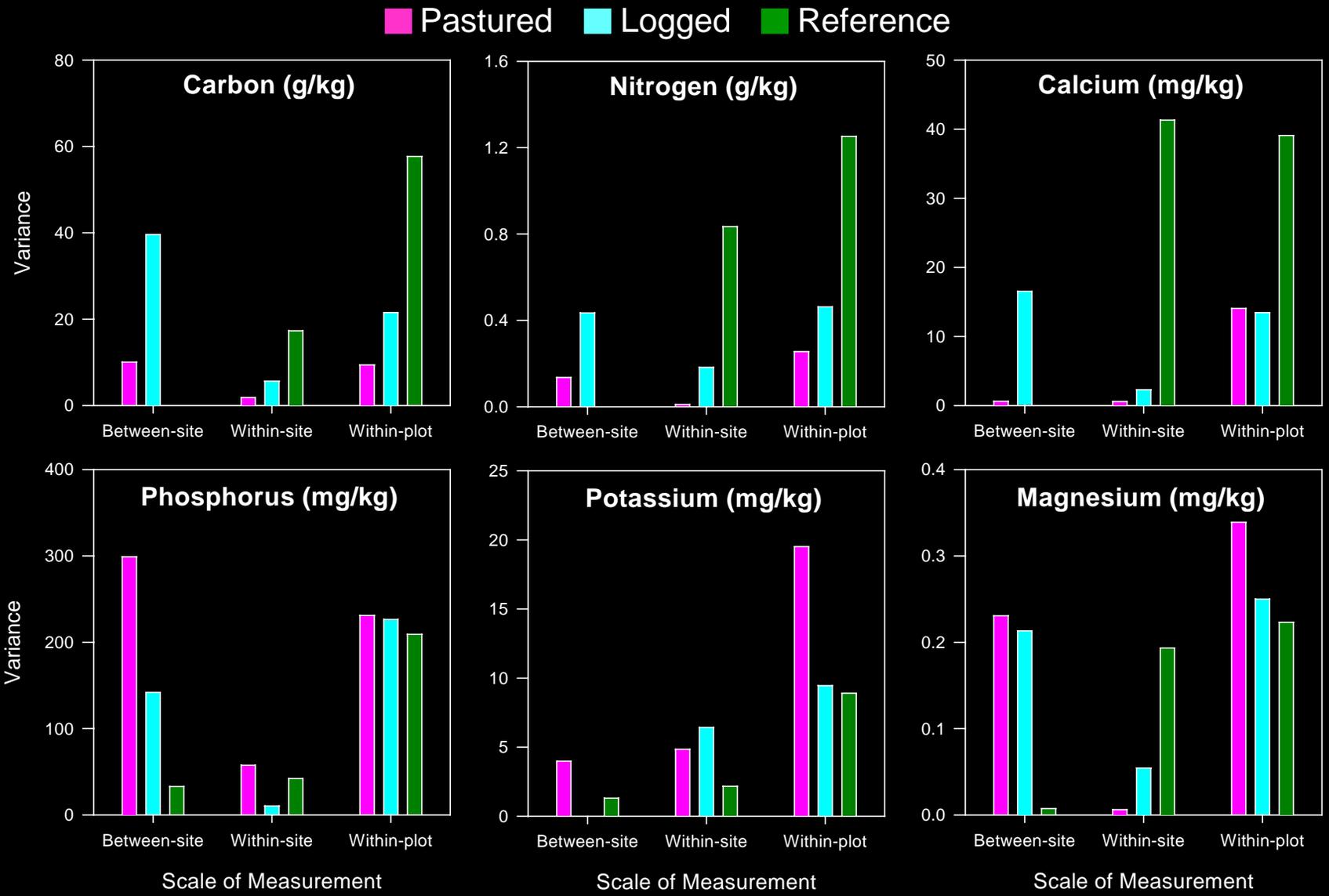
- average values
- variability at multiple spatial scales



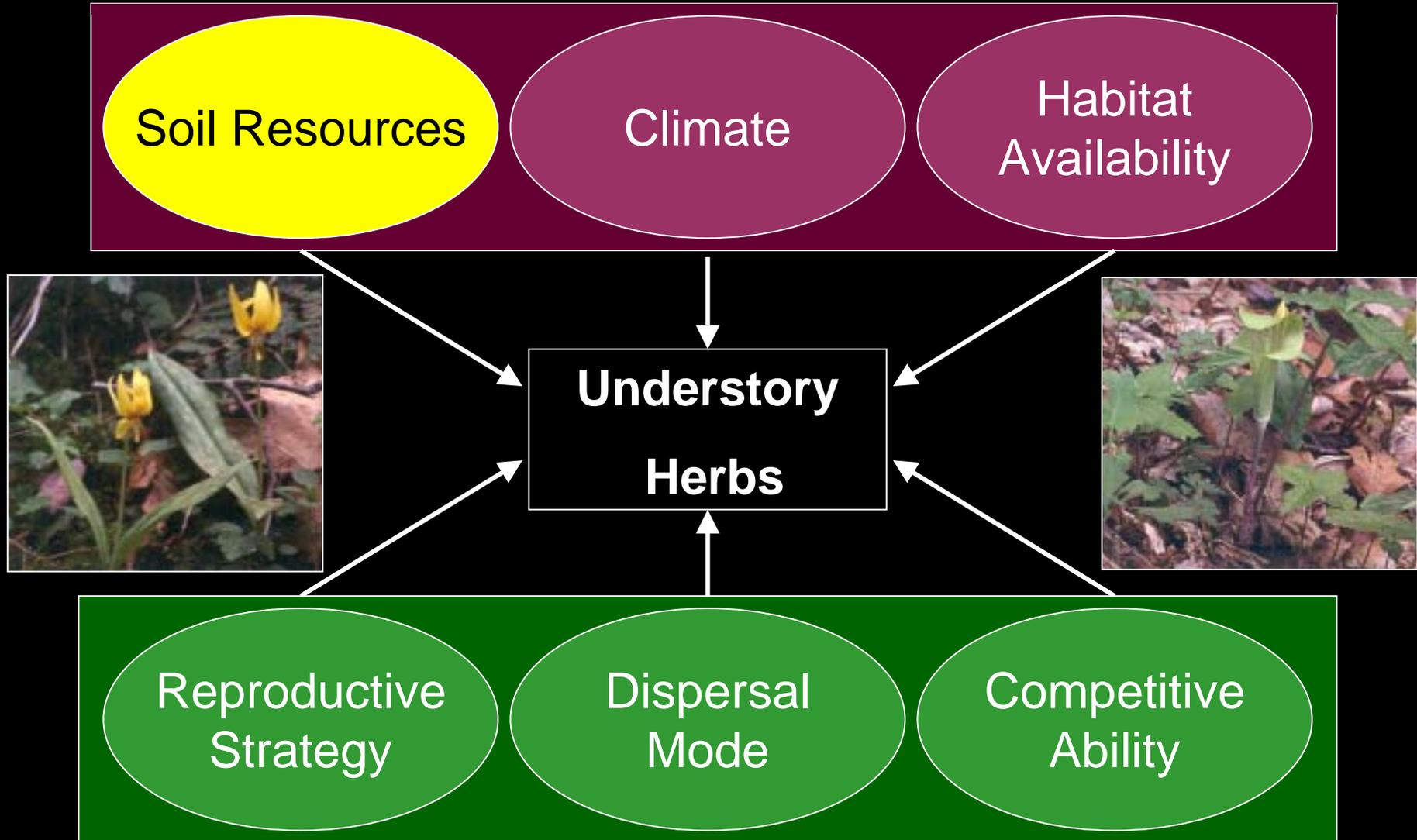
Changes in Average Soil Fertility



Changes in Variance at Multiple Spatial Scales



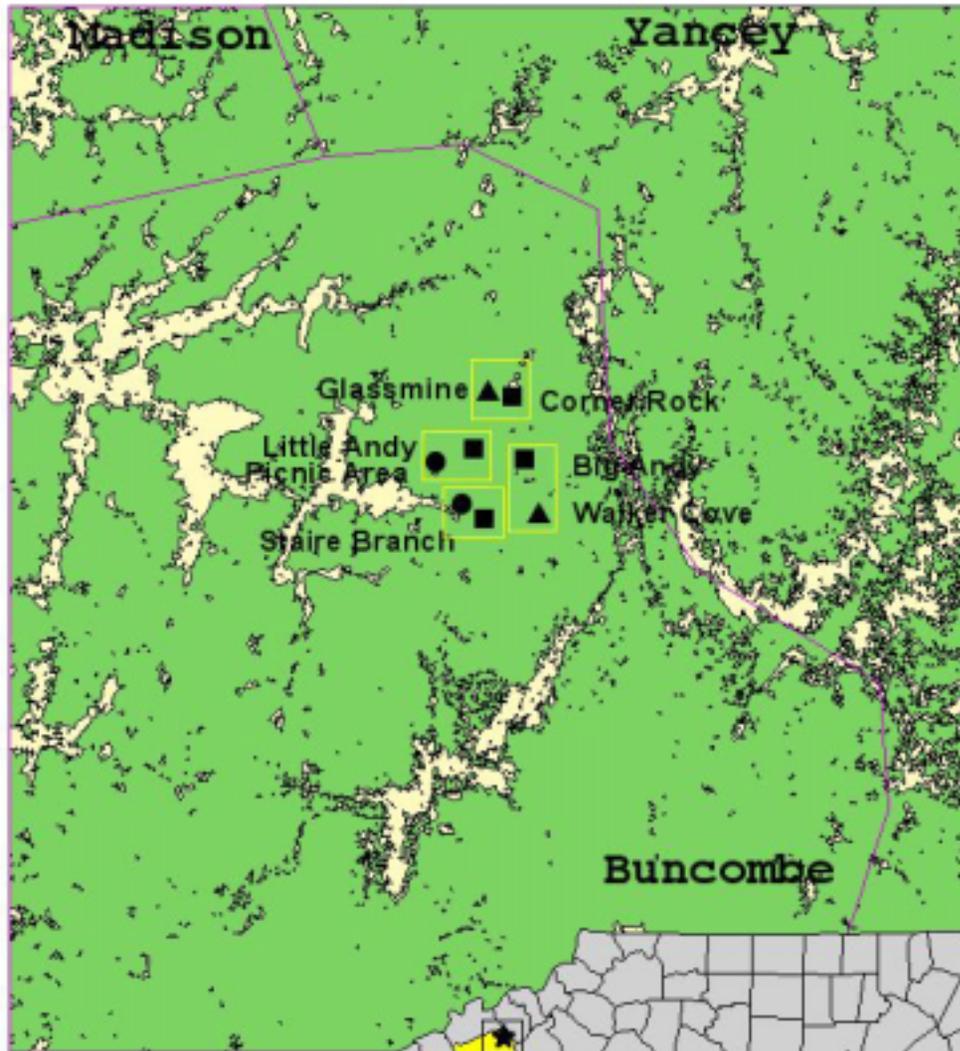
Factors Controlling Plant Distributions



What is the response of terrestrial systems to changes in land use?

1. How does aboveground biomass of herbaceous plants vary among sites that differ in past land use?
2. How does past land use influence the growth of herbaceous species?





● **Pastured**
trees and stumps removed, forage grasses seeded, cattle and sheep grazed

■ **Logged**
trees removed, no burning

▲ **Reference**
no physical signs of anthropogenic disturbance

0 2000 4000 6000Meters

Approach

Within each 20x20-m plot ($N=16$):

➤ Measured morphological characteristics of 10 individuals from each of twelve focal species (2002-2003)

- stem height/diameter
- leaf length/width
- # inflorescences

➤ Calibrated measurements with biomass of harvested specimens to estimate stem/leaf biomass and leaf area

➤ Collected soil cores (2002) and leaves (2003) to determine chemistry





Aster divaricatus



Polygonatum sp.



Orchis spectabilis



Osmorhiza sp.



Sanguinaria canadensis



Goodyera pubescens



Astilbe biternata



Disporum lanuginosum

Arisaema triphyllum

Cimicifuga racemosa

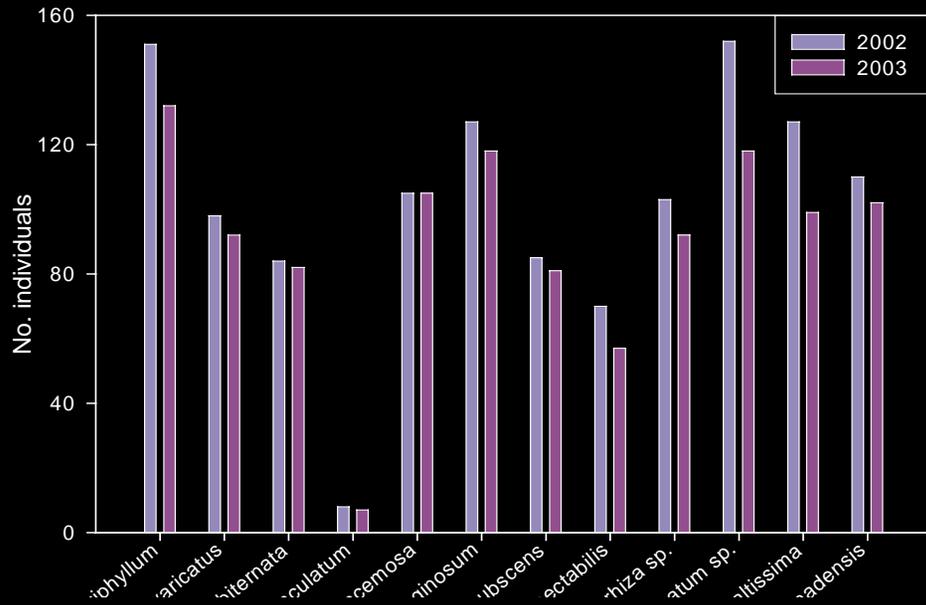
Chimaphila maculatum

Prenanthes altissima

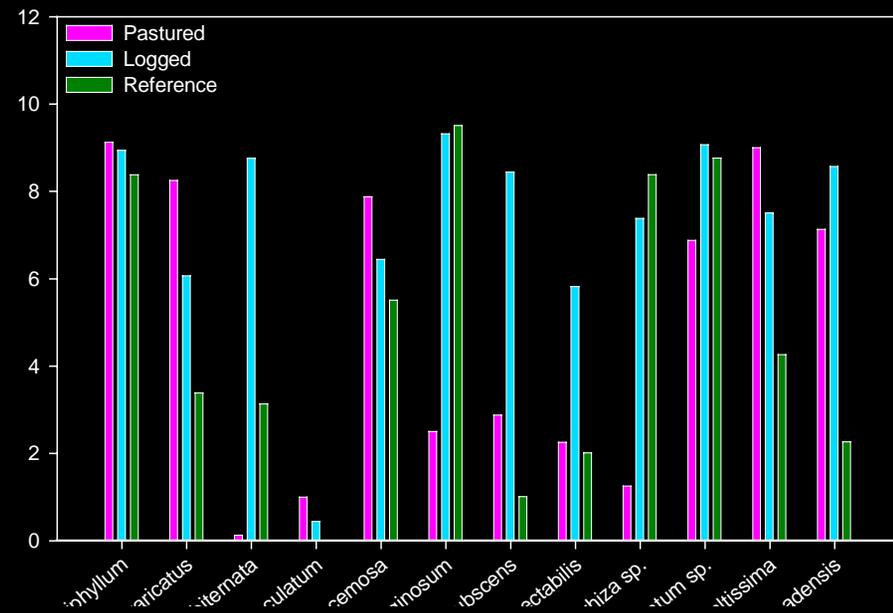
No. of plants sampled:

- 1220 individuals in June 2002
- 1085 individuals relocated in June 2003

Total # by species and year



Mean # by species and LU



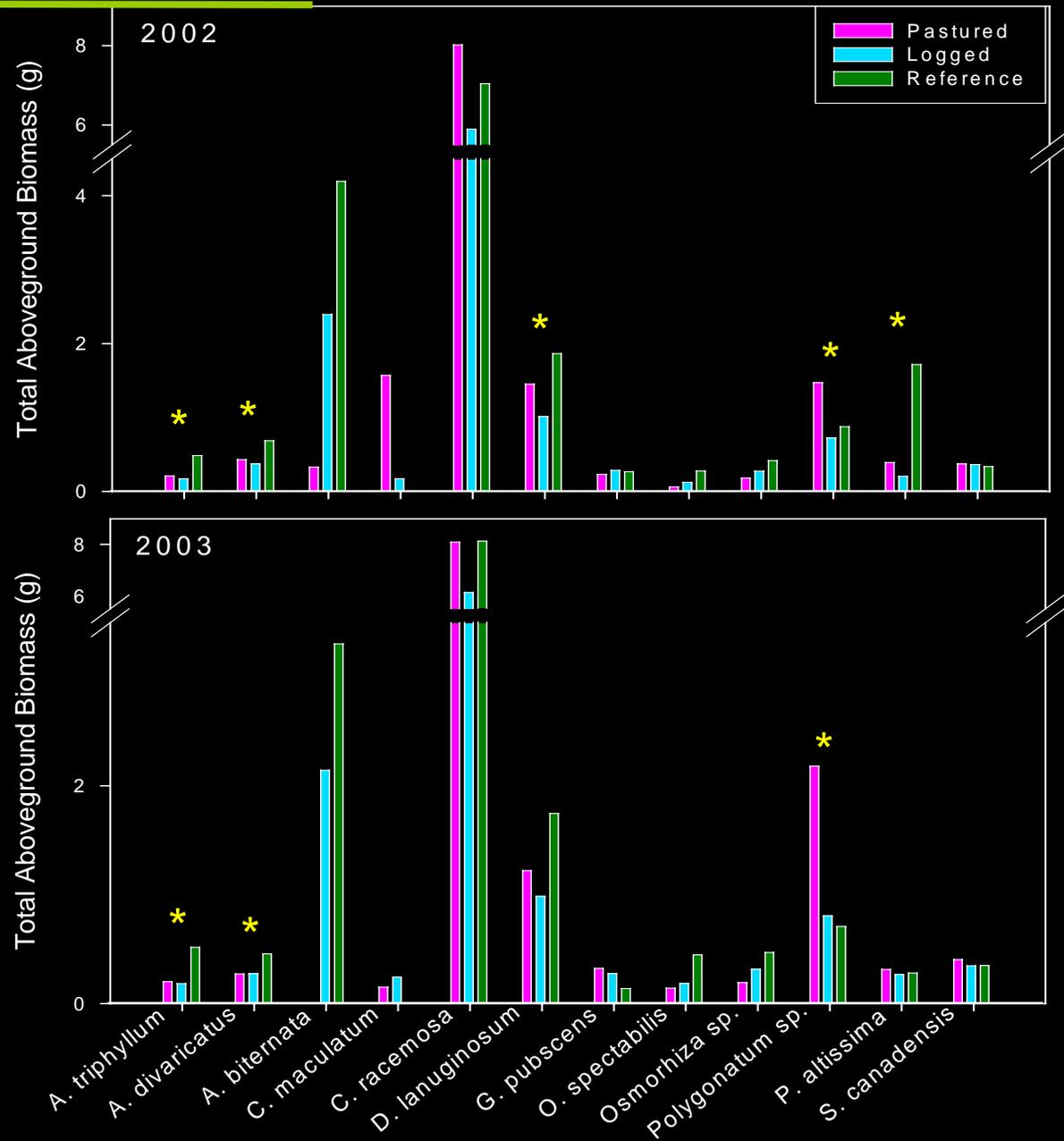
Total Aboveground Biomass

LU: $P = 0.024$
 Ref. > Past. > Log.

LU X Sp: $P = 0.001$
A. triphyllum
A. divaricatus
D. lanuginosum
Polygonatum sp.
P. altissima

LU: $P = 0.015$
 Ref. > Past. > Log.

LU X Sp: $P = 0.004$
A. triphyllum
A. divaricatus
Polygonatum sp.



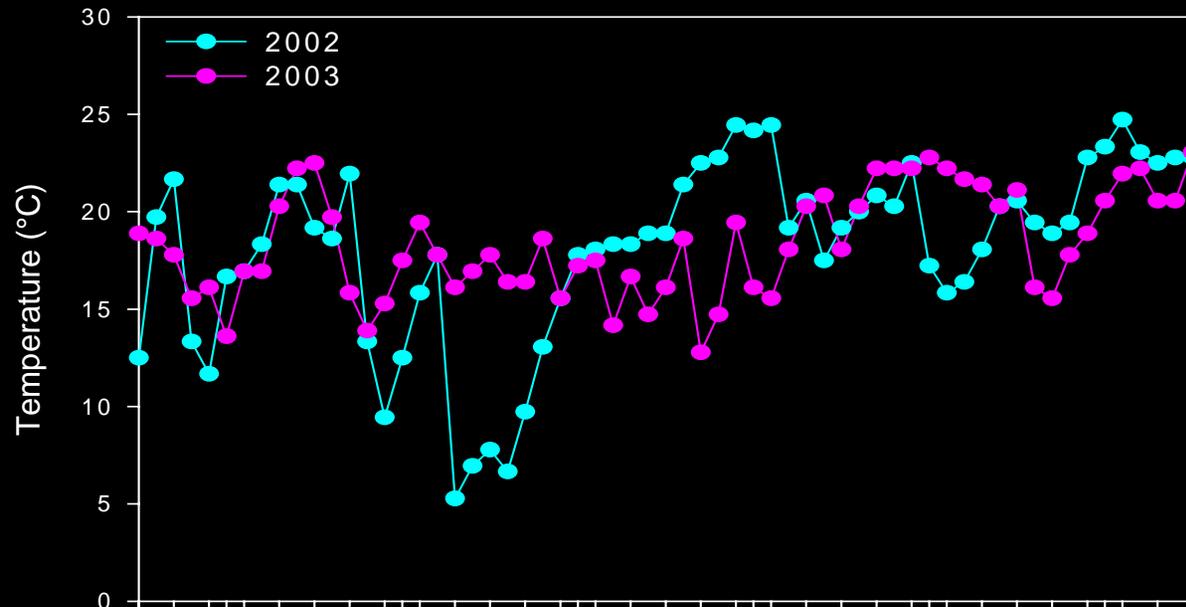
LU=Land use
 Sp=Species
 obs. were log-transformed

Biomass Allocation

Property	Year	LU		LU X Sp	
		<i>F</i>	<i>P-value</i>	<i>F</i>	<i>P-value</i>
stem biomass (g)	2002	76.53	<0.001	4.26	<0.001
	2003	9.89	0.02	1.11	0.36
leaf biomass (g)	2002	14.13	<0.01	1.79	0.03
	2003	2.55	0.17	1.48	0.11
leaf area (cm ³)	2002	11.40	0.01	1.72	0.04
	2003	2.91	0.15	1.34	0.18

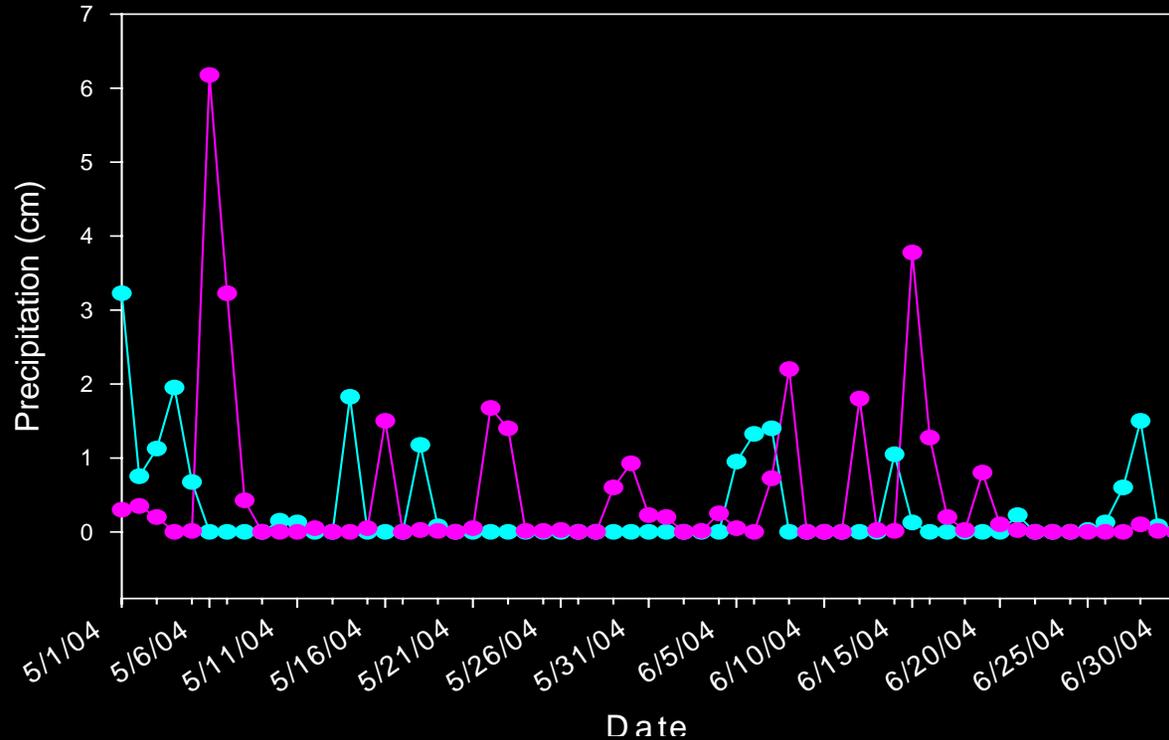
Mean Temperature (°C)

	<u>2002</u>	<u>2003</u>
May	15.4	17.2
June	20.9	19.6



Mean Precipitation (cm)

	<u>2002</u>	<u>2003</u>
May	0.36	0.56
June	0.25	0.39



LU: $P = 0.45$
 Past. > Log. > Ref.

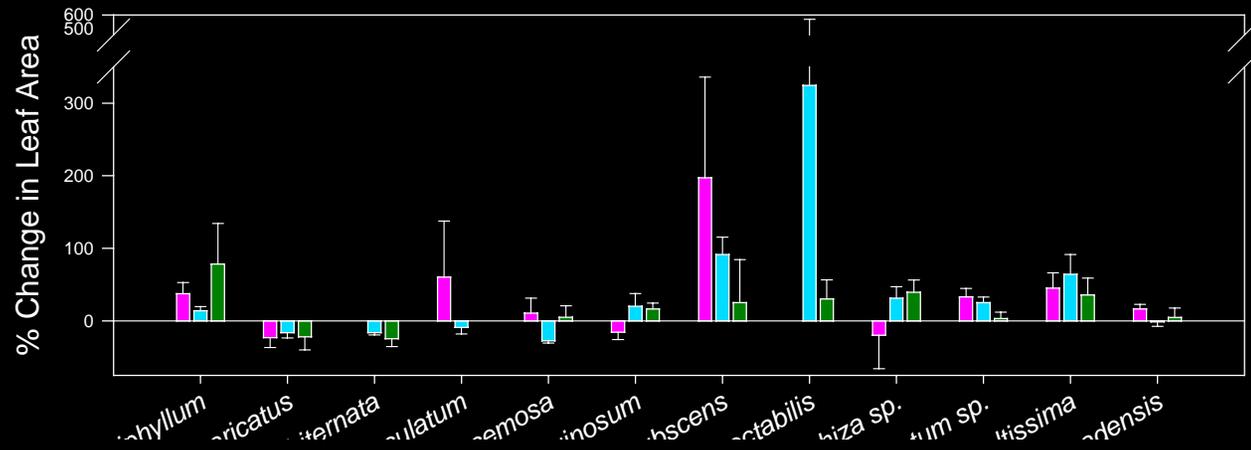
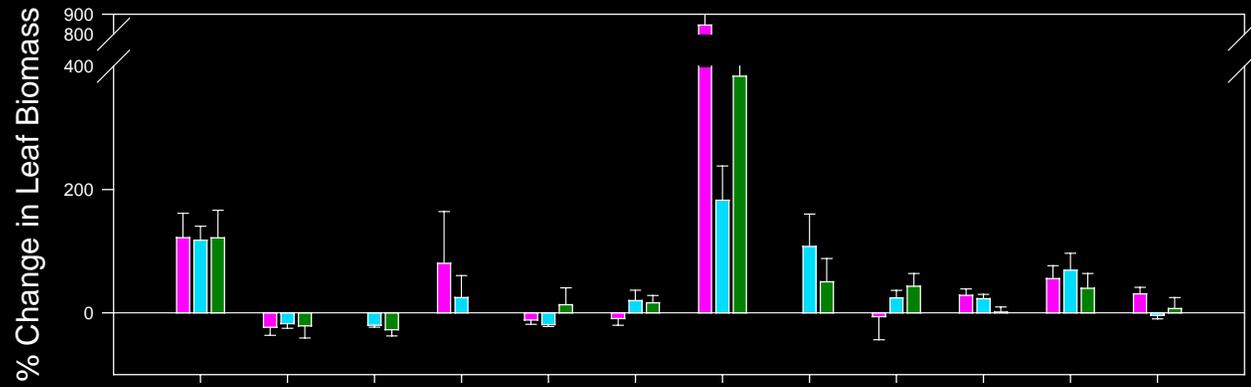
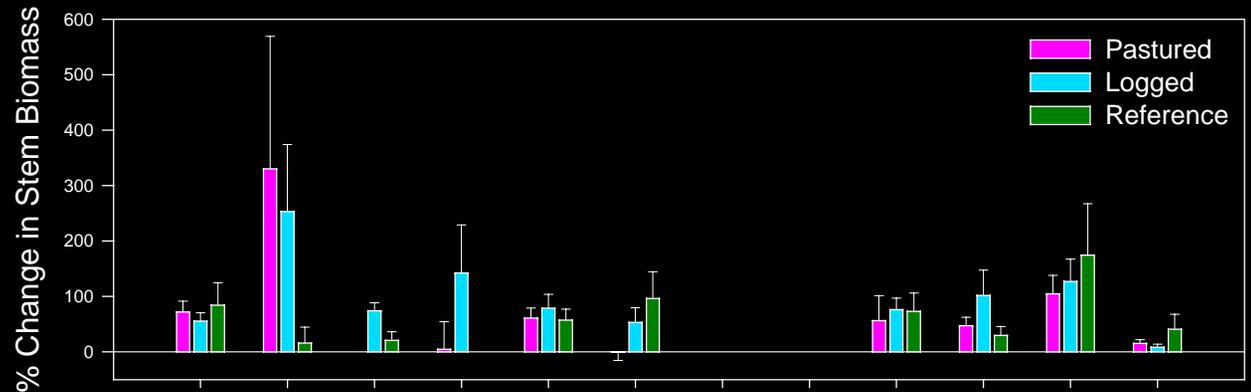
LU X Sp: $P = 0.15$

LU: $P = 0.03$
 Past. > Log. > Ref.

LU X Sp: $P = 0.55$

LU: $P = 0.11$
 Log. > Past. > Ref.

LU X Sp: $P = 0.11$



LU: $P = 0.52$
 Ref. > Past. > Log.

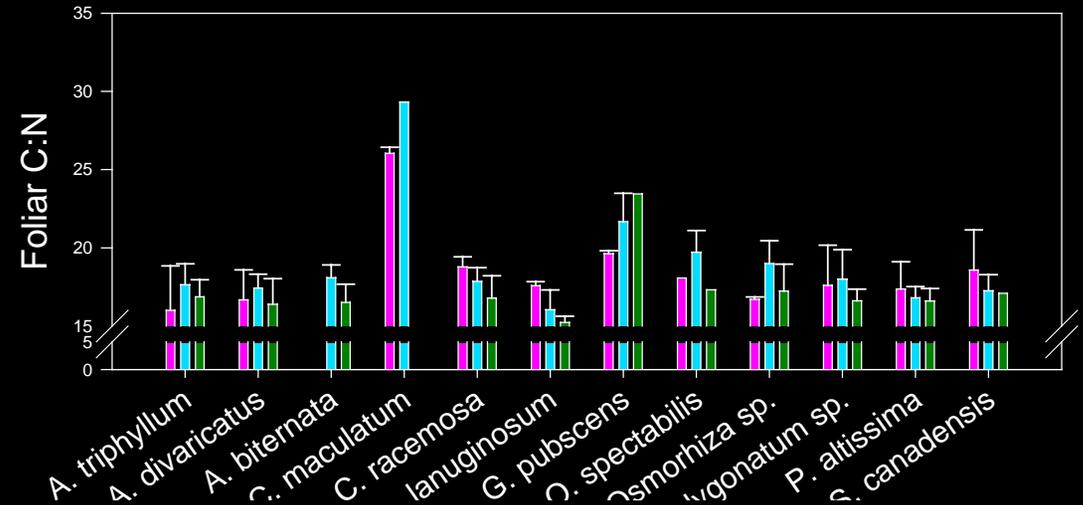
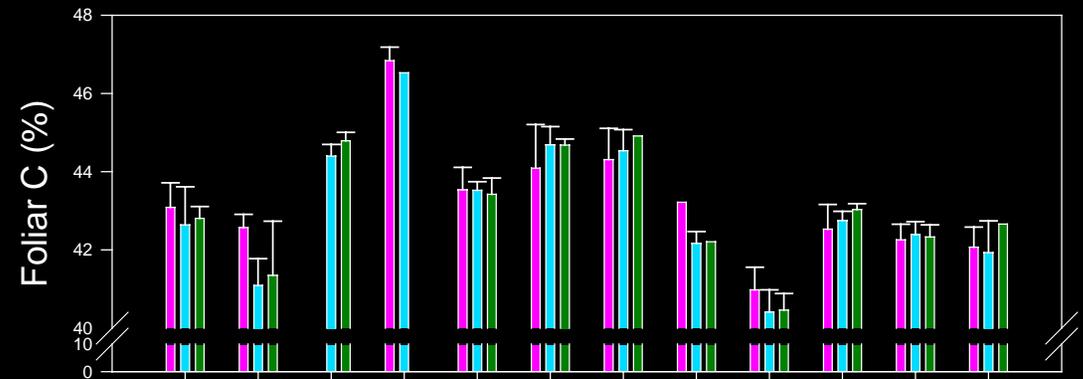
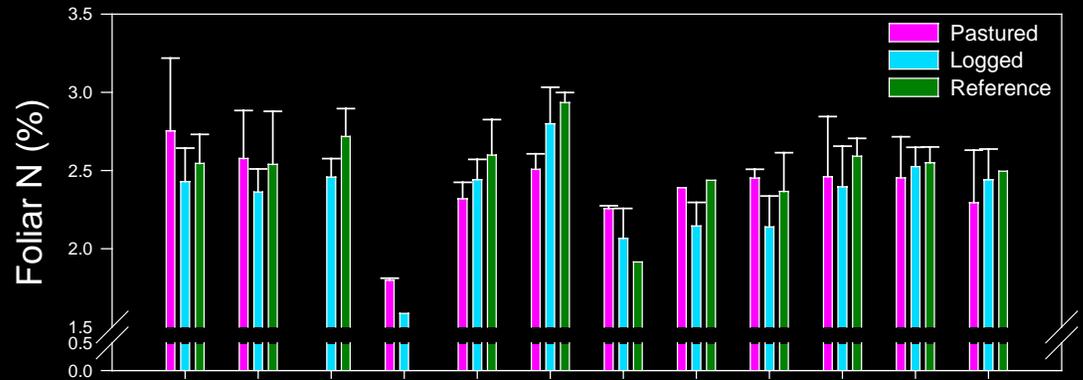
LU X Sp: $P = 0.003$

LU: $P = 0.76$
 Past. > Log. = Ref.

LU X Sp: $P = 0.007$

LU: $P = 0.50$
 Past. = Log. > Ref.

LU X Sp: $P = 0.0005$



Conclusions

Effects of past land use on plant productivity are COMPLEX

- not all species are affected the same way
- effects vary with year

Not yet clear why productivity varies with past land use

- soil fertility may explain some of the differences in growth
 - species vary in nutrient use efficiency

Yearly variation may relate to differences in weather

- start of growing season, daily temperatures, precipitation
- results suggest effects of past land use may be more moderate under less severe conditions

Acknowledgments

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