

The Role of Fire in Shaping Wetland Community Structure

Michael A. Kost

University of Michigan

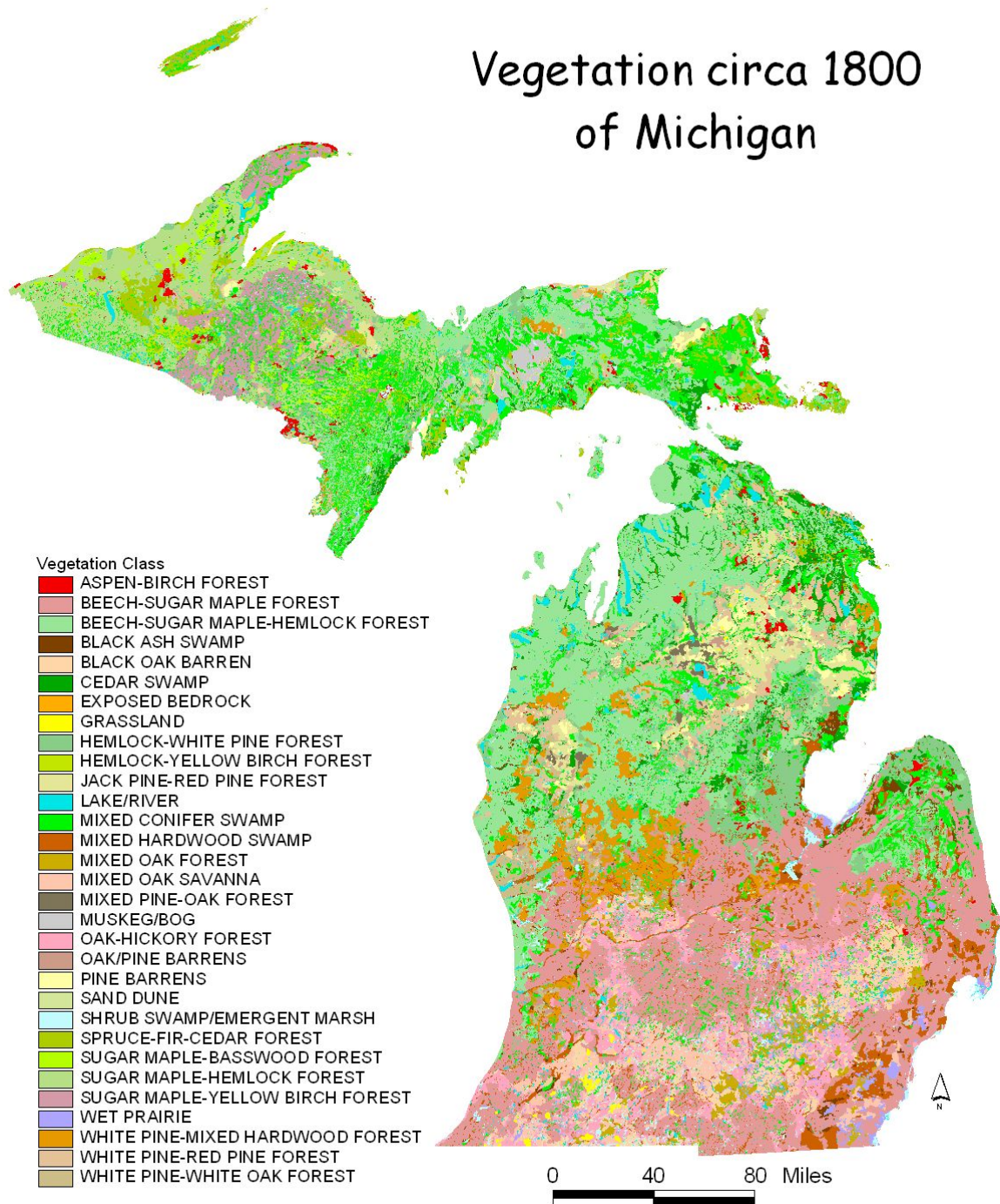
Matthaei Botanical Gardens and Nichol Arboretum

<http://www.lsa.umich.edu/mbg/>

Fire shaped the historical vegetation patterns across much of Michigan

Historically, fire-dependent communities such as non-forested uplands and wetlands co-occurred in large landscape blocks

Vegetation circa 1800 of Michigan



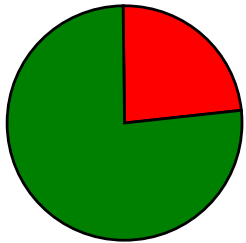
Fire burns across upland-wetland ecological gradient





1800s Distribution of Fire Dependent and Gap Phase Dynamic Ecosystems

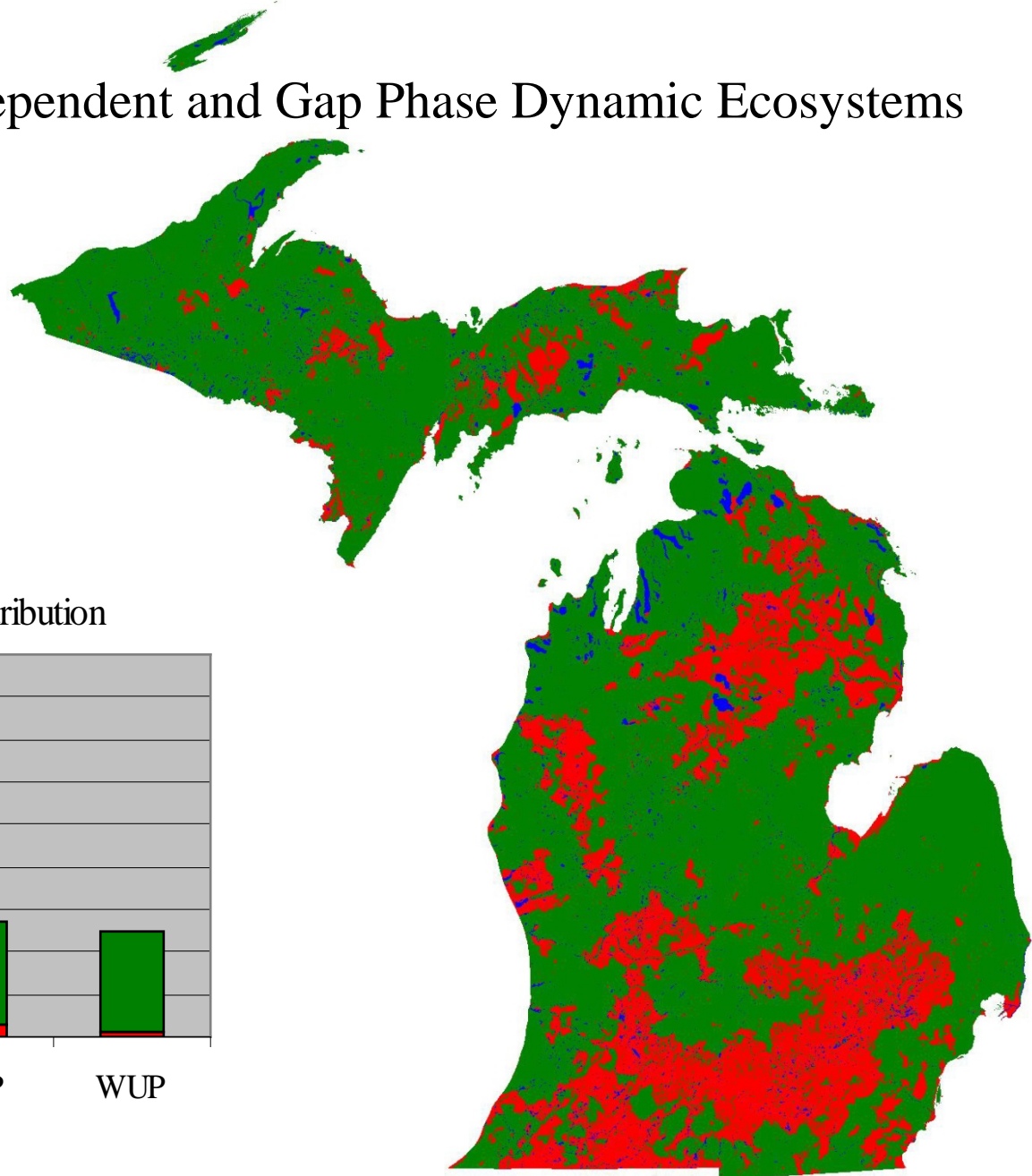
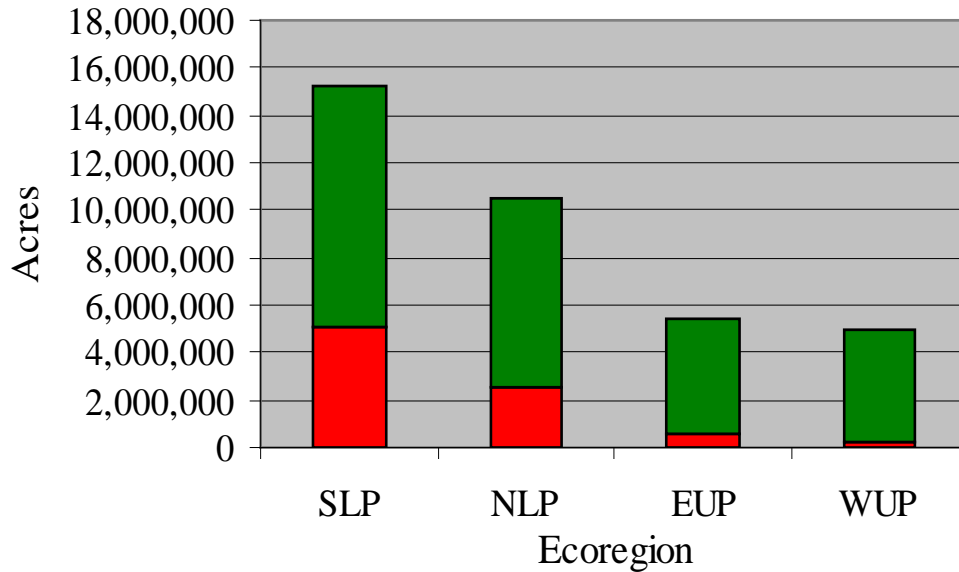
1800s Disturbance Classes



■ Fire Dependent

■ Gap Phase

1800s Ecoregional Distribution



Prairie fen



Prairie fen support many rare species

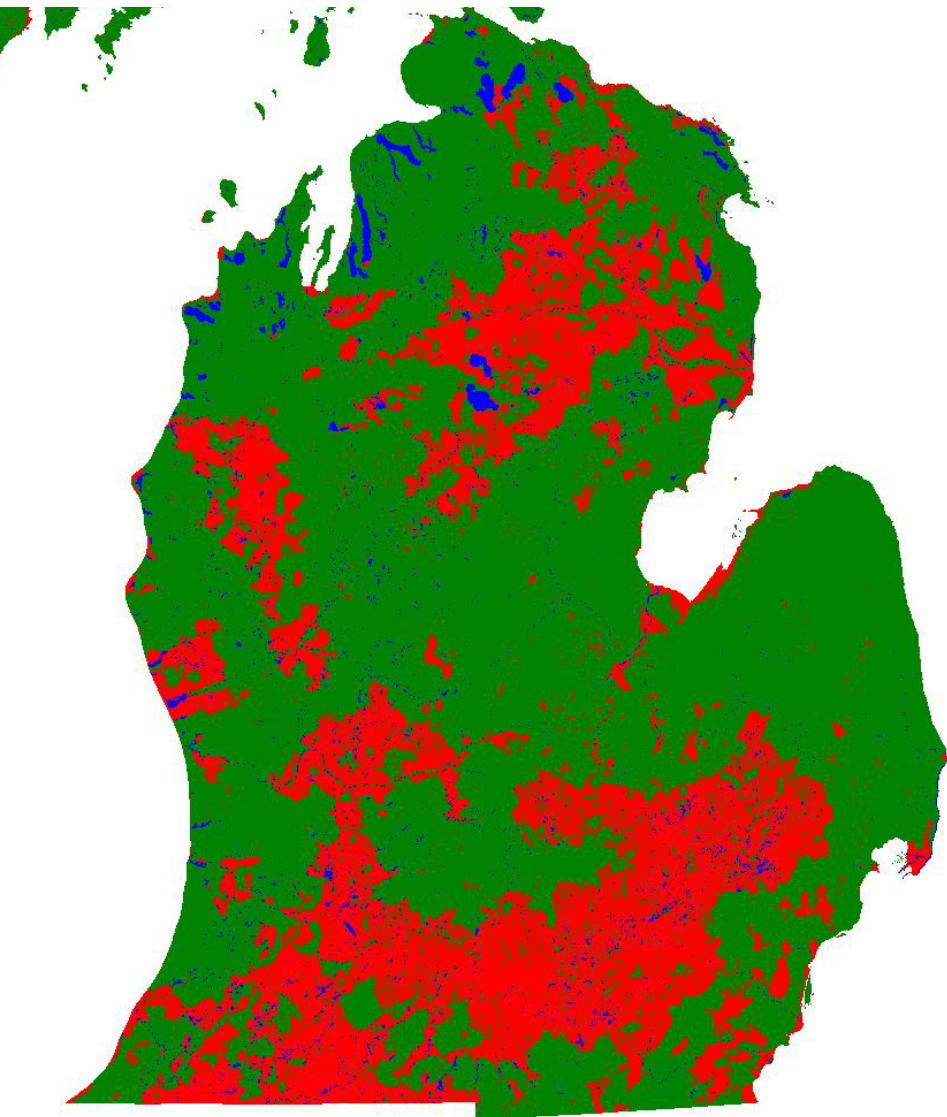




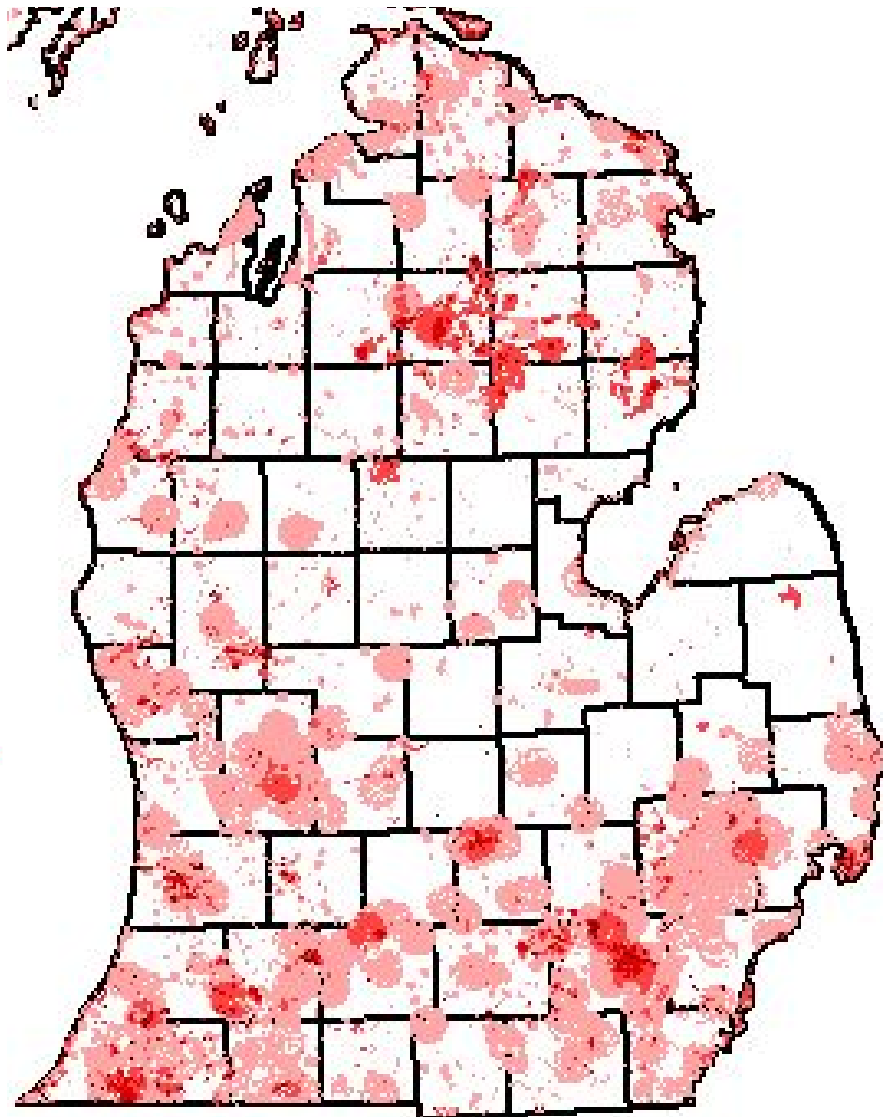
Prairie Fen converts to Southern Shrub-Carr and Rich Tamarack Swamp

Where are the biological rarities?

Circa 1800s Fire/Gap Phase



Rare Species Hot Spots



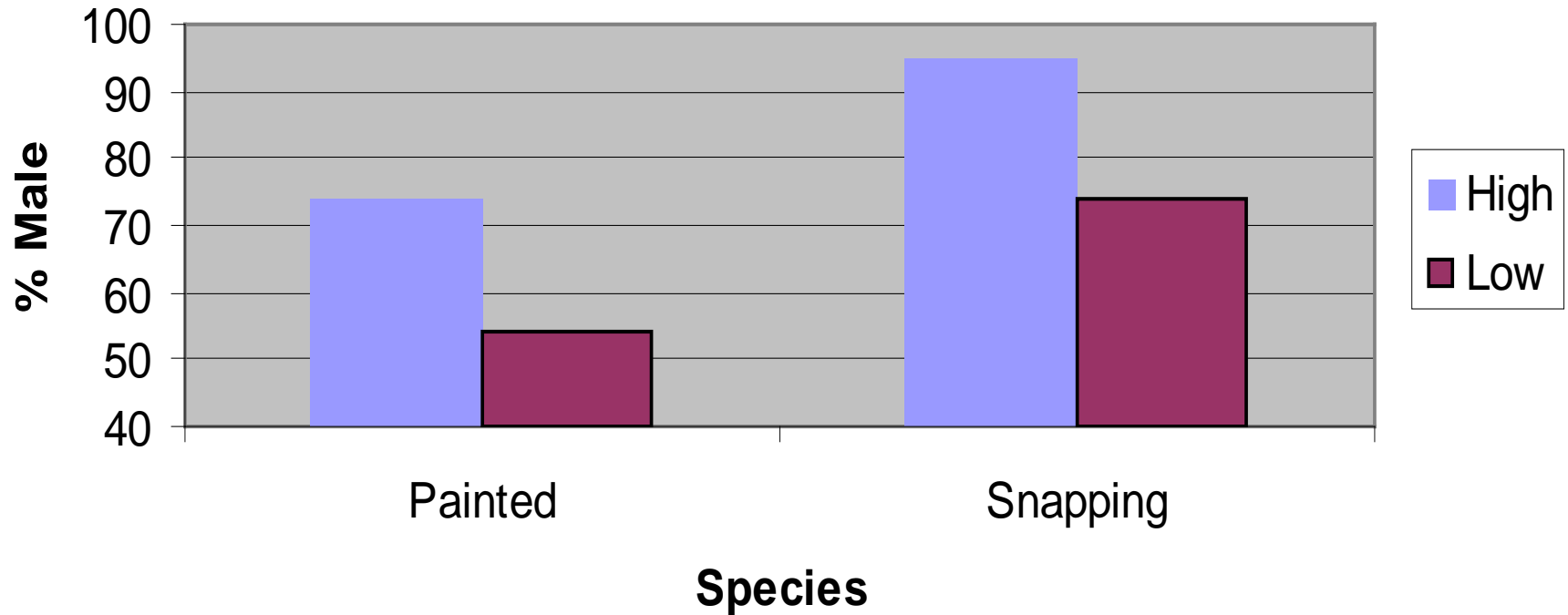
Fire suppression likely contributing to high rates of mortality for female turtles

With few open sunny areas remaining, female turtles now frequently lay eggs in gravel along road and consequently suffer high rates of mortality





Turtle Population Structure in Areas of High and Low Road Density



Painted Turtle (74% vs. 54% males; $p = 0.01$); Snapping Turtle (95% vs. 74% males; $p = 0.08$); high road density = >1.5 km roads/km² of landscape

Steen, D.A. and J.P. Gibbs. 2004. Effects of Roads on the Structure of Freshwater Turtle Populations. Conservation Biology vol. 18.

54 Prairie Remnants re-sampled

8 to 60% of original plant species
lost over 32- to 52-year period

Heaviest losses occurred in the
wettest, most productive
communities

Short, small-seeded, and nitrogen-
fixing species showed largest
declines

Interruption of landscape-scale
process of wildfire may be eroding
biodiversity in many habitats
worldwide.



Leach, M.K. and T.J.
Givnish. 1996. *Science*
273:1555-1558.

Sedge Meadow (Wet Meadow) occurs along frequently flooded streams and on old glacial lakebeds

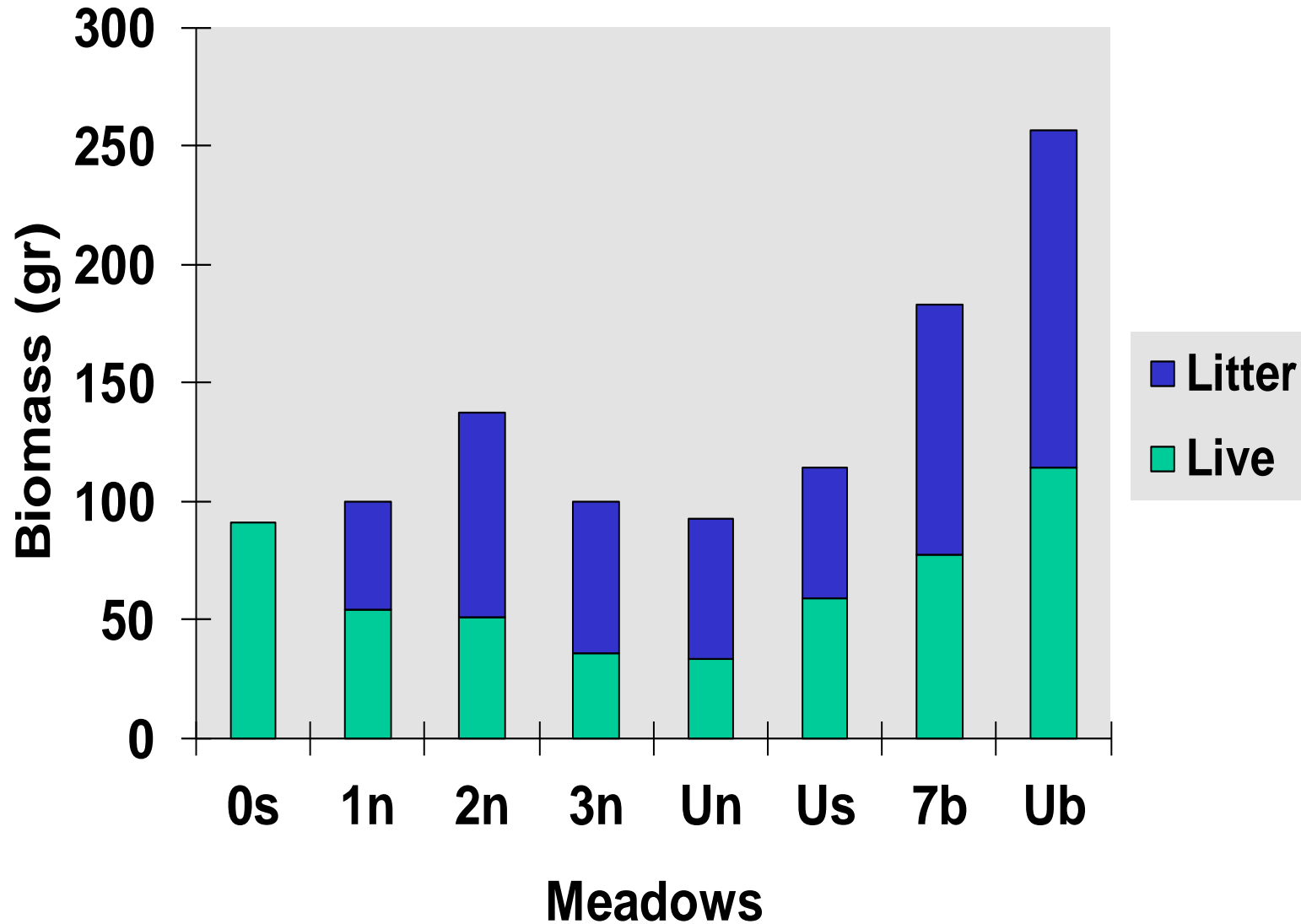




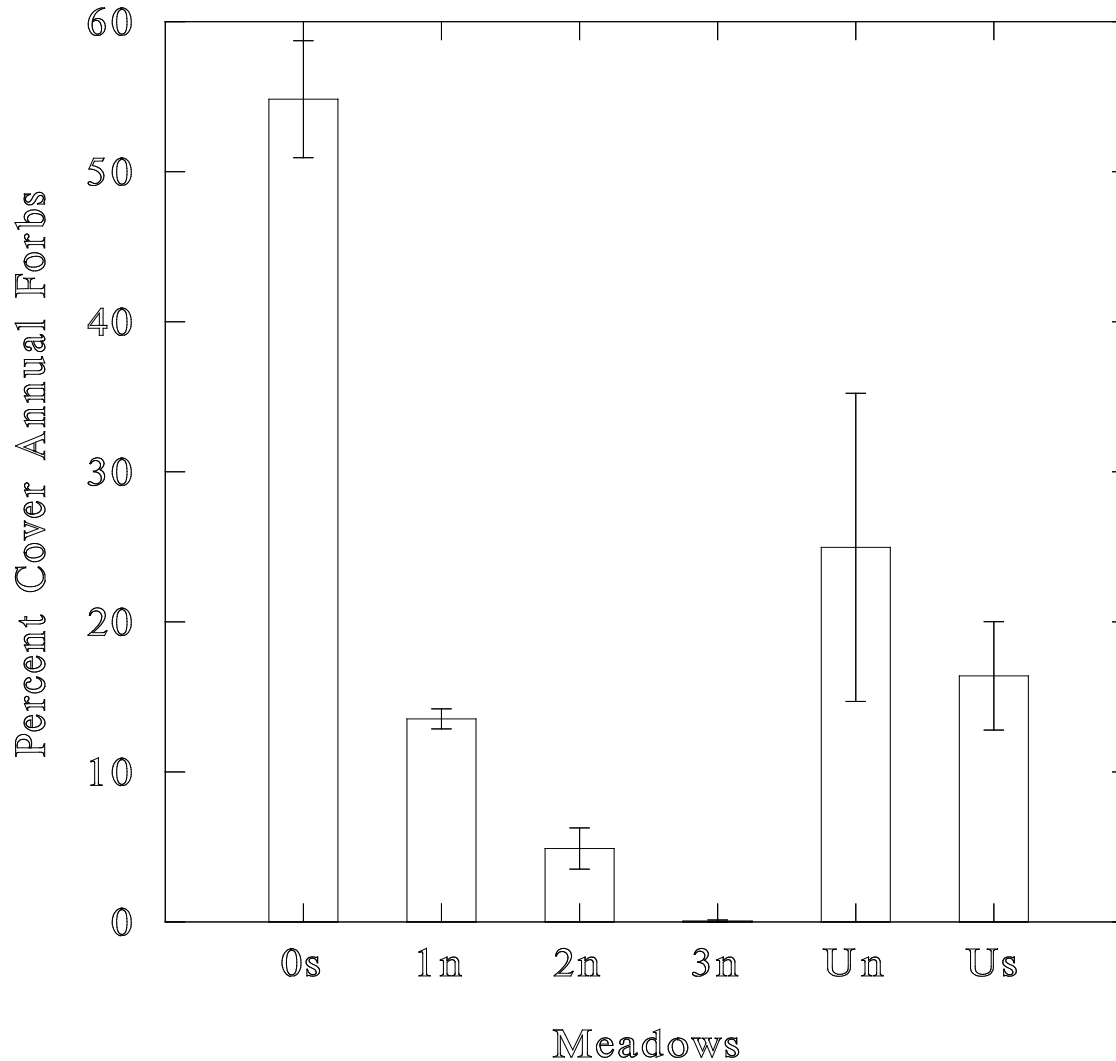
Thick layer of dried sedge leaf litter in spring



Mean Biomass by Meadow

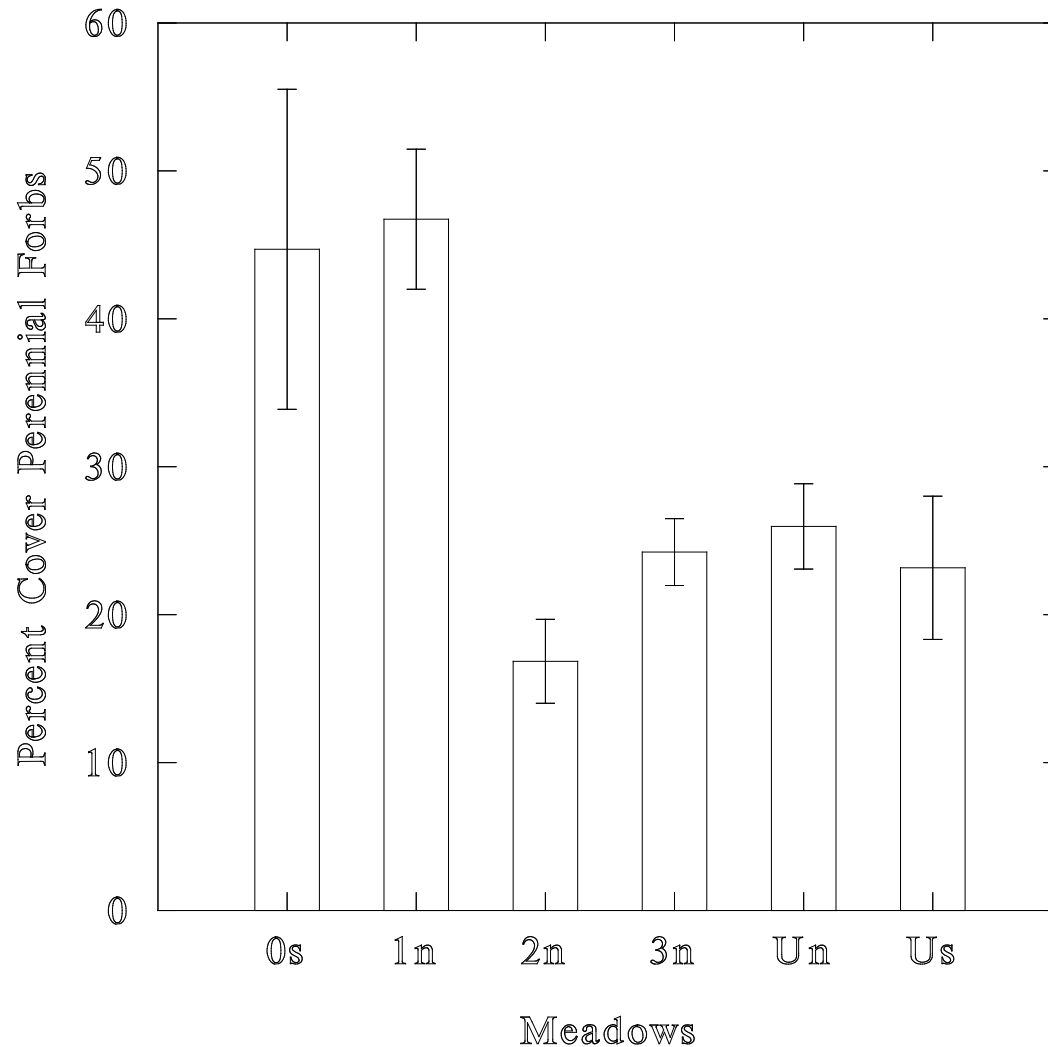


Annual forb percent cover (mean \pm s.e.) of transects by meadow at Lulu Lake



Mitchell's satyr
lays eggs on
small plants -
often on annual
forbs.

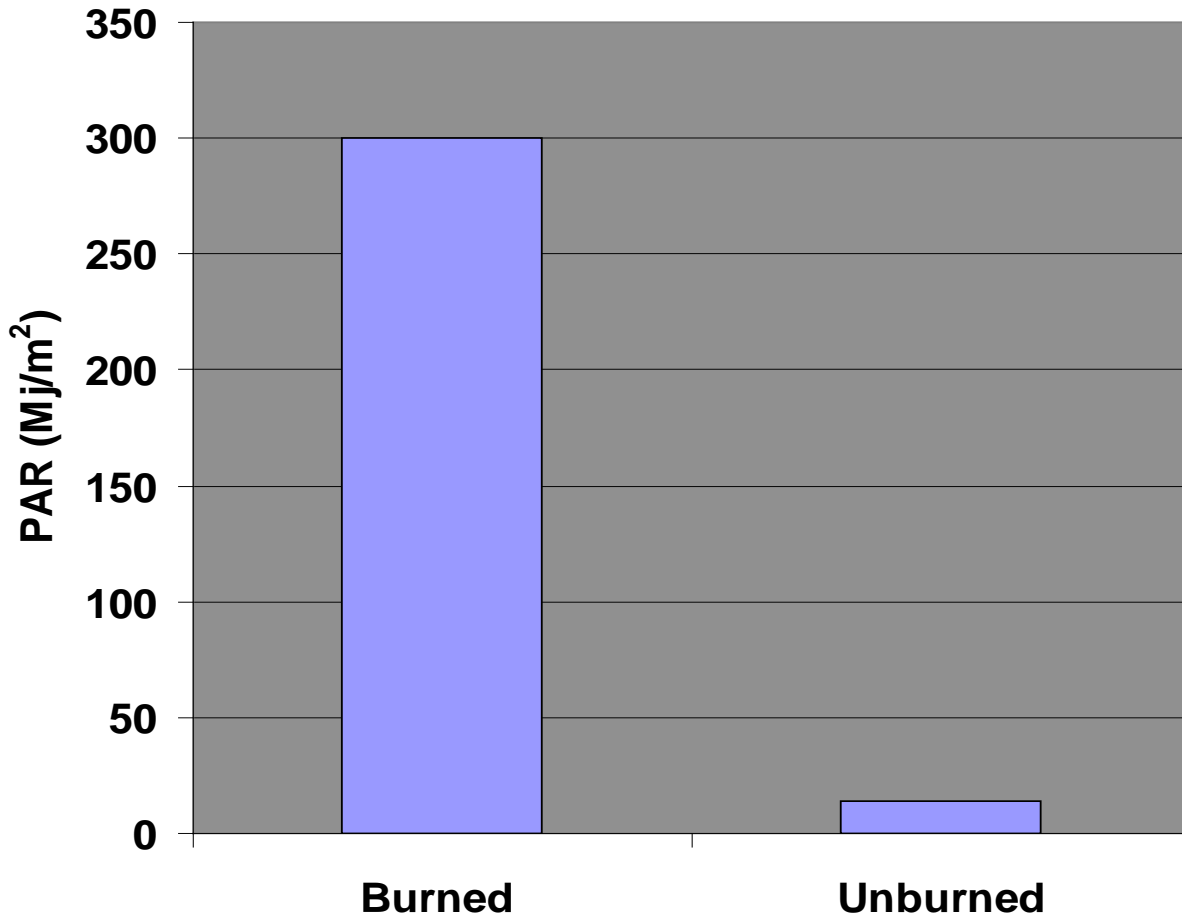
Perennial forb percent cover (mean \pm s.e.) of transects by meadow at Lulu Lake



Response to Burning

- Annual and Perennial forbs increase in abundance
 - Annuals forbs (*Pilea pumila*) increase for 1 year
 - Perennial forbs increase for 2 years
- Live standing biomass increases for 1 year
- Litter returns to preburn levels in 1-2 years

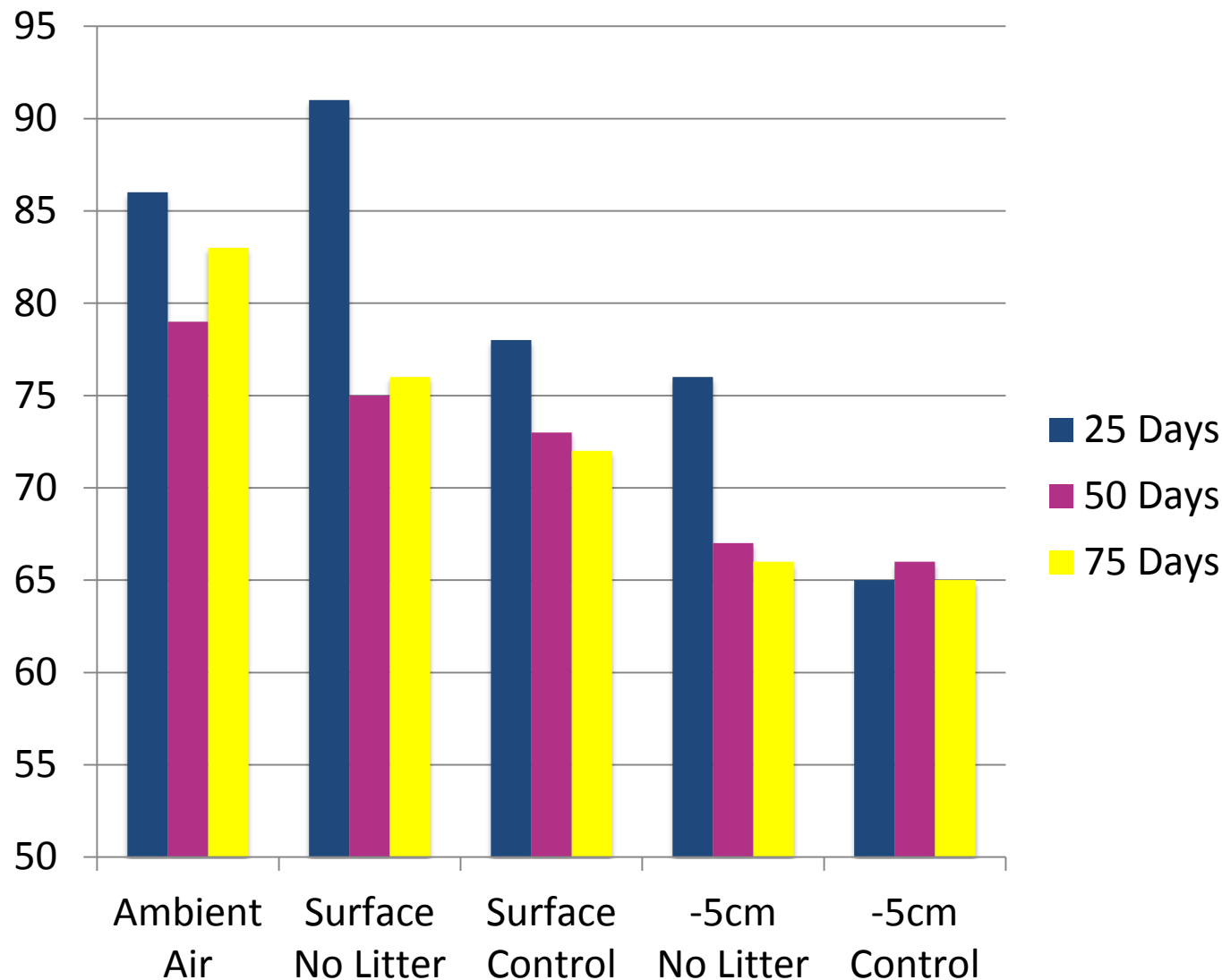
Ground Layer Photosynthetically Active Radiation (PAR) in Lowland Prairie during the first 30 days of following burning



Sunlight helps trigger seed germination and increases soil temperatures

Knapp, A.K. 1984. Amer. J. Bot. 71:220-227.

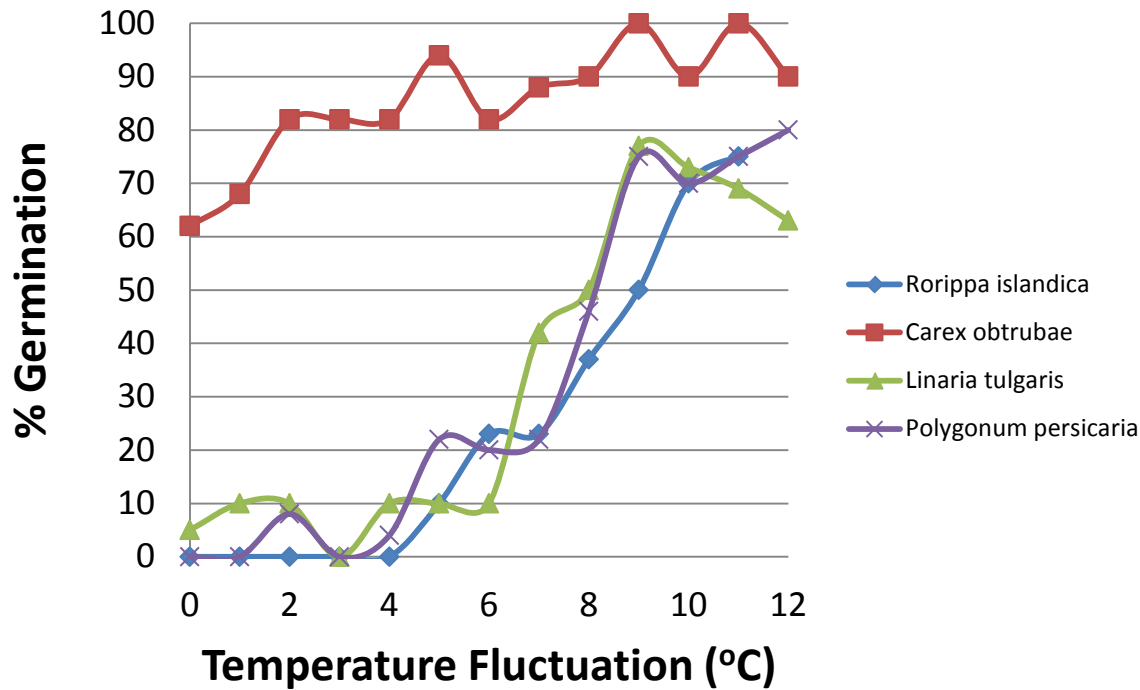
Surface and Below Ground Temperature following Litter Removal



Litter removal in spring resulted in higher soil temperatures

- facilitates seed germination
- jumps starts spring growth
- contribute to greater biomass and flowering

% Seed Germination with increasing Diurnal Temperature Fluctuation

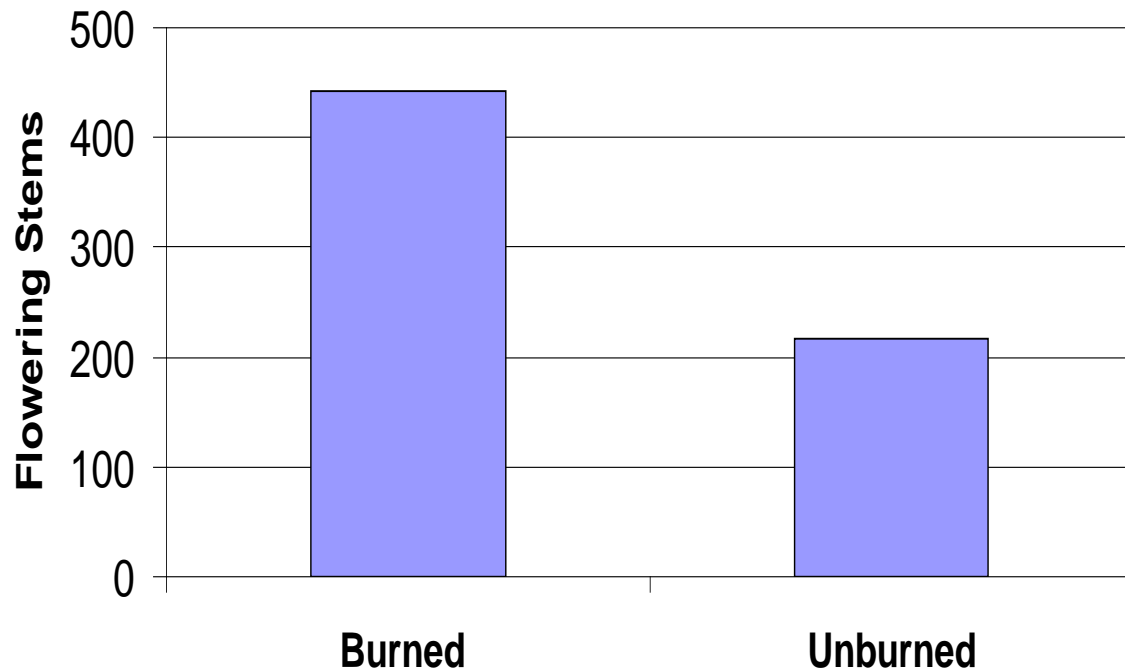


Diurnal (daily) Temperature Fluctuation triggers seed germination.

Burning removes litter and blackens surface. Soil temperatures become warmer during the day and colder at night, which triggers seed germination.

Thompson K. and J.P. Grime. 1983. *Journal of Applied Ecology* 20:141-156.

Flowering Stems in Burned and Unburned Lakeplain Wet-mesic Prairie



Increased flowering provides more pollen, nectar, and seeds for wildlife.

Species showing significant ($p < .10$) increases include Big Bluestem, Indian Grass, Marsh Blazing Star, and Culver's Root. (Albert et al. 1996) (Algonac State Park).

Conclusions

- Fire shapes landscape vegetation patterns
 - Its absence / suppression contributes to losses in biodiversity at the species and community levels
- Prescribed fires helps maintain wetland plant diversity and replenish the seedbank
 - Reduces litter and releases stored nutrients
 - Increases amount of sunlight reaching soil surface
 - Increases diurnal temperature fluctuation
 - » Increases seed germination
 - Increases biomass
 - Increases flowering and seed set
 - Temporarily reduces competition from perennials
 - Facilitates seedling establishment

Recommendations

- In fire-dependent landscapes:
 - Include wetlands in burn plans
 - Allow wildfires to burn across wetlands where safety permits
- Provide Refugia for fire-sensitive species by subdividing wetland into multiple burn units
 - Wet lines or raked lines provide excellent fire breaks with little long-term disturbance

Thank You!

