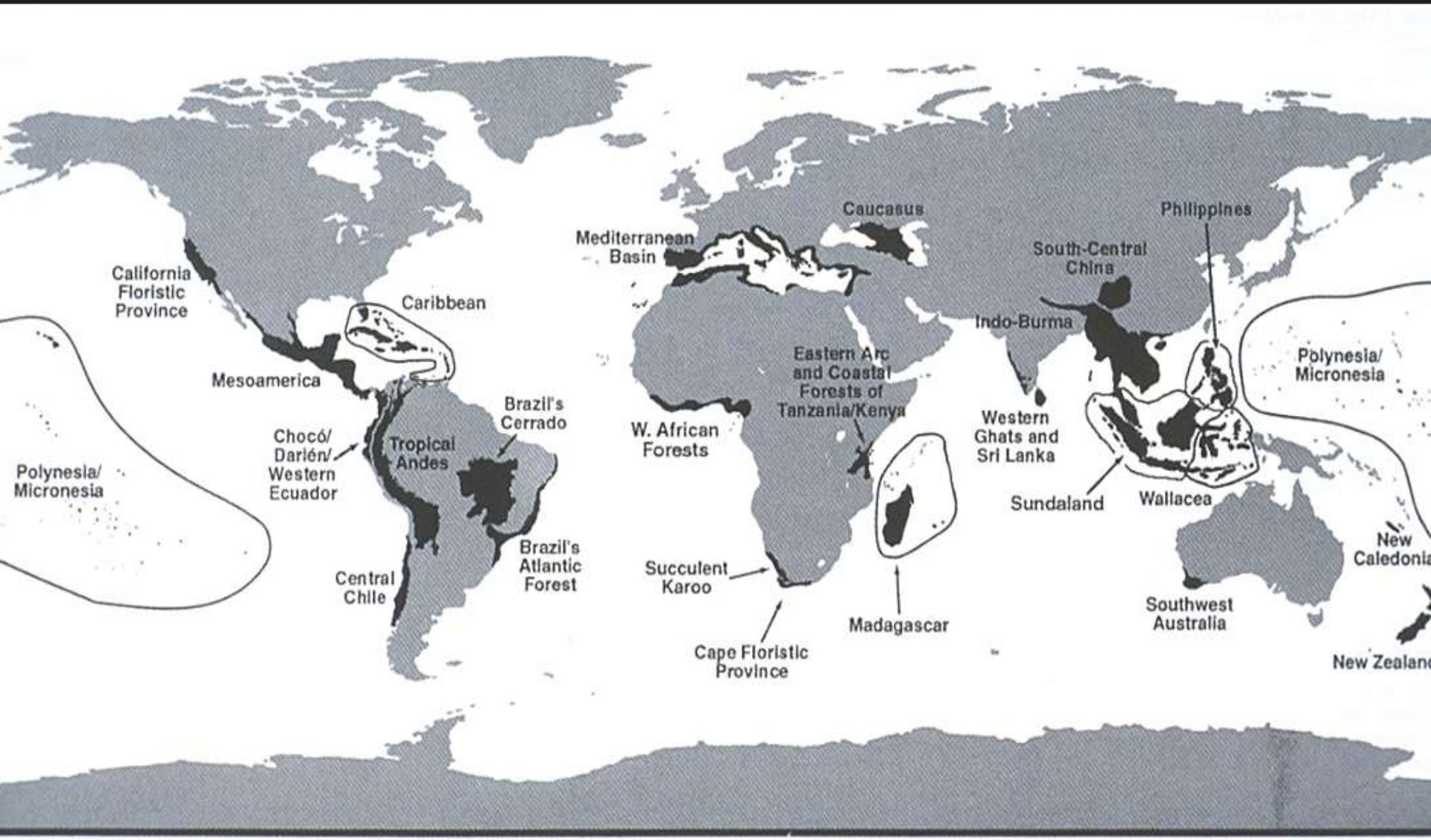
Southern Grasslands as a broad case study: Ecological History and Future

https://www.youtube.com/watch?v=iKQ1E4t-nY0

Global Hotspots



The 25 hotspots. The hotspot expanses comprise 30–3% of the red areas.

From: Myers et al. (2000)

Origins and Maintenance

What is a Grassland?

Virgin Longleaf Pine-Wiregrass
The Wade Tract
Thomasville, GA

Grassland Definitions and Inclusions

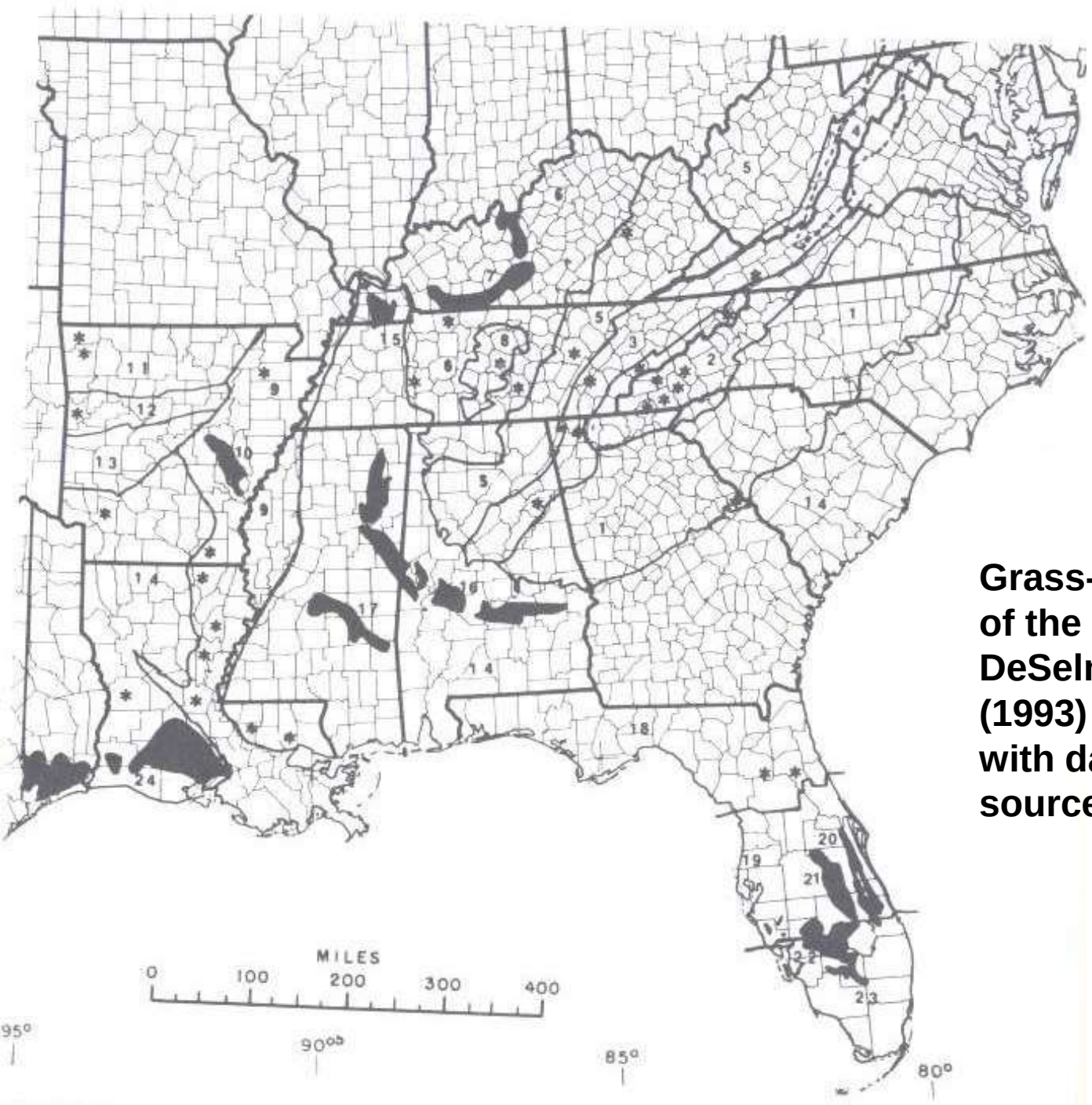
- Prairies (treeless or nearly so)
- Grassy Balds (mountaintop prairies)
- Savannas and Woodlands (typically 10%-60% canopy cover)
- Barrens, Glades, and Outcrops (highly variable, often occurring in mosaic patterns)
- Canebrakes (dominated by *Arundinaria gigantea*, in floodplains)

When most people in North America think of grasslands, they envision the vast prairies of the Great Plains

Zonal grasslands:

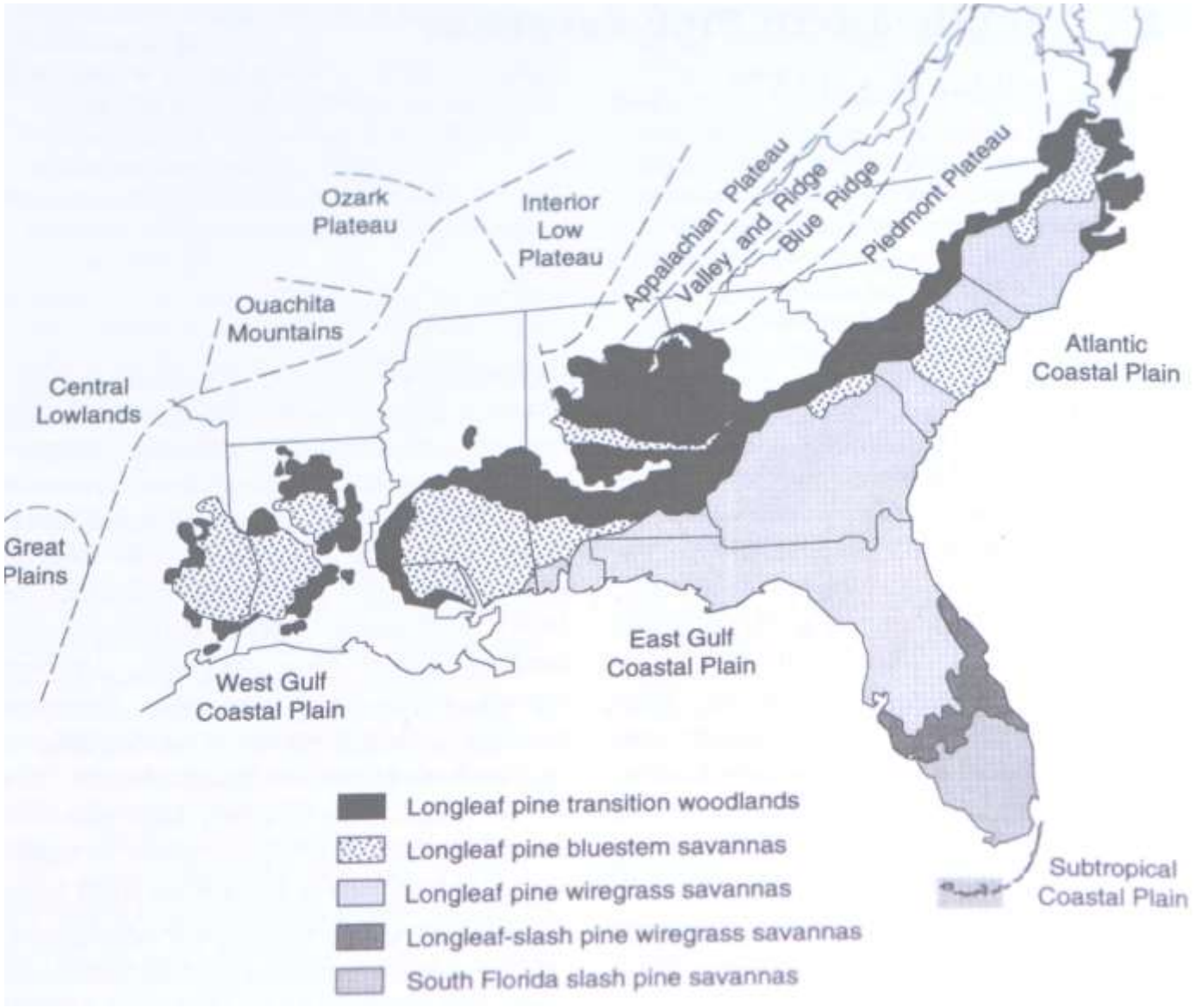
"able to maintain their existing composition and function on zonal soils (deep loams with good internal drainage, on gentle slopes) …occur along a climatic gradient between desert and forest…" Coupland (1991)

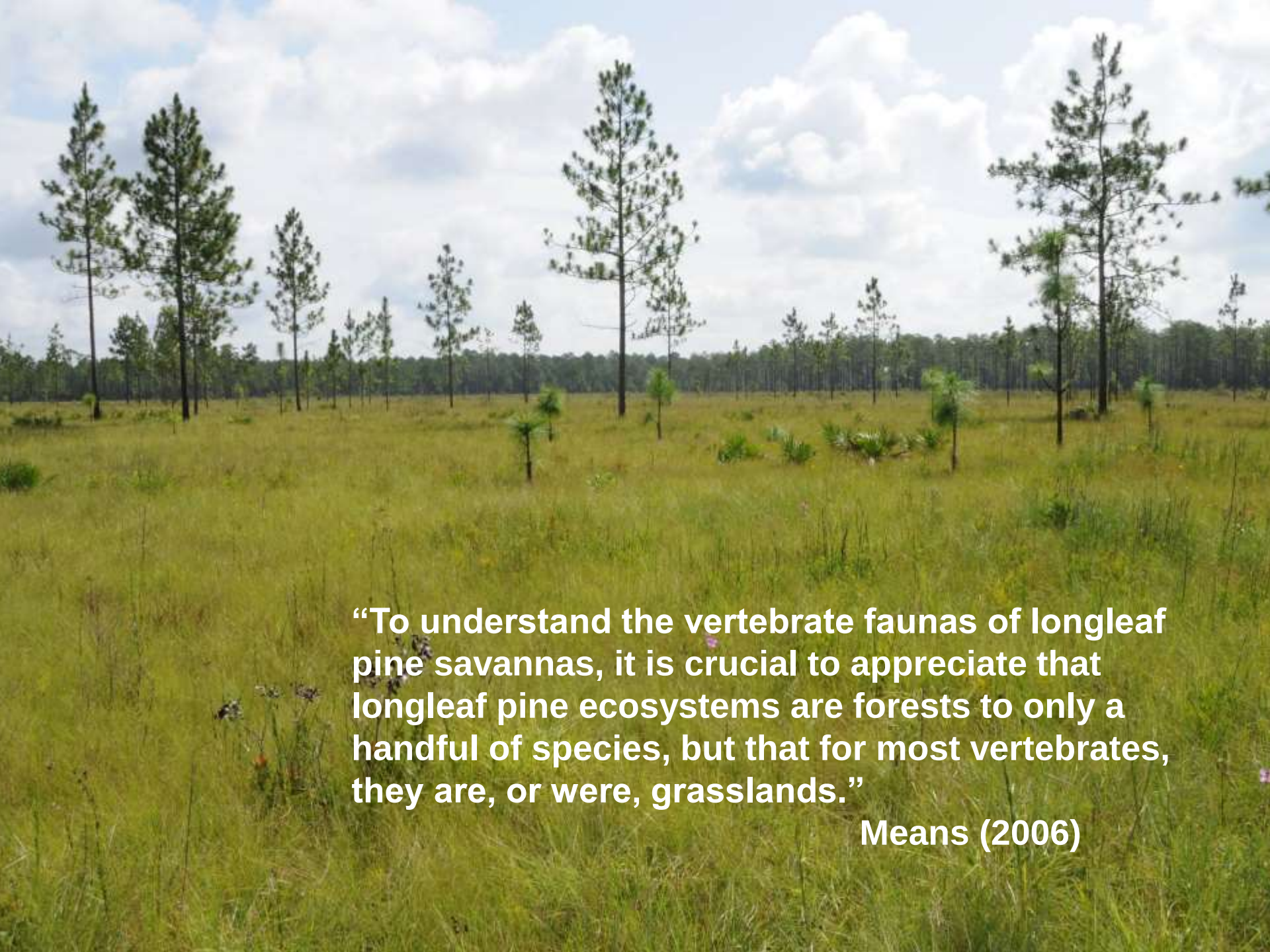

We have vast prairies in the South, too,
for example, the Florida dry prairie,
historically > 1.2 million acres



Grass-dominated areas of the Southeast. From DeSelm and Murdoch (1993) in Martin et al., with data from multiple sources.

Distribution of Pine Savanna and Woodland Types (from Platt 1999 in Anderson et al.)




“To understand the vertebrate faunas of longleaf pine savannas, it is crucial to appreciate that longleaf pine ecosystems are forests to only a handful of species, but that for most vertebrates, they are, or were, grasslands.”
Means (2006)

Biodiversity Value of Southern Grasslands

- Southern grasslands are the centers of radiation (speciation) for many grassland taxa of North America
- Southern grasslands are more ancient, more species-rich, and have a much higher rate of endemism than the grasslands of the Midwest and Great Plains (the "Prairie Region")
- The SE Coastal Plain has 1630 endemic plant taxa and 47 endemic genera, most associated with grasslands (Sorrie and Weakley 2001, Peet 2006) – only the California Floristic Province in North America supports more endemics
- Southern grasslands were major refugia for the grassland taxa of eastern and central North America during glacial episodes

Which is the Hotspot of Grassland Biodiversity?

	"Prairie Region"	Southeast
Andropogon	**2 spp.**	**19 spp. in FL** **16 spp. in NC** **11 spp. in LA**
Sorghastrum	**1 sp.**	**4 spp.**
Schizachyrium	**1 sp.**	**10 spp. in FL** **3 spp. in NC** **5 spp. in LA**
Liatris	**10 spp.**	**14 spp. in FL** **12 spp. in NC** **5 spp. in LA**
Echinacea	**3 spp.**	**9 spp.**

Source: A. Weakley (pers. comm.)

Example: The Bibb County (Ketona) Glades of Alabama

Recently Described Taxa Endemic to Bibb County Glades

(Other new taxa are still being described!)

Alabama gentian-pinkroot: ***Spigelia gentianoides*** **var.** ***alabamensis***

Cahaba daisy fleabane: ***Erigeron strigosus*** **var.** ***dolomiticola***

Cahaba paintbrush: ***Castilleja kraliana***

Cahaba prairie-clover: ***Dalea cahaba***

Cahaba torch: ***Liatris oligocephala***

Deceptive marbleseed: ***Onosmodium decipiens***

Ketona tickseed: ***Coreopsis grandiflora*** **var.** ***inclinata***

Sticky rosinweed: ***Silphium glutinosum***

Source: J. Allison: www.mindspring.com/~jallison/lostworld.htm and Allison and Stevens (2001)

Spigelia gentianoides* var. *alabamensis
Alabama Gentian-pinkroot

Cahaba Torch
(Liatris oligocephala)

Marshallia mohrii
Coosa Barbara's Buttons

Cedar Grove, Rock and Shoals, Clarke County, GA
Philip Juras

Southeastern Cedar Glades:

- 448 native and 96 nonnative plant taxa
- 21 endemic/near-endemic plant taxa
- Many disjunct and peripheral species with centers of distribution north and west of the glade region

(Baskin and Baskin 2003)


Temperate grasslands, savannas, shrublands, and related communities are the most imperiled terrestrial ecosystems in North America and the world
Craft Prairie
Arkansas Valley, AR

Noss, LaRoe, and Scott (1995)

Biological Report 28
February 1995

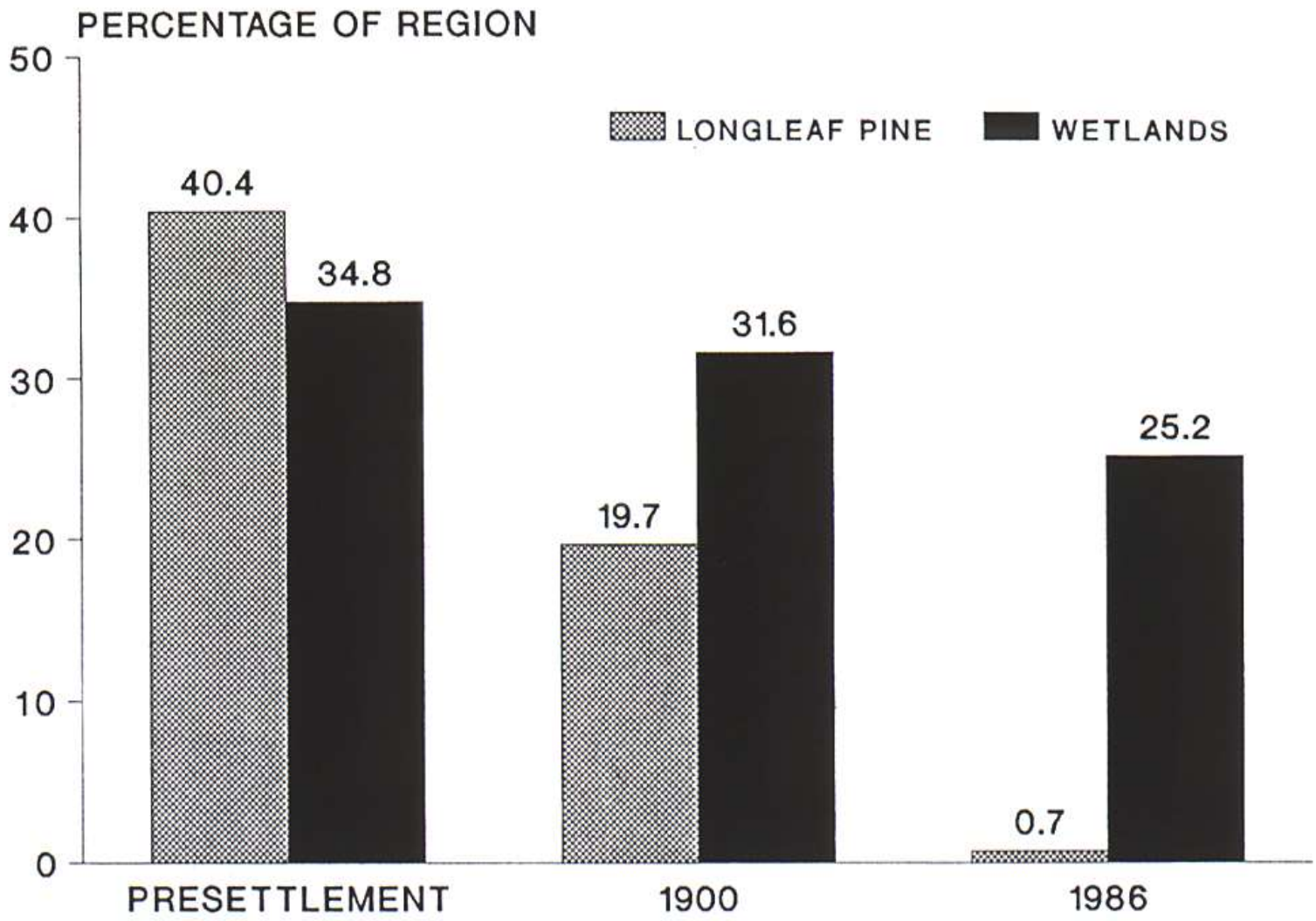
Endangered Ecosystems of the United States: A Preliminary Assessment of Loss and Degradation

National Biological Service
U.S. Department of the Interior

Ecosystem (Biome) Type	% converted	% protected	C:P
Temperate grasslands, savannas, and shrublands	45.8	4.6	10:1
Mediterranean forests, woodlands, and scrub	41.4	5.0	8:1
Tropical/subtropical dry broadleaf forests	48.5	7.6	6:1
Temperate broadleaf and mixed forests	46.6	9.8	5:1
Tropical/subtropical coniferous forests	27.3	6.7	4:1

Adapted from Hoekstra et al. 2005

Wiregrass Savanna
Apalachicola NF, FL
Philip Juras



From: Noss (1989)

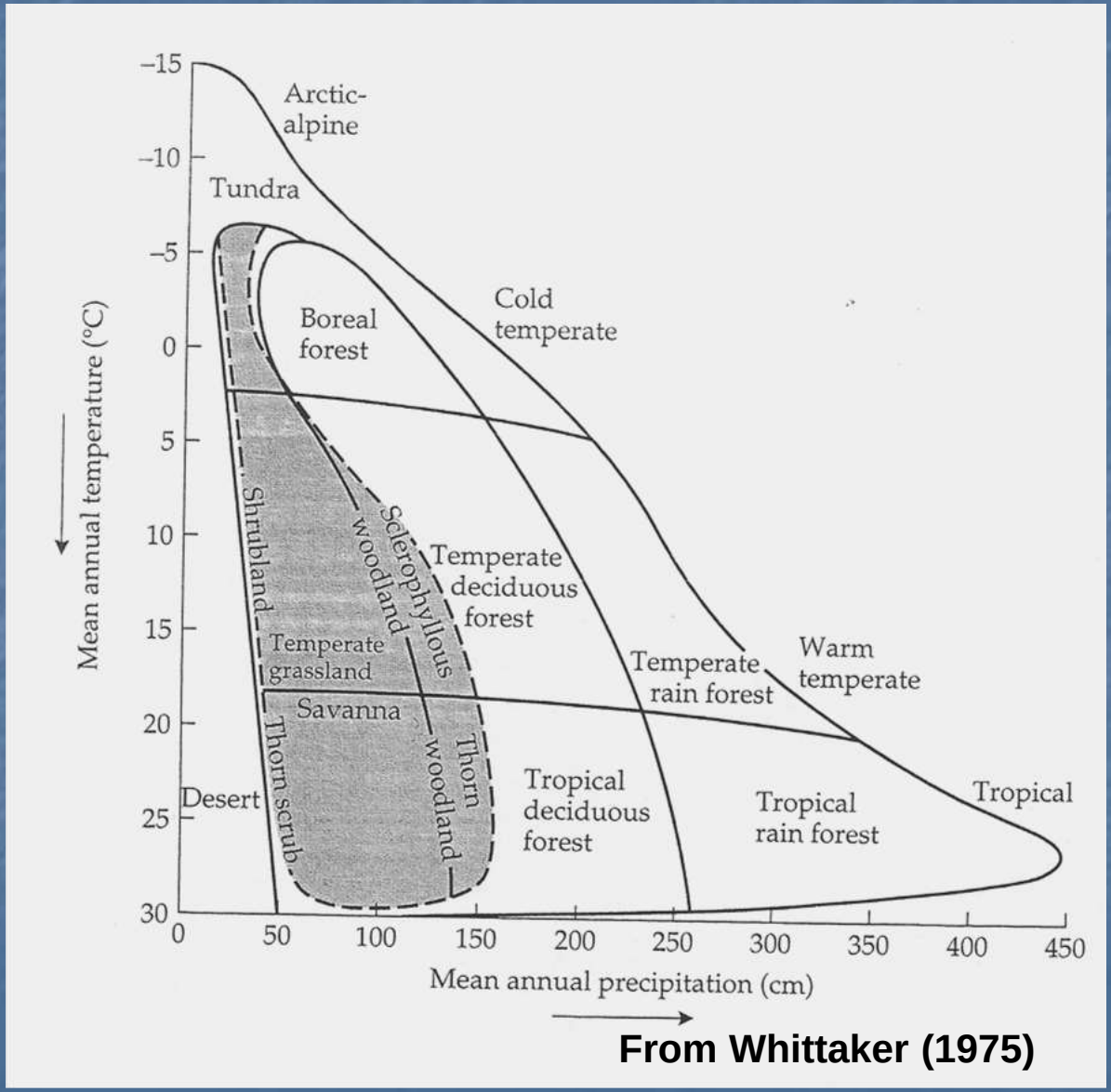
Premise:

By understanding how Southern grasslands arose and were maintained (or changed) over time, we have a basis for intelligent conservation, restoration, and management of these ecosystems.

Factors that might create or maintain southern grasslands

- Climate and weather (e.g., drought)
- Substrate (edaphic factors) and landform
- Fire (lightning or humans)
- Other disturbances (e.g., hurricanes, tornados, flooding) and combinations
- Competitiveness
- Large Herbivores
- Interactions and Synergisms

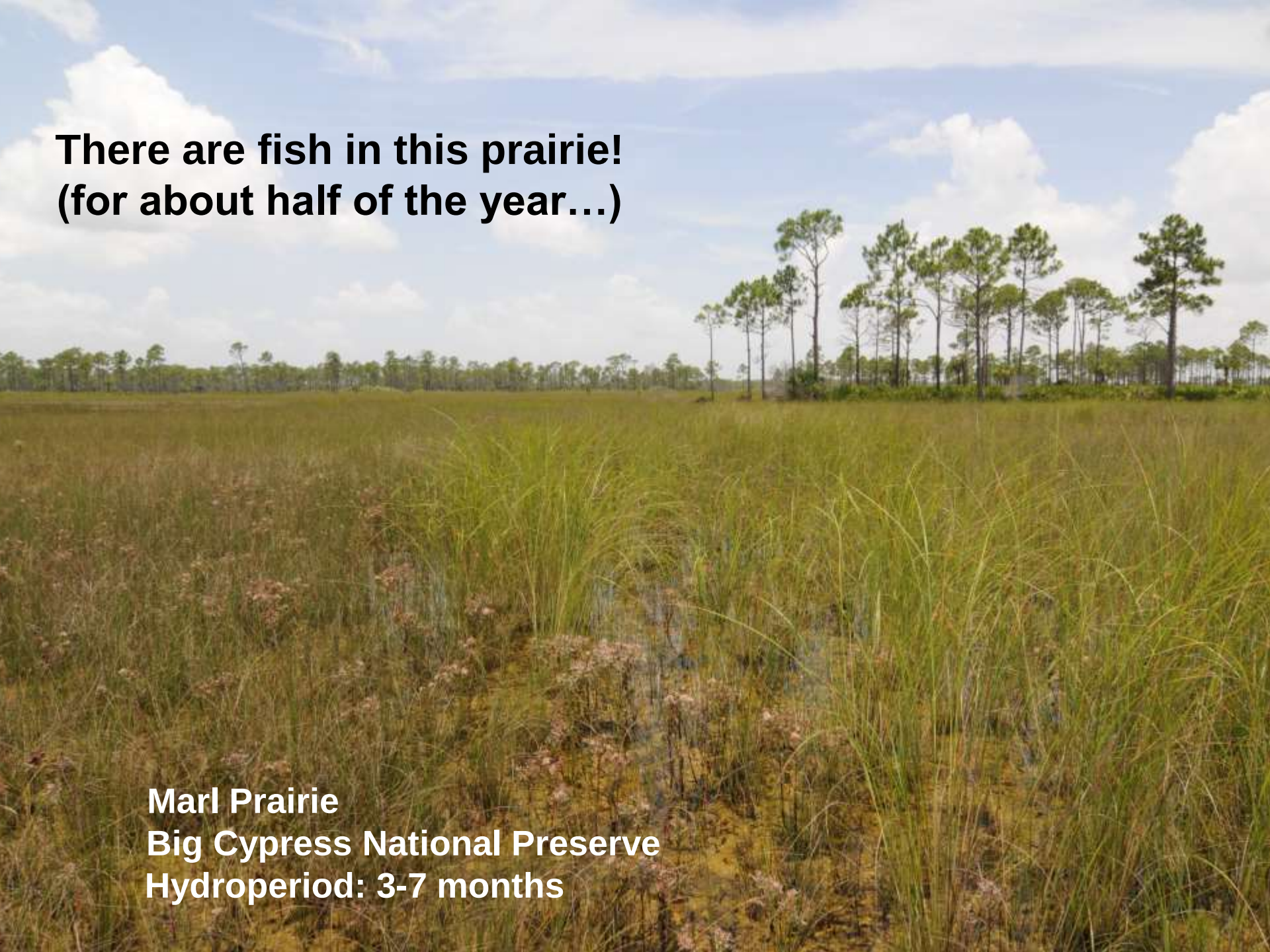
Climate and Weather



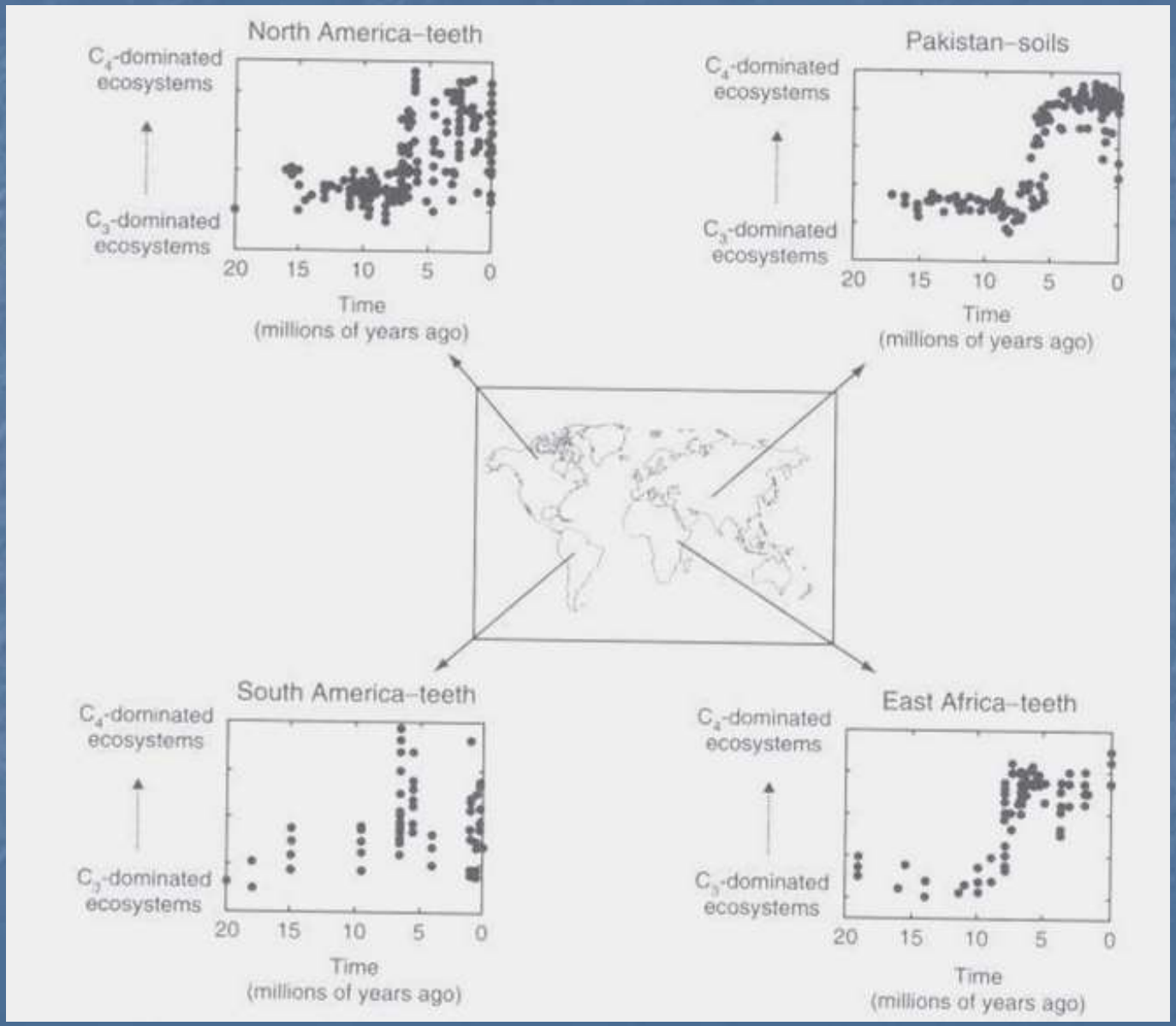
From Whittaker (1975)

Average Annual Precipitation of the United States (in inches).
Zonal prairies: 10-40” Southeastern Grasslands: 40-70”

Source: *National Atlas Of the United States*


There are fish in this prairie!
(for about half of the year…)
Marl Prairie
Big Cypress National Preserve
Hydroperiod: 3-7 months

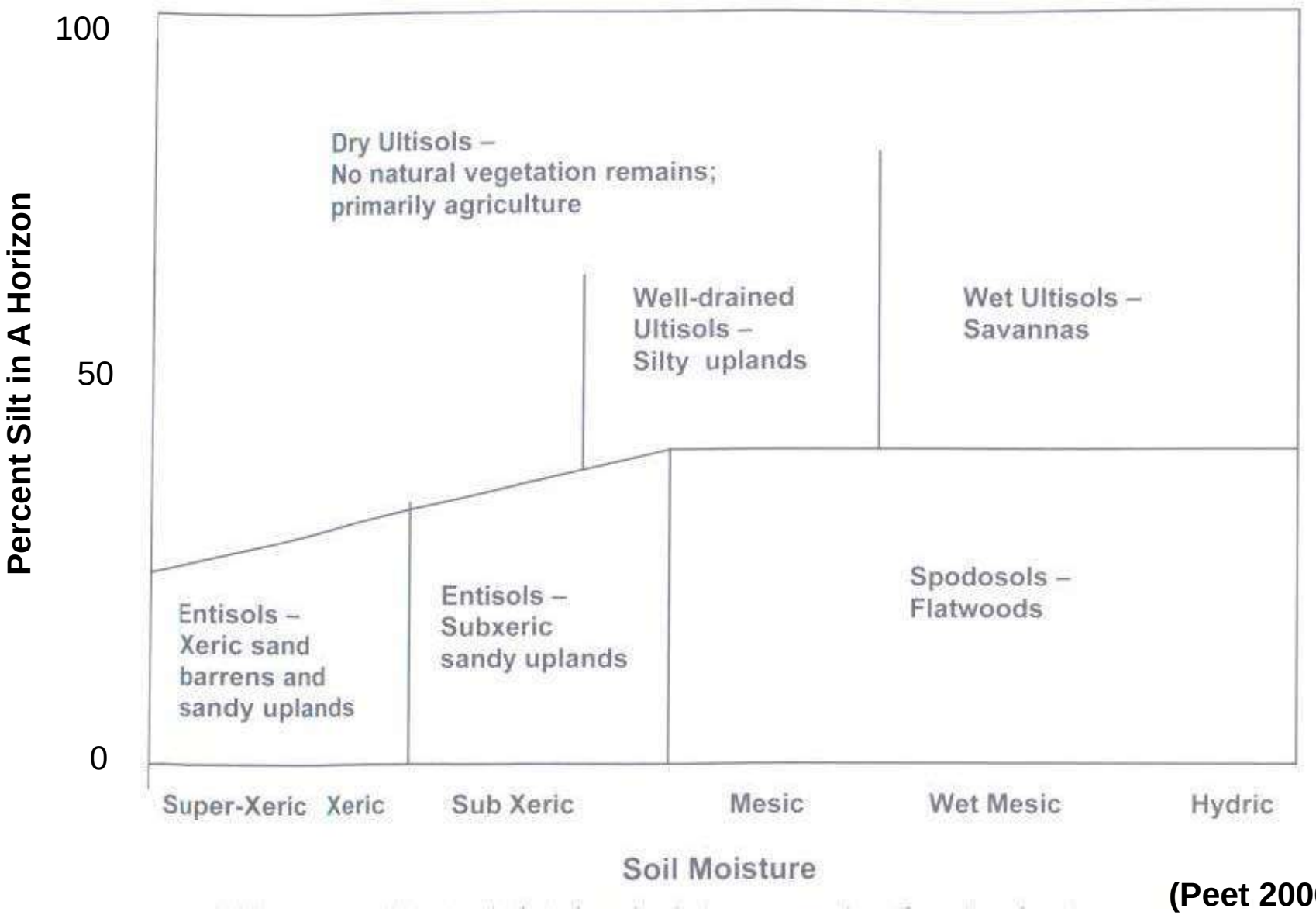
The explosion of C_4 grasses 8 mya, replacing C_3 forests with C_4 savannas and prairies (Beerling 2007)



Many species of glade and outcrop communities in the Southeast, such as this Cedar Gladecress (*Leavenworthia stylosa*) endemic to the Central Basin of Tennessee, have their closest relatives in the West.

***Astrolepis integerrima*, False Cloak Fern, is disjunct in the Bibb Co. Glades of Alabama, 700 miles from its nearest locality in West Texas. (Photo by Jim Allison)**

Model Landscape of Coastal Plain Longleaf Pine Communities Showing Dominant Vegetation in Relation to Soil Silt Content and Soil Moisture



(Peet 2006)


Sarracenia flava
Yellow Pitcherplant

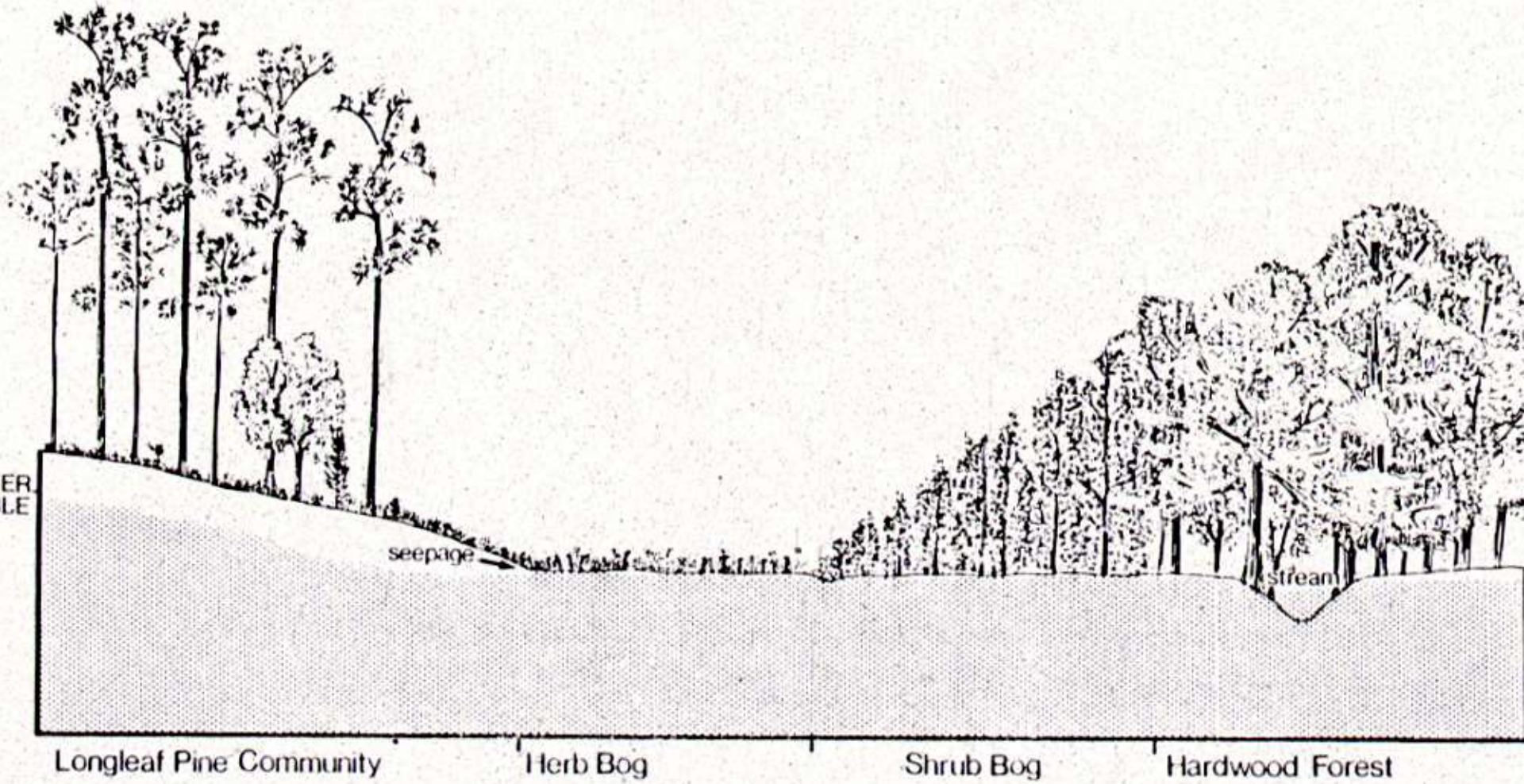


Figure 63. Flatwoods seepage bog developed along a gentle slope/moisture gradient.

Fire

(and positive feedback between flammable plants and fire)

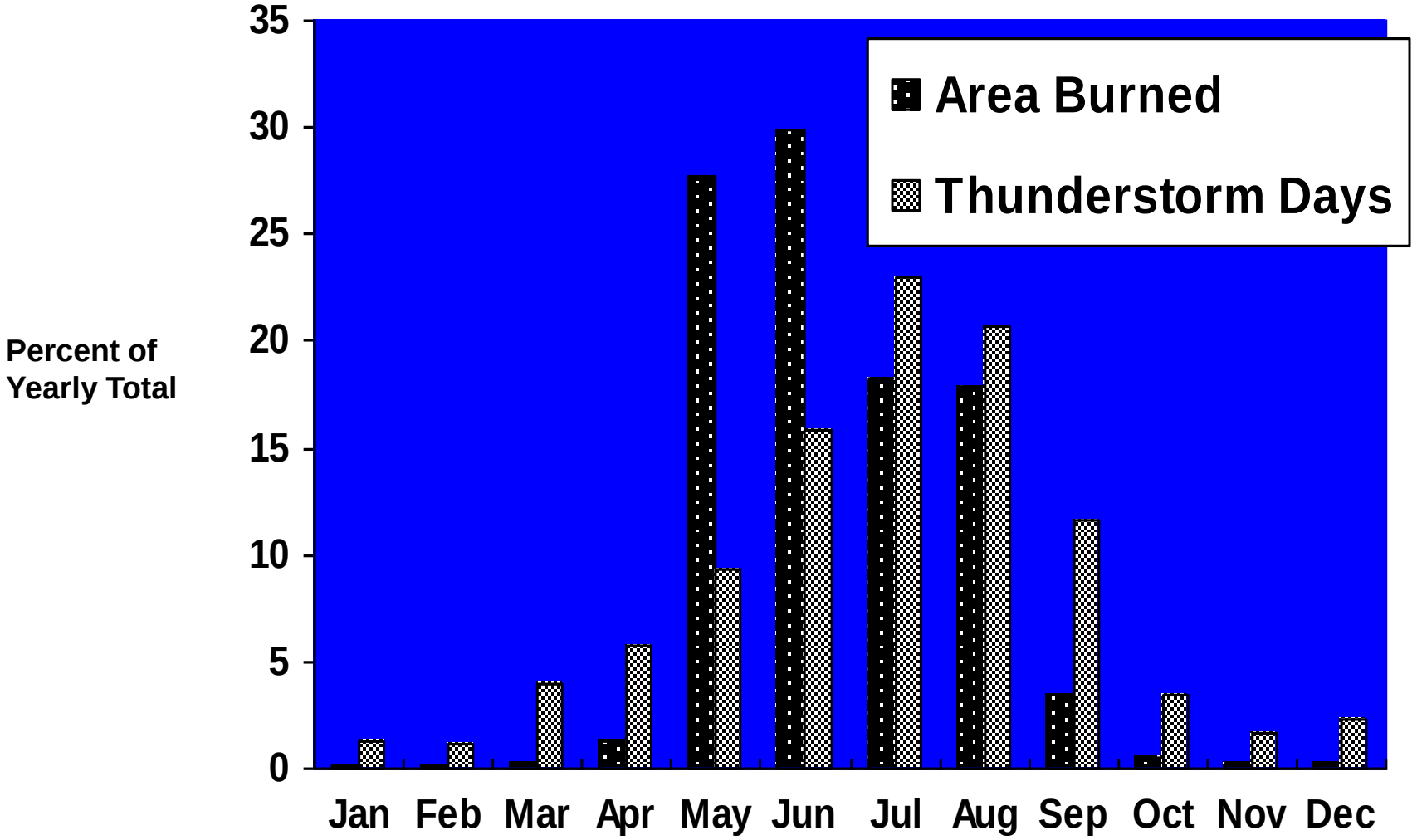
Ecological Role of Fire

- Often is better thought of as an ecological driver than as a disturbance per se
- Reduces competition for key resources
- Promotes regeneration
- Recycles nutrients and affects water and sediment delivery throughout watersheds
- Maintains populations of fire-adapted species and the communities they compose
- Inhibits invasion of species poorly adapted to fire
- Creates and maintains a shifting landscape mosaic

"Lightning as an environmental factor was on earth long before the evolution of man. The antiquity of fire seems apparent in that the most ancient of tree families, such as the conifers, and the apparently oldest genera of grasses, such as *Aristida, Stipa, Andropogon*, etc., have the greatest concentration of those genes responsible for resistance and adjustment to a 'fire environment.'"

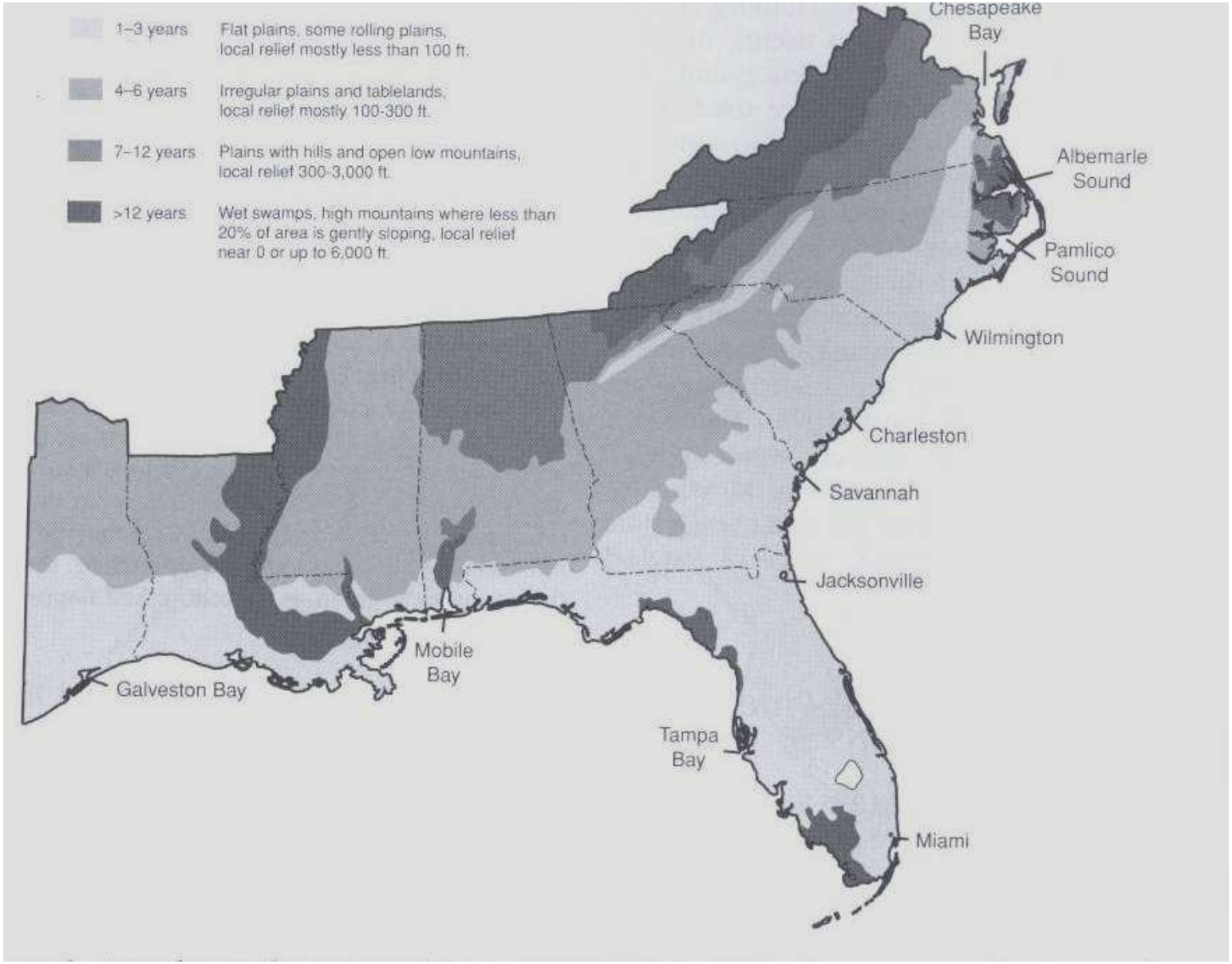
- E.V. Komarek (1964)

The Natural Fire Season Based on Thunderstorms (e.g., North Florida)



From: Bill Platt
after Komarek (1964)

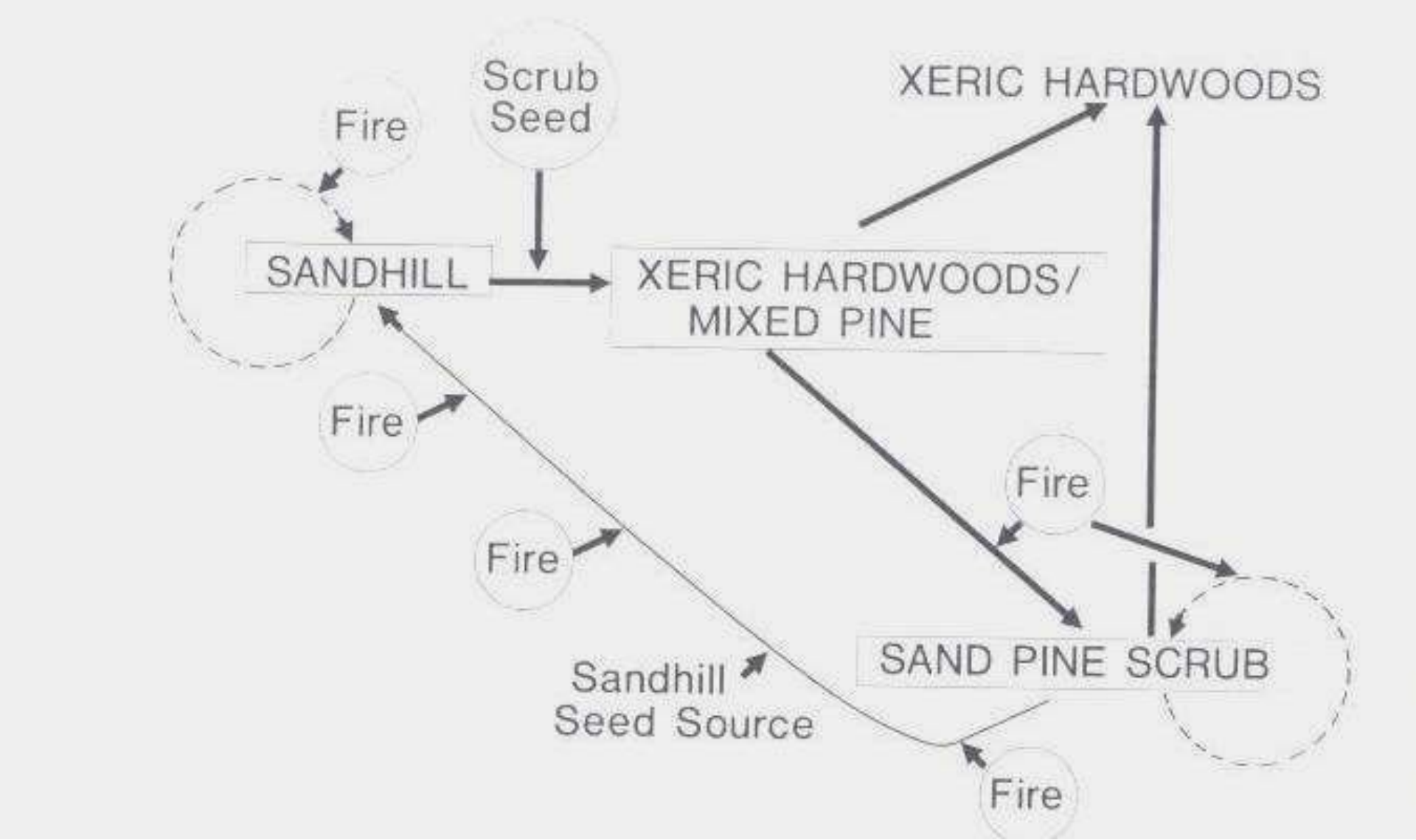
Presettlement Fire Regimes (for most exposed portions of the landscapes). From Frost (2006) adapted from Frost (1995)



Rapid Recovery and Self-Perpetuation

Longleaf Pine Savanna a Few Weeks after Fire
Apalachicola NF, Florida

Model of Potential Successional Pathways over Several Centuries with Alternating Fire Frequencies and with Shifting Dominance by Pine and Oak. From Stout and Marion (1993) in Martin et al., adapted from Myers (1985)



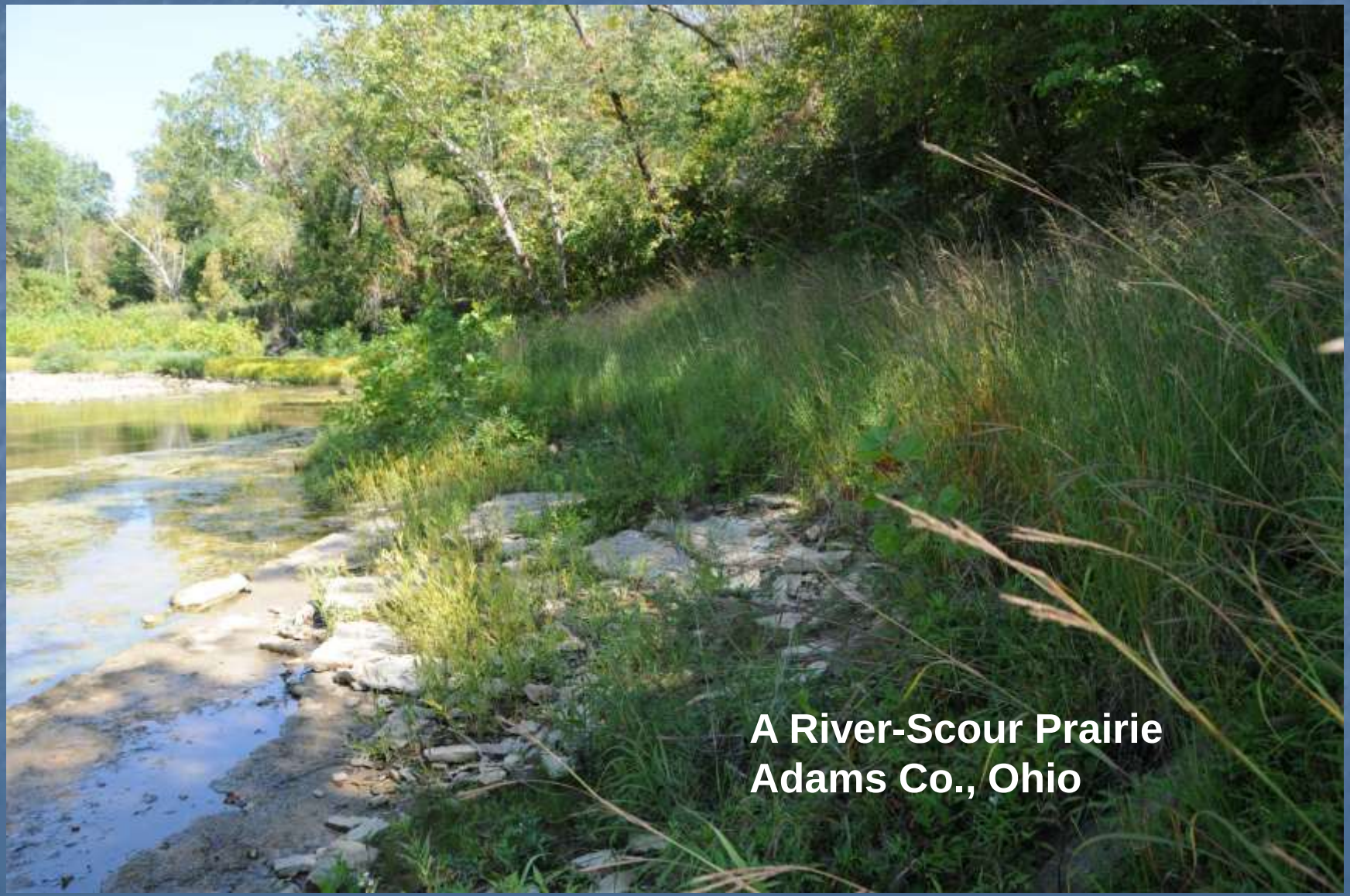
The Dixie Crusaders and Smokey Bear

Concerted efforts to eliminate fire and grasslands

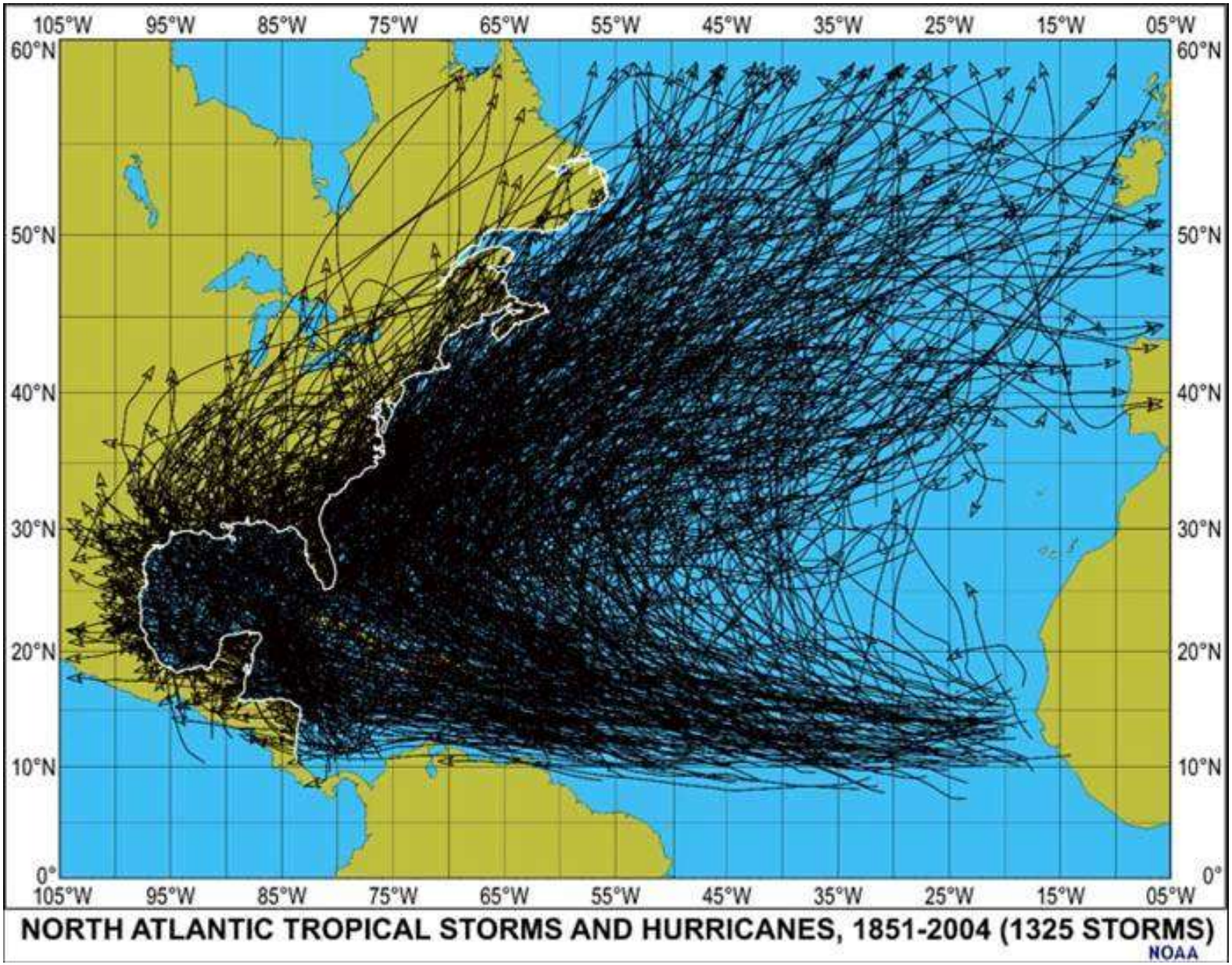
Anthropogenic Refugia

Powerline refugium for
Echinacea laevigata
and other rare plants
Picture Creek Diabase Barrens
Durham Co., NC

Other Disturbances and Combinations



It gets windy in the Southeast….



Large Herbivores

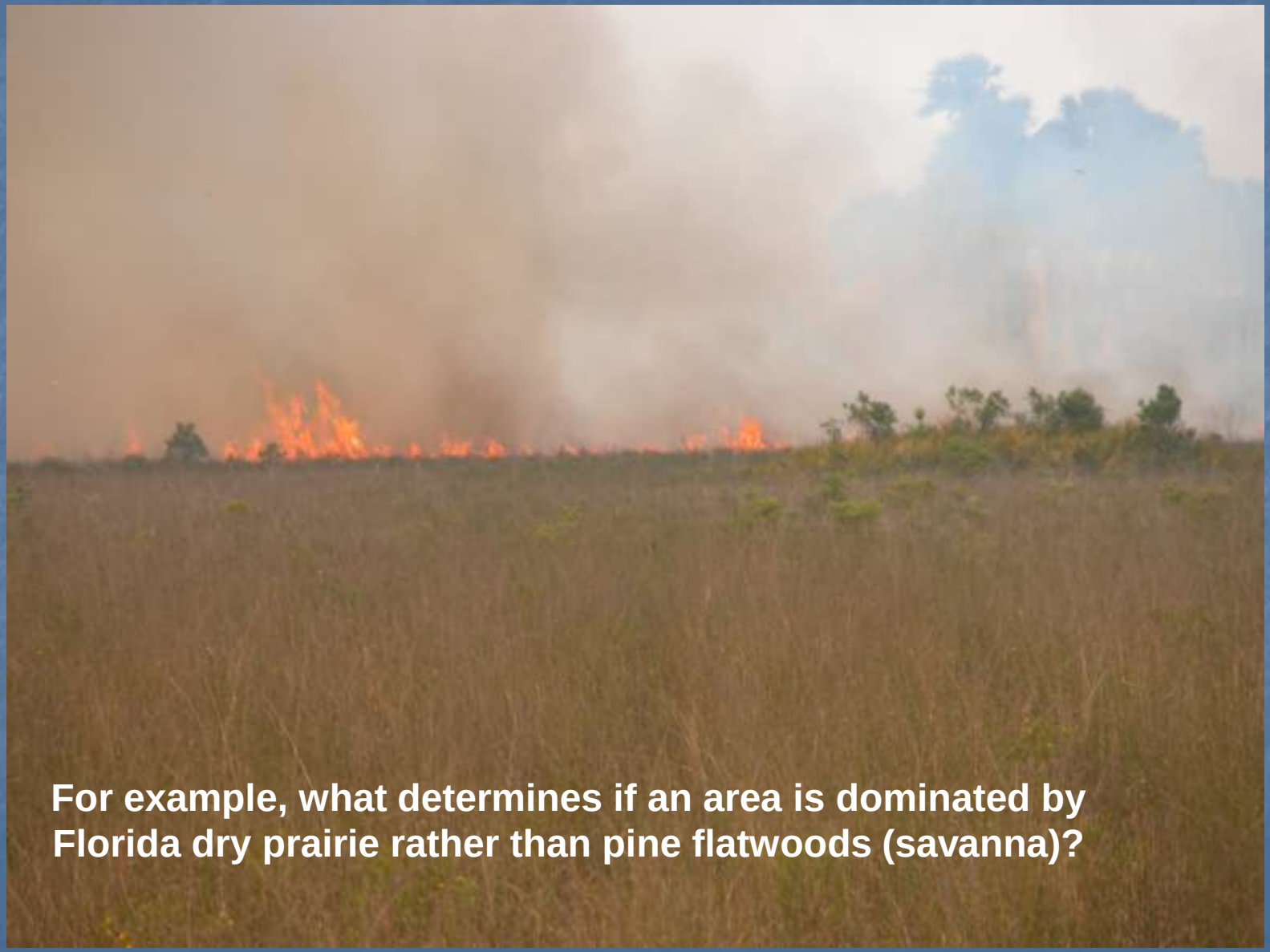
"Chain of Herbivores" Hypothesis (Weigl and Knowles 1995)

After European Settlement – Sheep, Goats, Cattle, and Horses

Pre-European Settlement Herbivores: Bison, Elk, and Deer

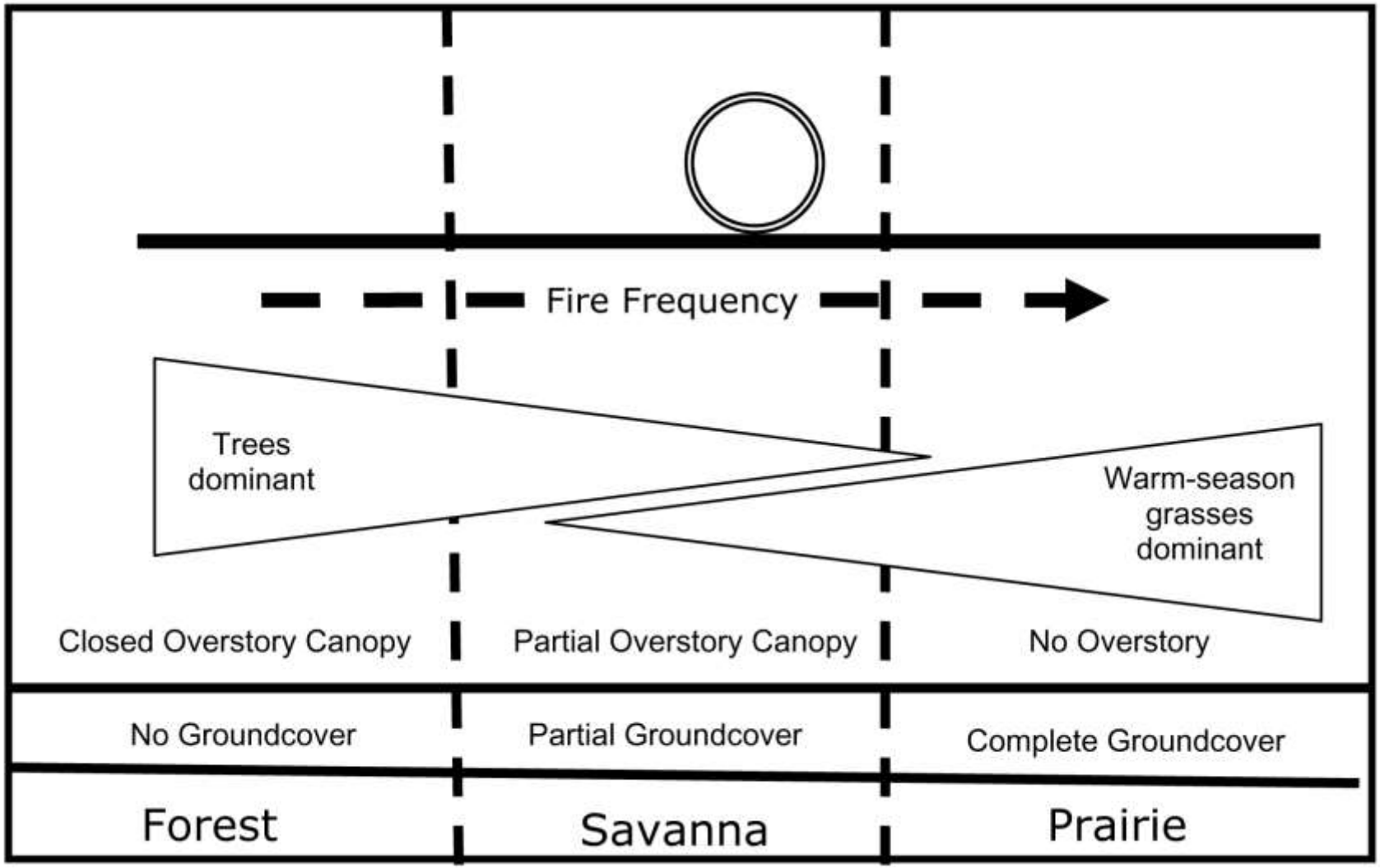
Pleistocene Megaherbivores – ca. 20 spp. Documented in Region

Interactions and Synergisms



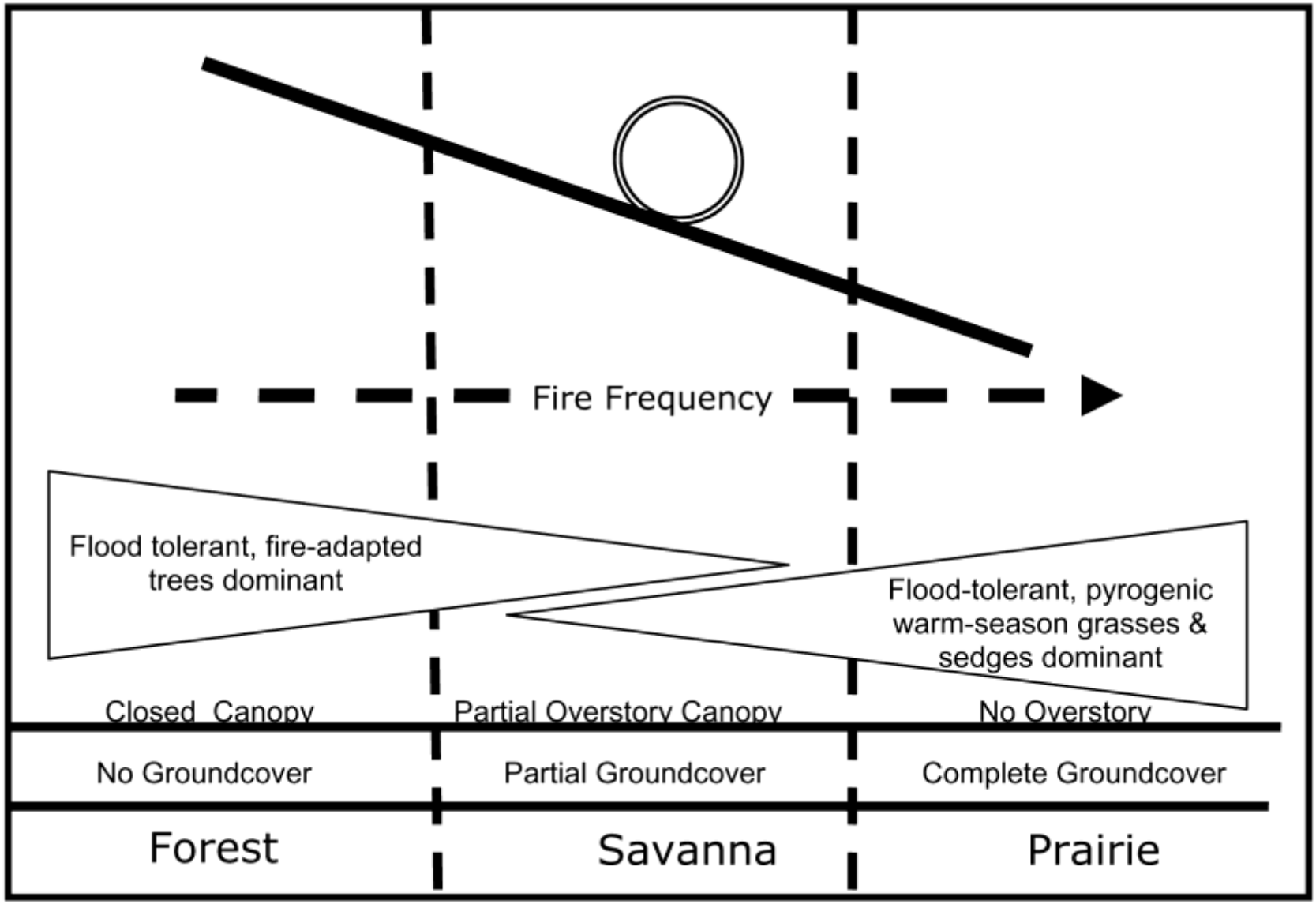
For example, what determines if an area is dominated by Florida dry prairie rather than pine flatwoods (savanna)?

Hypothesized responses of an ecosystem to fire frequency along a landscape gradient from forest to savanna to prairie. From Platt (2006) adapted from concepts in Gilliam and Platt (2006) and Beckage et al. (2006).

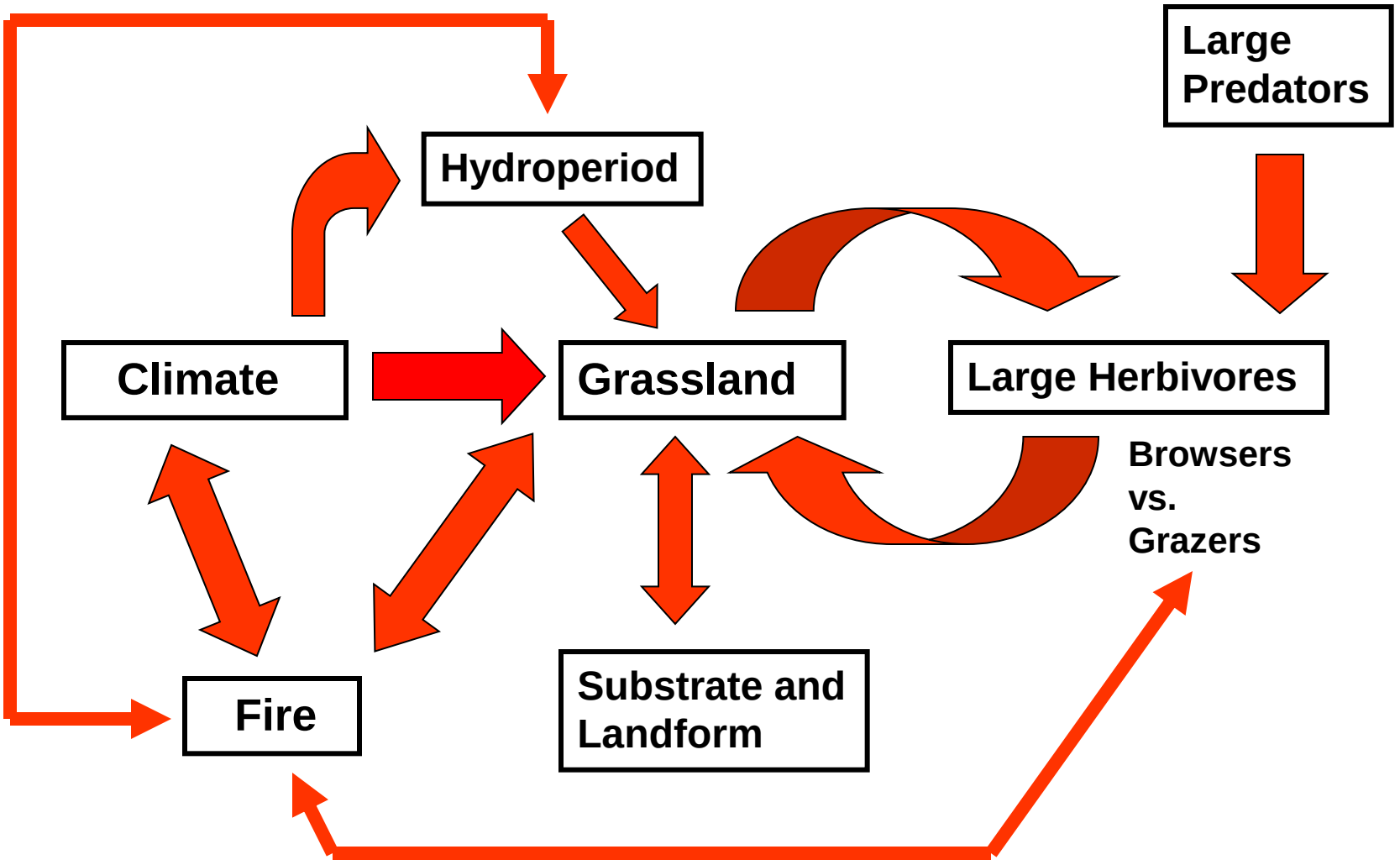



Flatwoods ecotone
with dry prairie
Three Lakes WMA, FL

Predicted effects of frequent flooding combined with fire on the position of an ecosystem along the forest-prairie continuum. From Platt (2006) adapted from concepts in Gilliam and Platt (2006) and Beckage et al. (2006).



General Model for Origin and Maintenance of Southern Grasslands



Advantages of Ecosystem-level Conservation

- Can't possibly consider the needs of all species individually
- Protecting and managing ecosystems will protect the majority of species (the "coarse filter" hypothesis) and is more cost-effective than a species-by-species approach
- Focusing on ecosystems allows direct consideration of abiotic factors and ecological processes
- Nevertheless, individual "focal" species and species composition are often the best indicators of ecosystem quality and integrity

The Future?

- Coastal grasslands are threatened by a combination of sea-level rise and development and may be most at risk
- Interior grasslands will expand relative to forests with a hotter and drier climate
- The most xeric sites (glades, outcrops) may lose plant cover

- Longleaf pine communities appear relatively resilient to climate change, though oaks may dominate over pines
- Over the long run, southern grasslands will wax and wane with climatic changes as in the past (if we allow them to)
- How we treat these ecosystems – restoration and management vs. destruction – will largely determine their fate