Fire and Flooding Interactions:
Vegetation Trajectories in the Southern Everglades Marl Prairies, Florida

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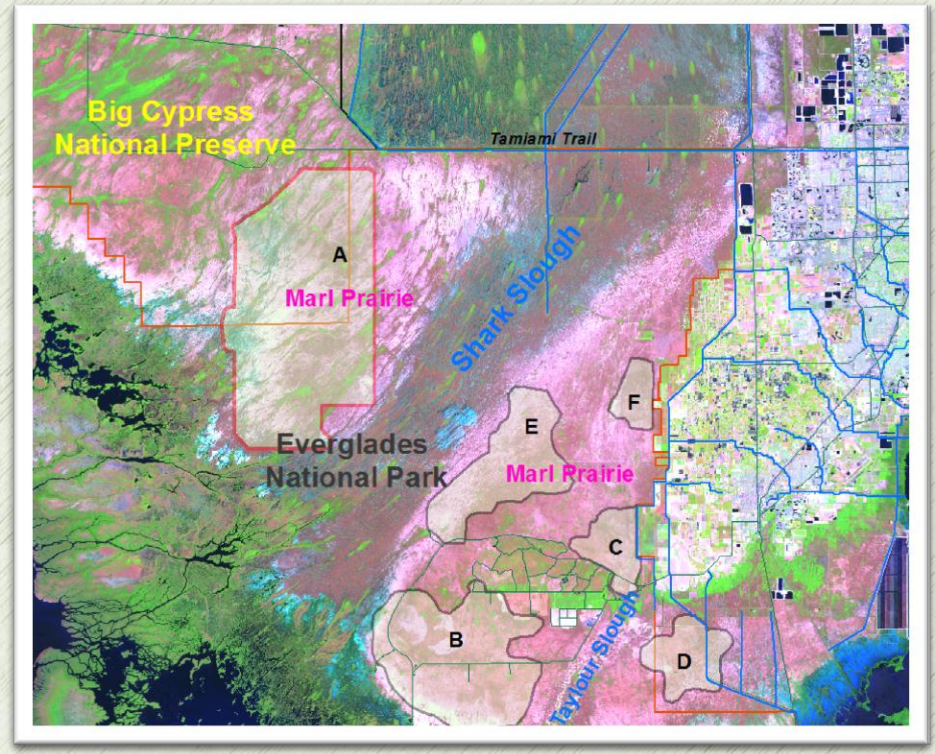
Southern Everglades marl prairies

- At relatively high elevation, marl prairies flank both sides of Shark River and Taylor Sloughs
- With short to moderate hydroperiod (60-240 days)
- Have thin calcitic soils underlain by limestone bedrock
- Vegetation primarily of grasses and sedges from 0.5 to 1.5 m in height

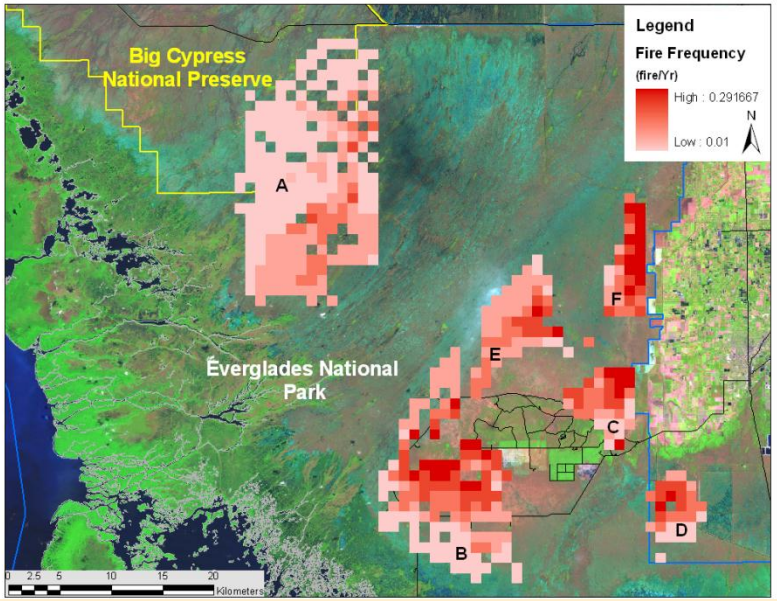


Habitat of

Cape Sable seaside sparrow (CSSS) (*Ammodramus maritimus mirabilis*): a federally listed endangered species. ***Current population ~3,000.***

Cape Sable seaside sparrow
(Photo by David LaPuma)

Fire frequency (fire/year)



Everglades Marl Prairie landscape:

- A matrix of pyrogenic vegetation
- Fire frequency **up to** 3-4 fires/decade

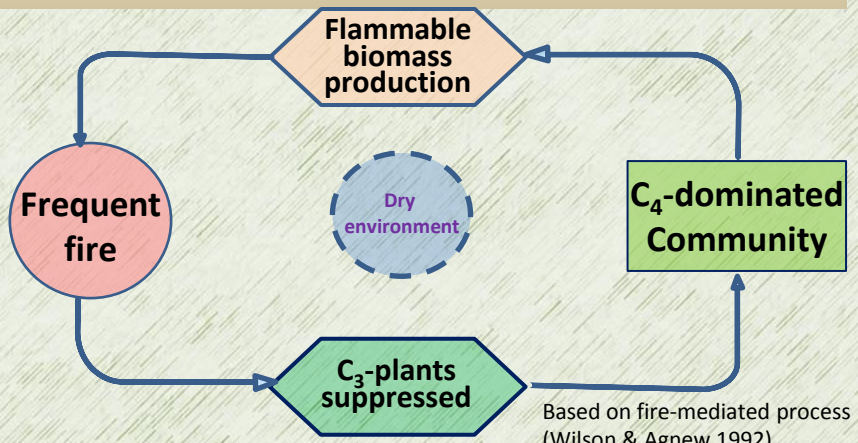
High proportion of C_4 plants:

Muhly grass (*Muhlenbergia capillaris* var. *fillipes*),
Blue stem (*Schizachyrium rhizomatum)*,
Bluejoint Panicgrass *(Panicum tenerum)*
and others

In dry environments, C_4 grasses have high:

- photosynthetic productivity
- light, nitrogen, & water use efficiency
- below ground reserves
- flammable litter fuels

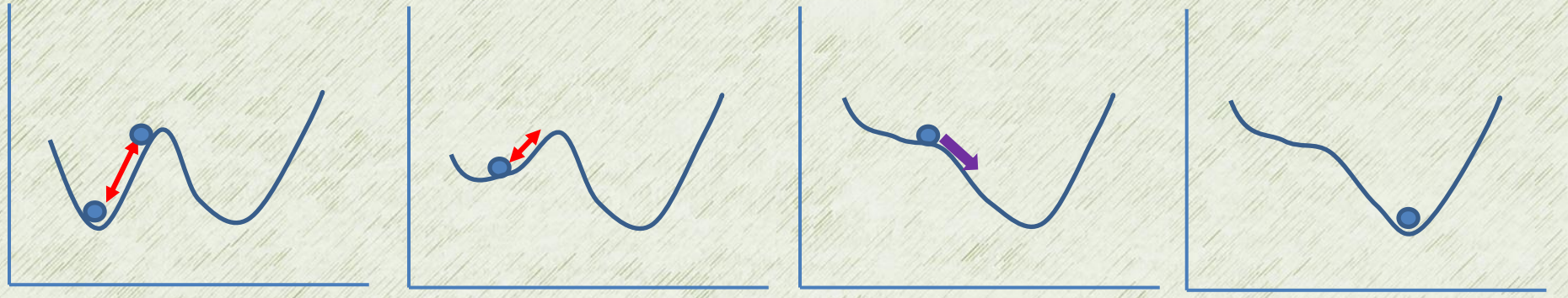
Ripley et al. (2010)



Based on fire-mediated process (Wilson & Agnew 1992)

Ecosystem resilience & regime shift

Ecological resilience - *the amount of disturbance that they can withstand before changing stable states or being significantly altered -* **(Holling 1973)**



Marl prairie
C_4-grass dominated
(Frequent burning
& Short hydroperiod)

Marl prairie
(Fire suppression
and/or
prolonged flooding)

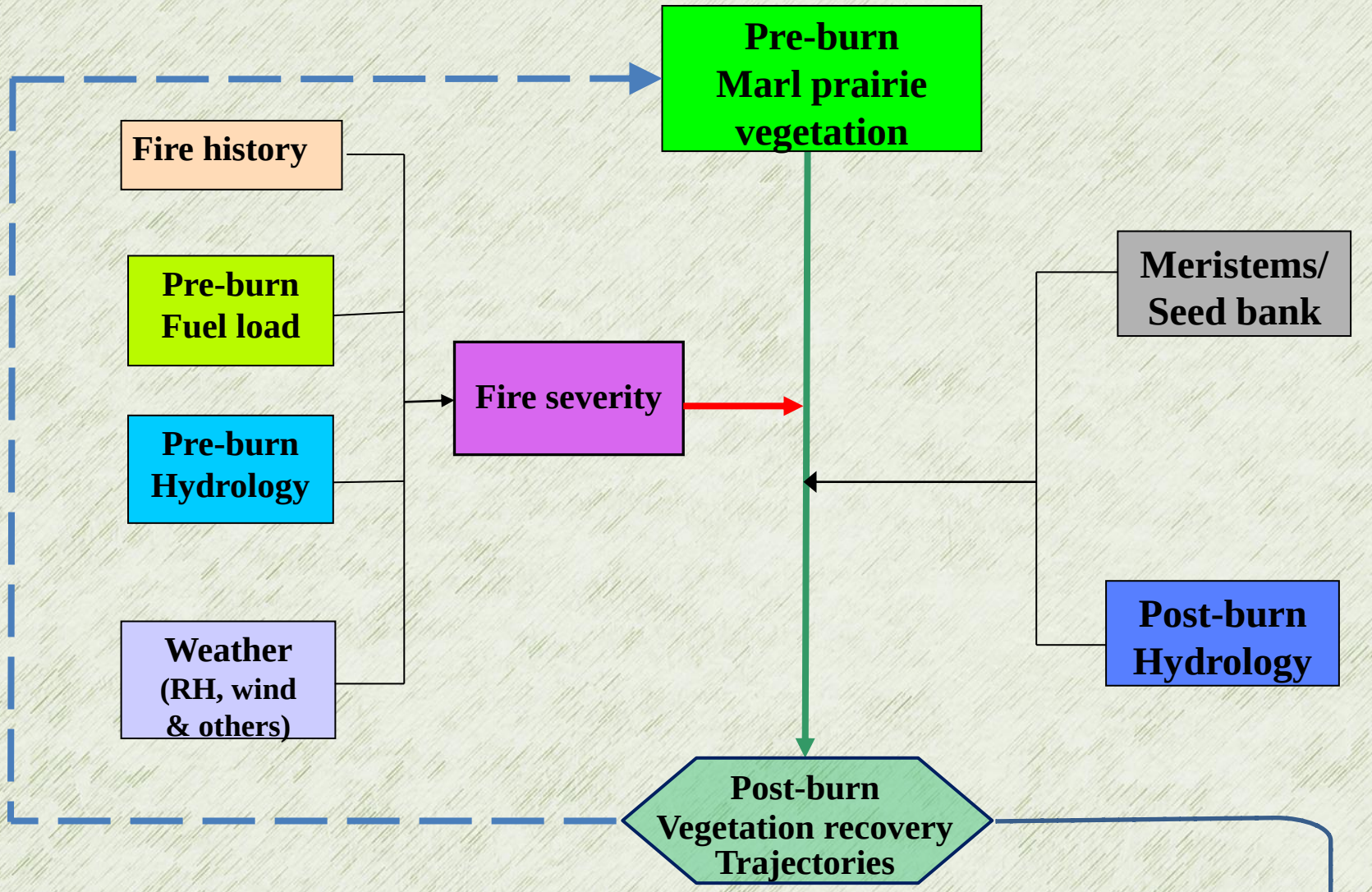
Regime shift
(Fire suppression
and/or
prolonged flooding)

Woody vegetation and/or Sawgrass/beakrush marsh

- A shift between ecosystem depends on **the internal resilience of the system** and/or the **magnitude of external forces (disturbances) –** **(Folke et al. 2004)**
- Multiple interacting disturbances (e.g. fire & flooding) **compounds the effects** which are generally greater than the effect of individual disturbance
- The effects of compounding multiple disturbances depend **on their sequential order and intensity.**

A Conceptual model

Fire, hydrology & vegetation interactions

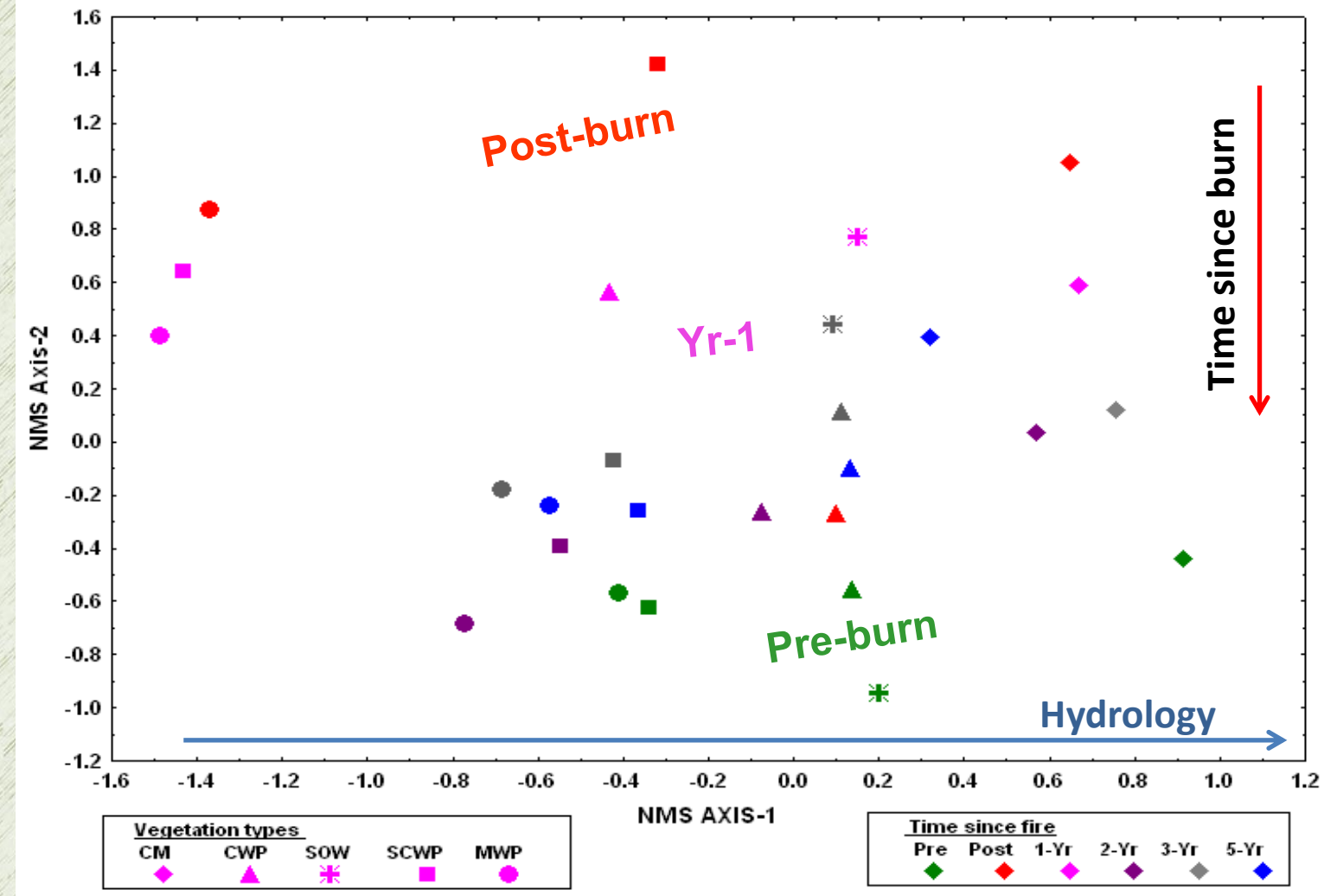


In marl prairies, post burn hydrologic conditions affect vegetation recovery trajectory resulting in vegetation composition that may or may not resemble the pre-burn vegetation

Post-burn Marl prairie vegetation?

Non-metric multidimensional scaling ordination (NMDS)

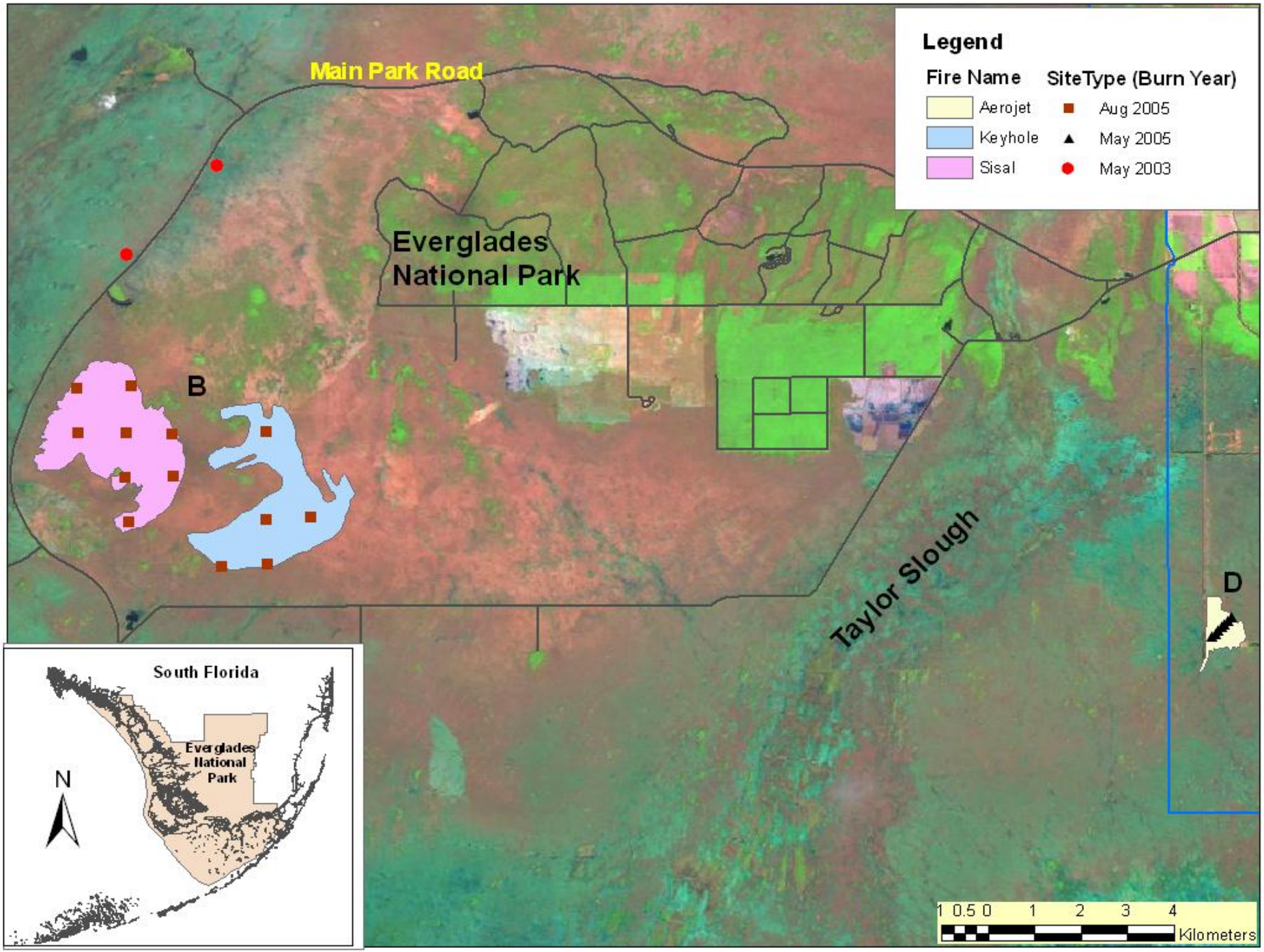
(Sites grouped by vegetation type and time since last fire)



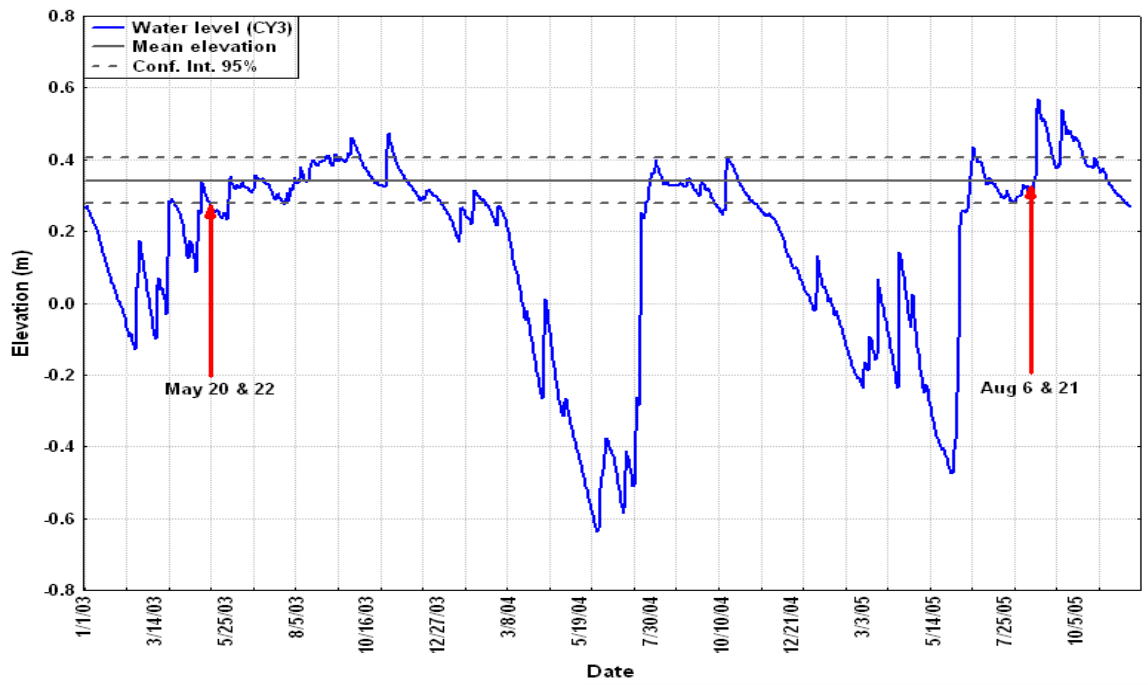
In general, vegetation composition 4-5 years after fire is indistinguishable from that in pre-burned condition.

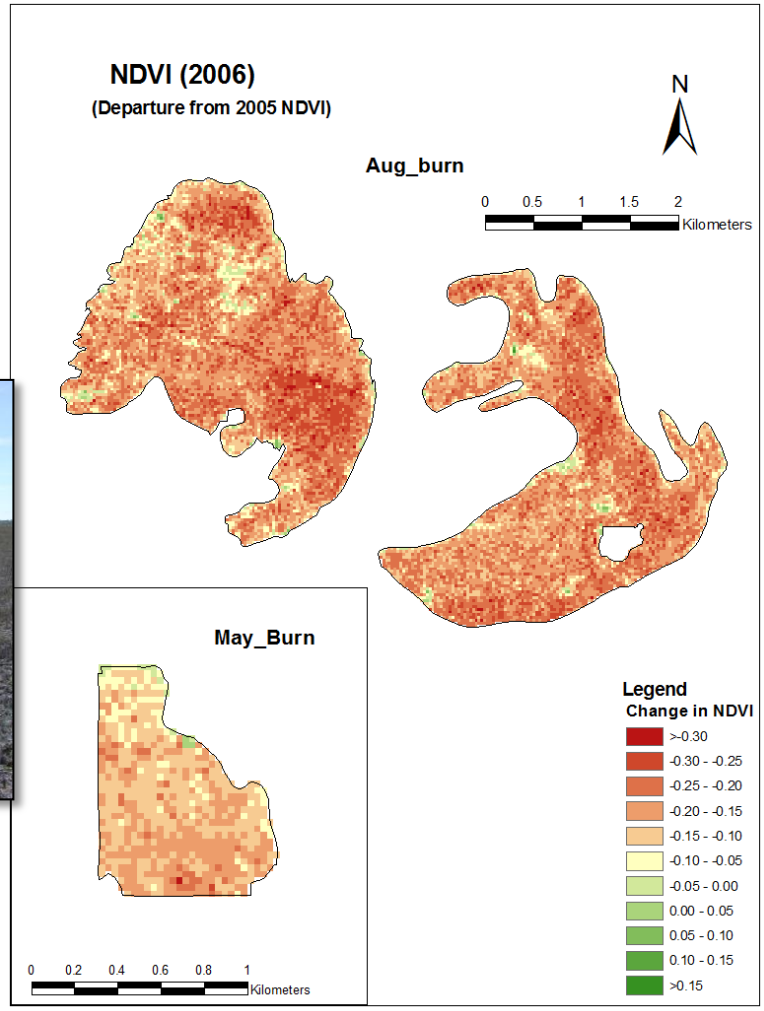
Fire and Flooding

….. However, sites that are flooded after fire may have vegetation composition different from that were before the sites burned.


Legend
Fire Name
SiteType (Burn Year)
Aerojet
Keyhole
Sisal
Aug 2005
May 2005
May 2003
Main Park Road
Everglades
National Park
B
D
Taylor Slough
South Florida
Everglades
National
Park
N
1 0.5 0 1 2 3 4
Kilometers

Vegetation at the sites burned in 2005



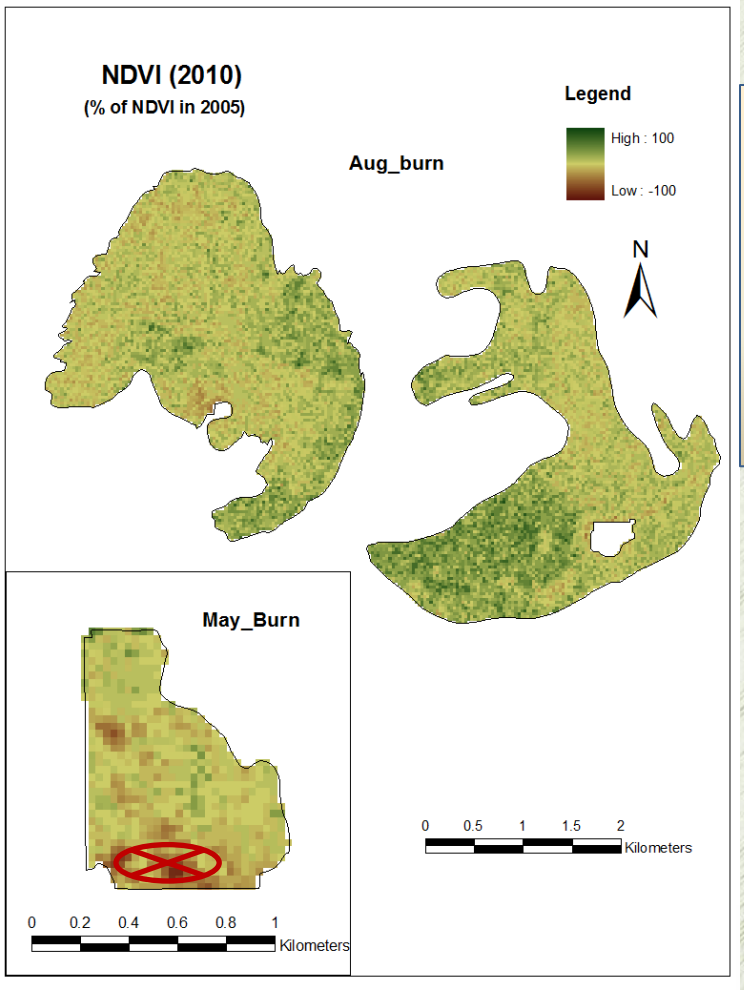


- **Flooding immediately after fire was detrimental to most of species in marl prairies**

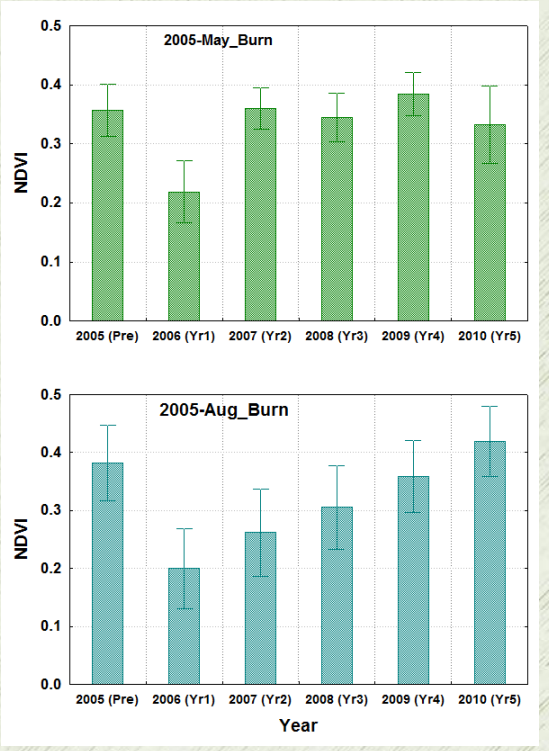
Landsat-5_015042

Date: 2005/01/25 & 2006/05/04

Vegetation recovery
(Change in NDVI)



Normalized Difference Vegetation Index (NDVI) values in 2010 as a percentage of NDVI in 2005 indicate spatially differentiated vegetation recovery



Differences in NDVI between two group of sites - Vegetation recovery was relatively slow at sites burned, and then immediately flooded.

However, water depth and duration of flooding at the gradually flooded burned (May_burn) sites also affected post-fire vegetation recovery.

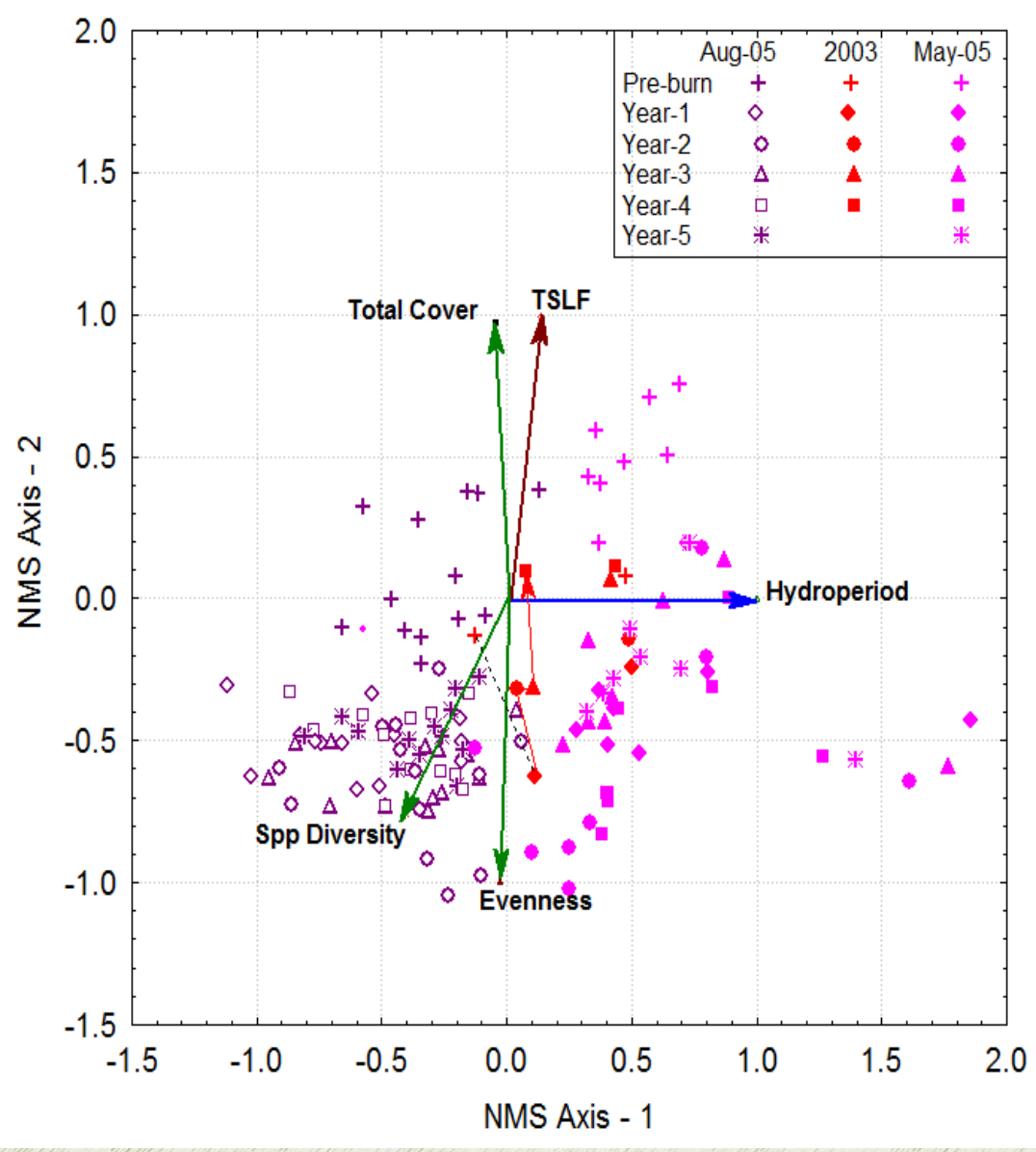


Figure – Site scores for Axis-1 & 2 3-d NMDS based on total cover at 2 sites burned in 2003 and 21 sites burned in 2005.

Vegetation trajectory

(Species composition)

Non-metric multidimensional scaling ordination (NMDS)

Analysis of Similarity (ANOSIM)

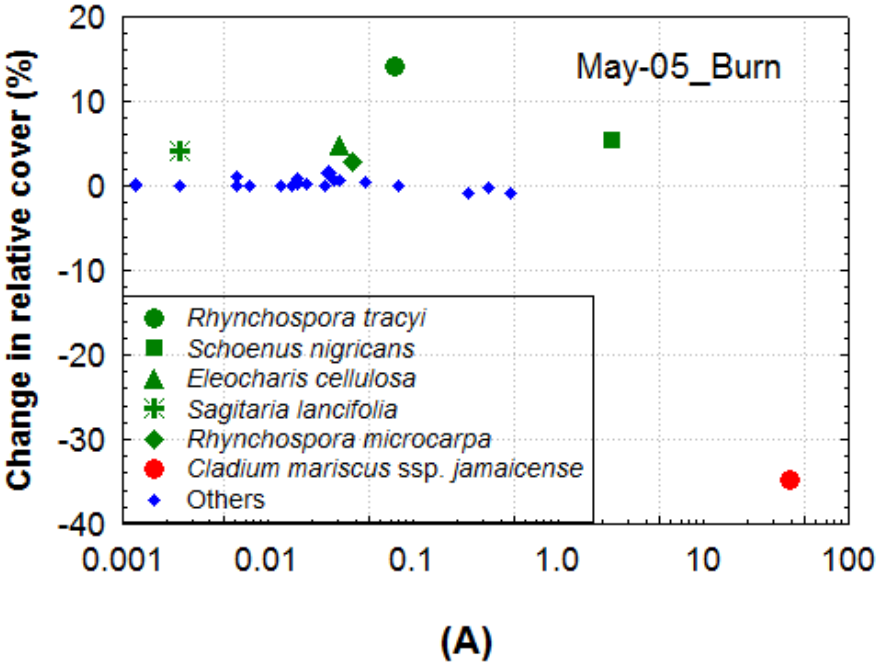
May_burn - R = 0.511, p = 0.002

Aug_burn - R = 0.732, p = 0.001

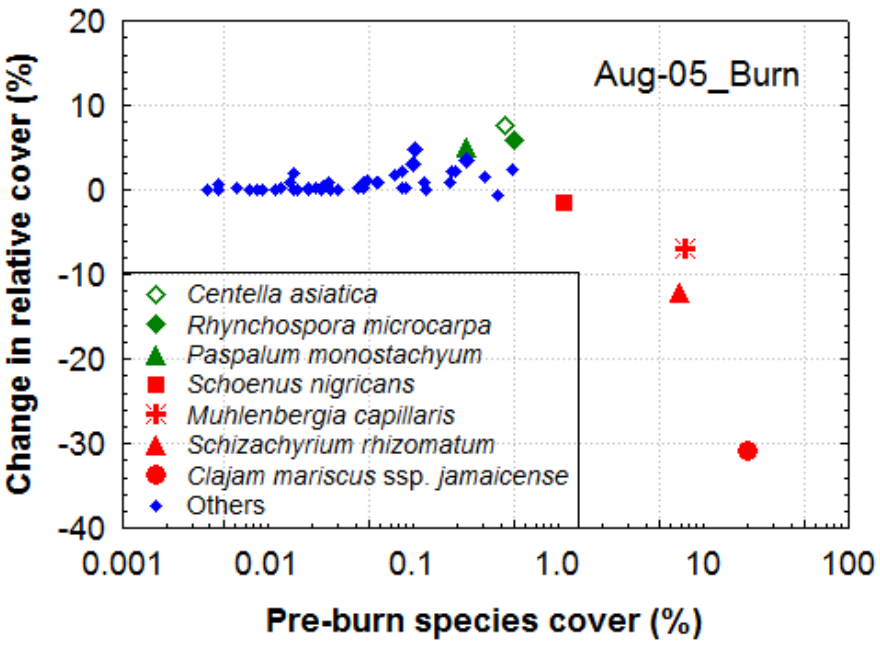
At the 2005 burn sites, plant species composition in the 5th post-fire year was significantly different from pre-burn species composition.

Vegetation trajectory

(Species composition)



(A)



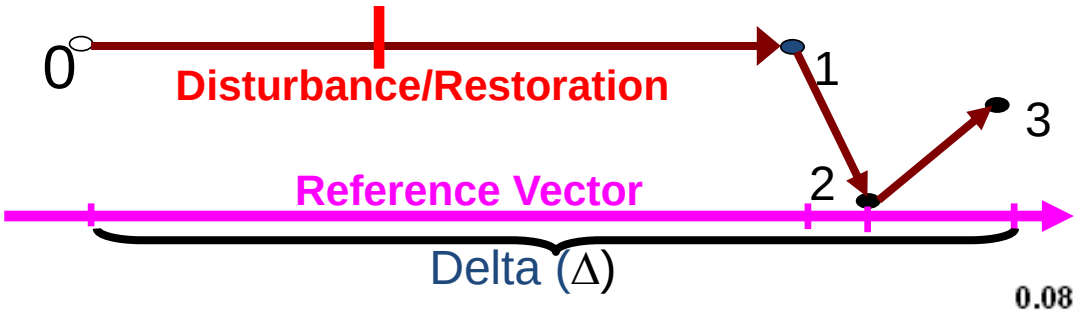
At the 2005 burn sites, relative cover of major species was 20-30% less than their pre-burn cover.

Schoenus (Black-top sedge) Wet Prairie

Trajectory Analysis

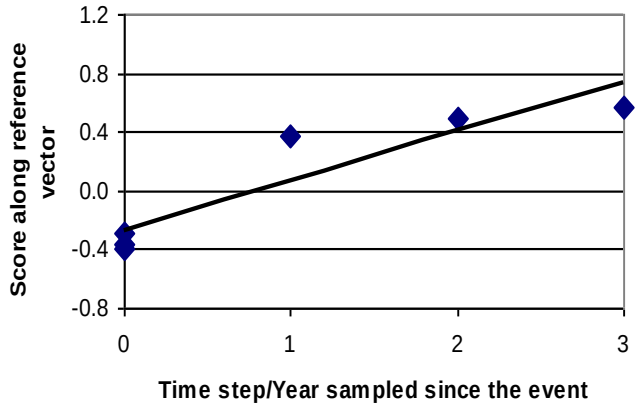
- *Ordination to summarize the community dynamics*
- *Vector fitting to define a target direction*

1. Delta (Δ) = Total distance moved in direction of reference vector

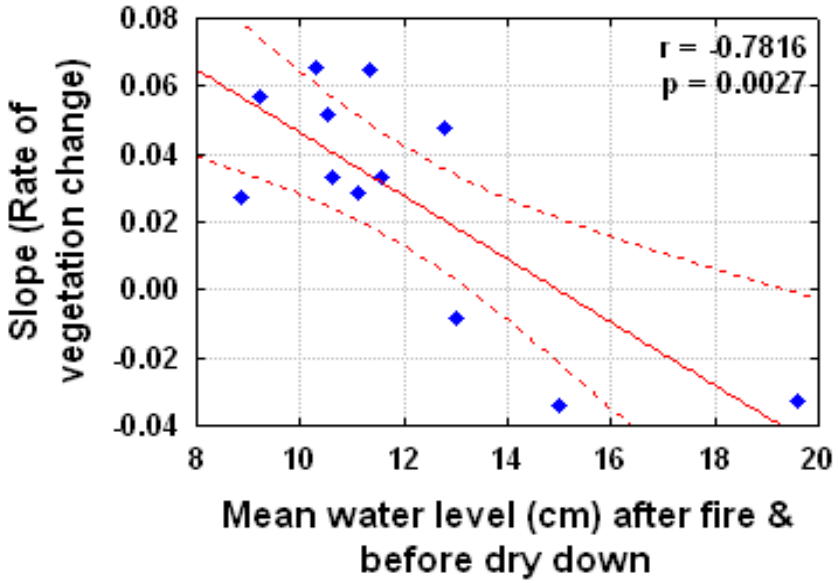


2. Slope = Mean rate of Change.

Slope of linear regression of projected scores along reference vector on time steps since an event.



(Source: Minchin et al. 2005)



Relationship between post-fire hydrologic condition and rate of vegetation recovery at sites burned in Aug, 2005

Conclusions

- Hydrologic conditions immediately after fire affect the course of post-fire vegetation recovery.
- Interaction between fire and hydrology acts as a disturbance of a greater magnitude, resulting in a different plant community types (i.e. change in states).
- However, interaction between fire and hydrology in marl prairies helps to maintain heterogeneity within the landscape, and probably, high species richness.

Acknowledgments

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Thank you