Mapping and Assessing Tree Island Fire Damage and Recovery within the Short-Hydroperiod Marl Prairie Grasslands of the Everglades

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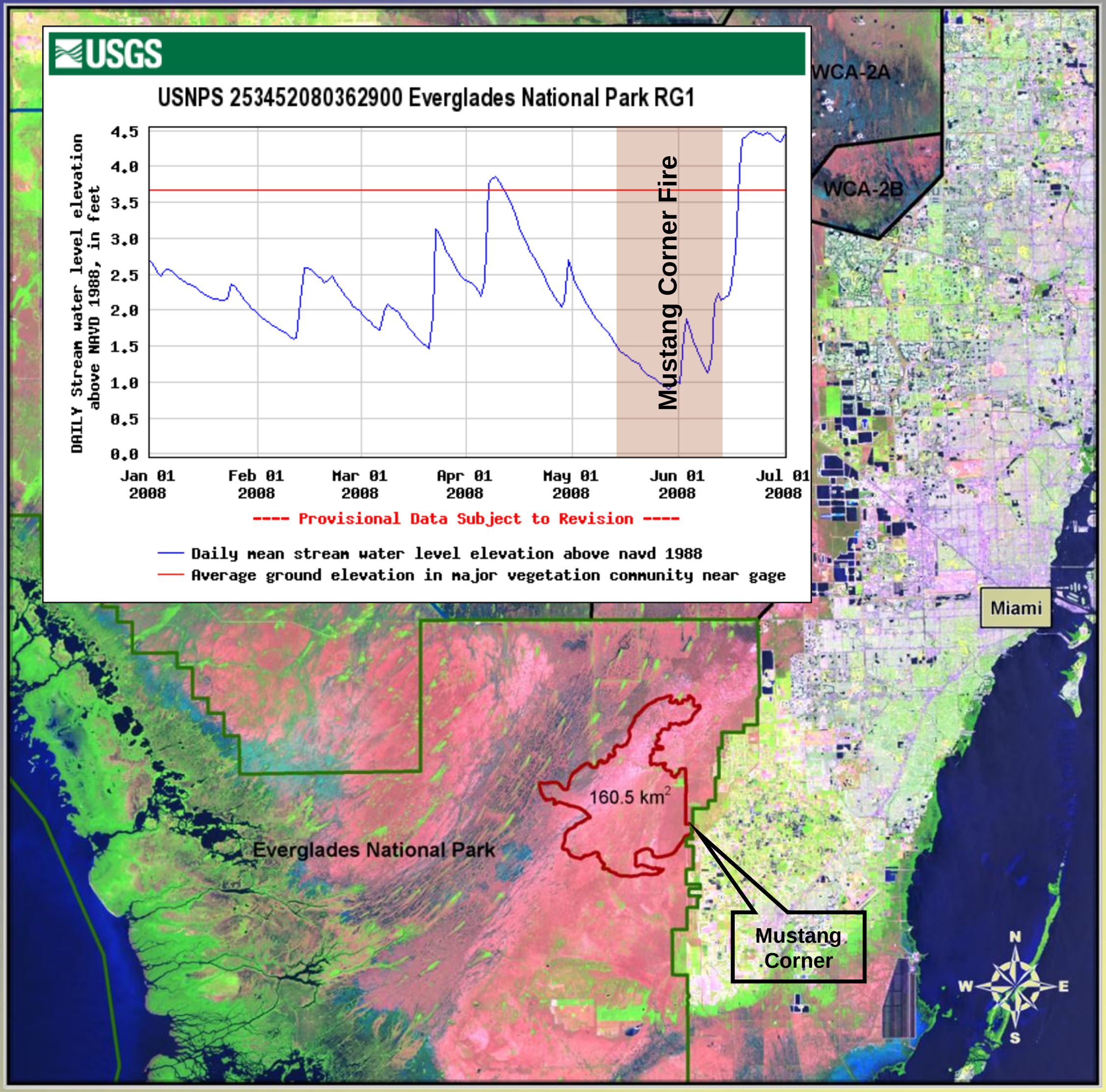
Periodic natural fires, together with suitable hydrologic regime, maintain and advance the dominance of C_4 vs C_3 graminoids (Sah et al. 2008), and suppress the encroachment of woody stems (Hanan et al. 2009) within the marl prairies of the Everglades.

However:

1. Fire can burn through tree islands oxidizing soils and consuming all litter and understory vegetation and top killing most, if not all, of the trees present.

2. Significant soil loss, as a result of a fire, can lead to striking shifts in community structure and composition (Zaffke 1983) and may lead to tree island loss.

Mustang Corner Fire: May 14th – June 4th, 2008



- Anthropogenic
- burned ~39,500 acres

Jun 26 2008 – About three weeks post-fire


Nov 2011 – 43 months post-fire

Project Objectives:

1. Create a pre-Mustang Corner fire tree island map.
2. Determine the total number of tree islands that burn as a result of the fire.
3. Identify tree islands that show no signs of recovery.
4. Determine why some tree islands burned while others did not.

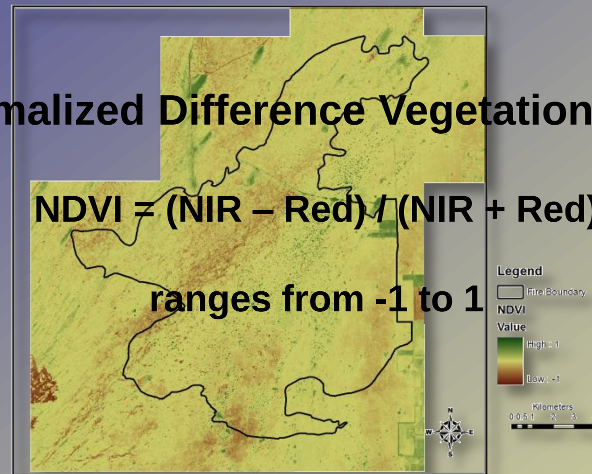
2004 CIR Orthophoto

NDVI

Normalized Difference Vegetation Index

NDVI = (NIR – Red) / (NIR + Red)

ranges from -1 to 1

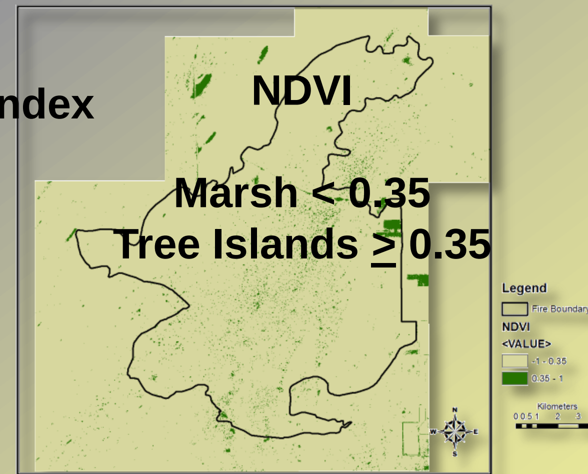


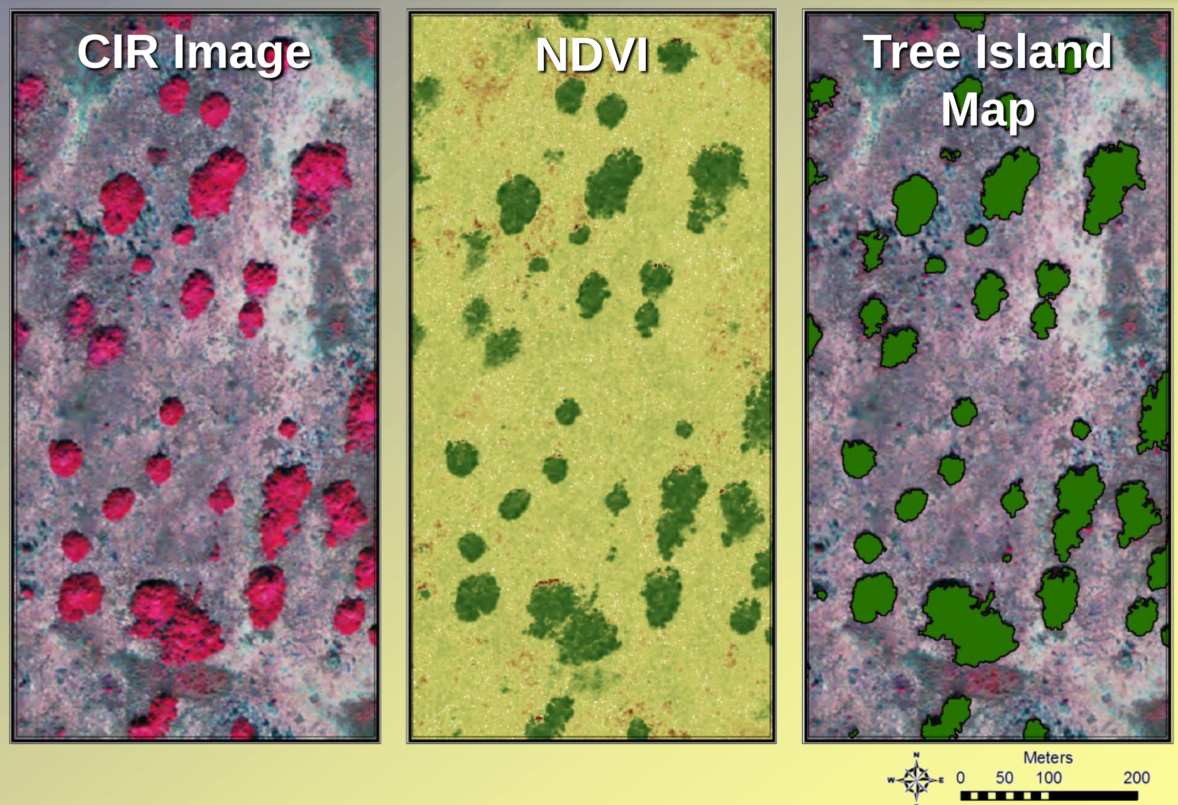
Categorized NDVI

NDVI

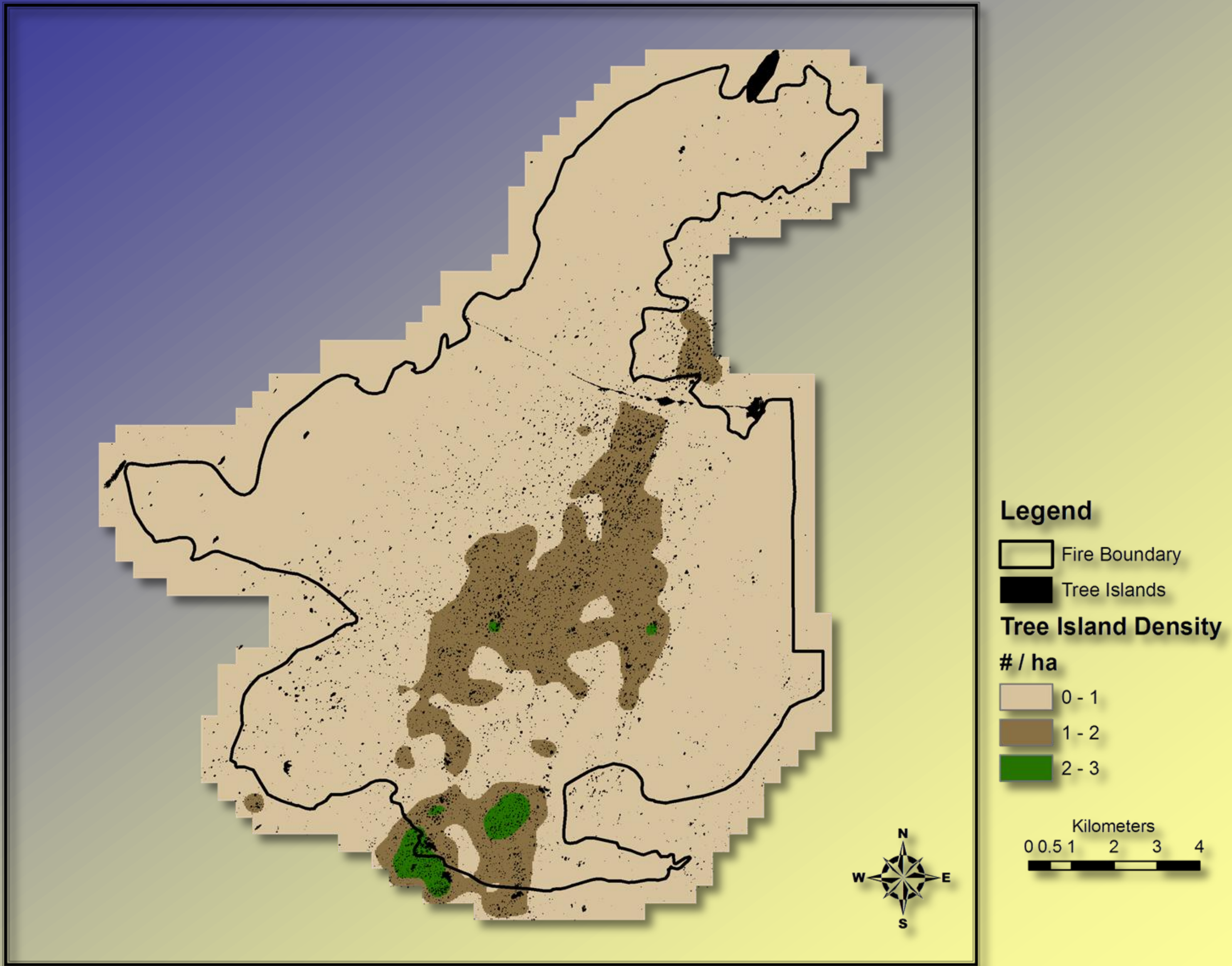
Marsh < 0.35

Tree Islands $\geq$ 0.35

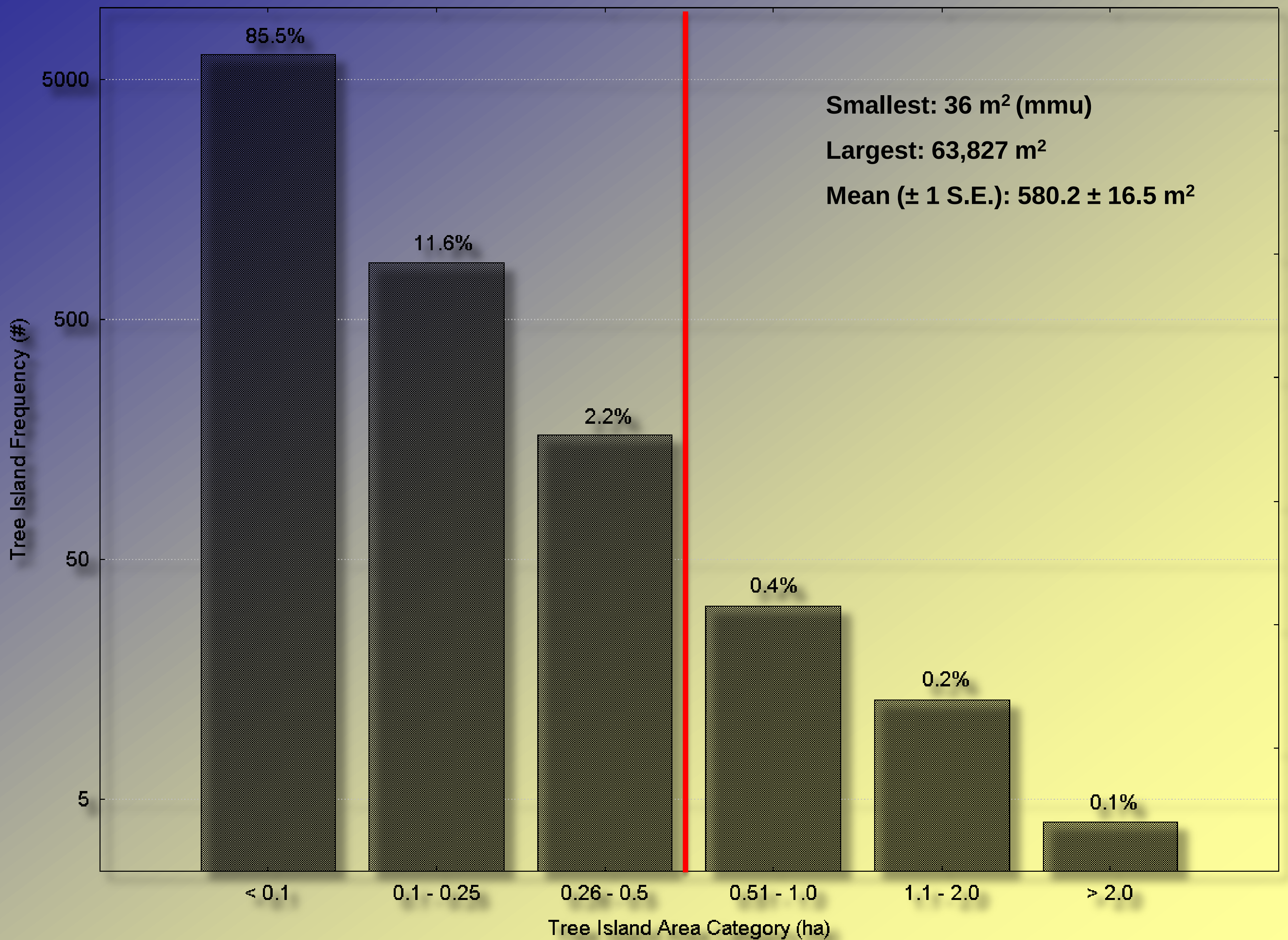




Tree Island Kernel Density Map

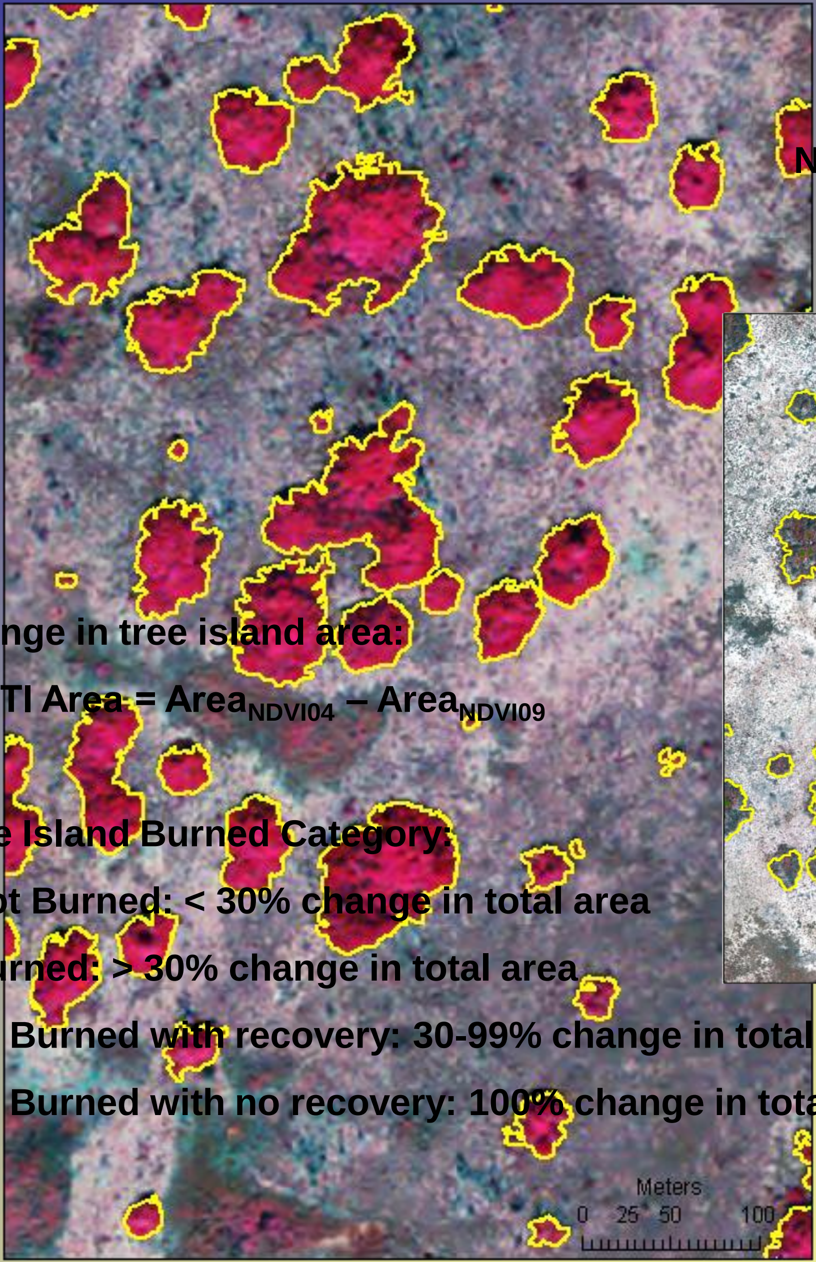


7,412 tree islands mapped within the fire boundary

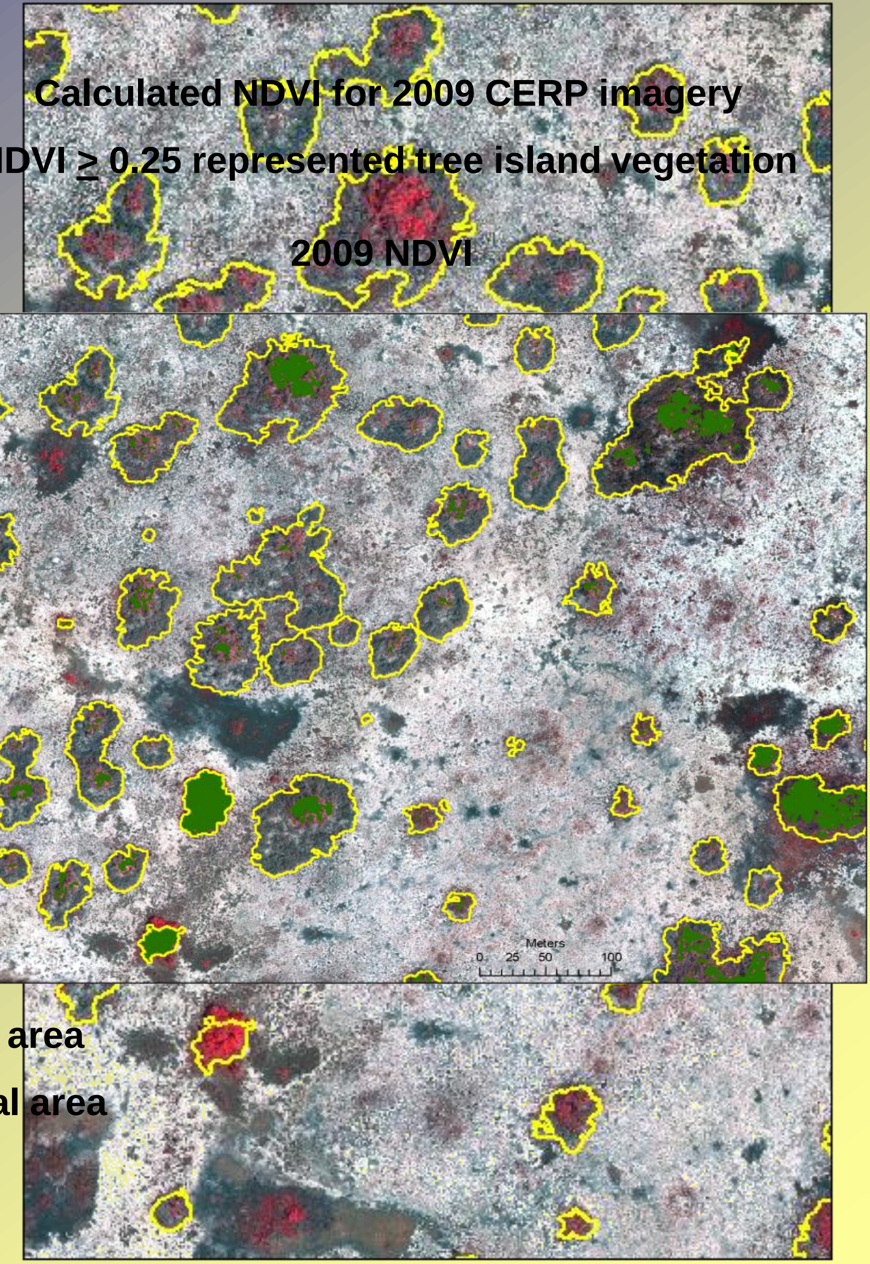


85.5%
11.6%
2.2%
0.4%
0.2%
0.1%
Smallest: 36 m² (mmu)
Largest: 63,827 m²
Mean (± 1 S.E.): 580.2 ± 16.5 m²
5000
500
50
5
Tree Island Frequency (#)
< 0.1
0.1 - 0.25
0.26 - 0.5
0.51 - 1.0
1.1 - 2.0
> 2.0
Tree Island Area Category (ha)

2004 Orthophoto: pre-fire



2009 CERP: post-fire



Calculated NDVI for 2009 CERP imagery

NDVI $\geq$ 0.25 represented tree island vegetation

2009 NDVI

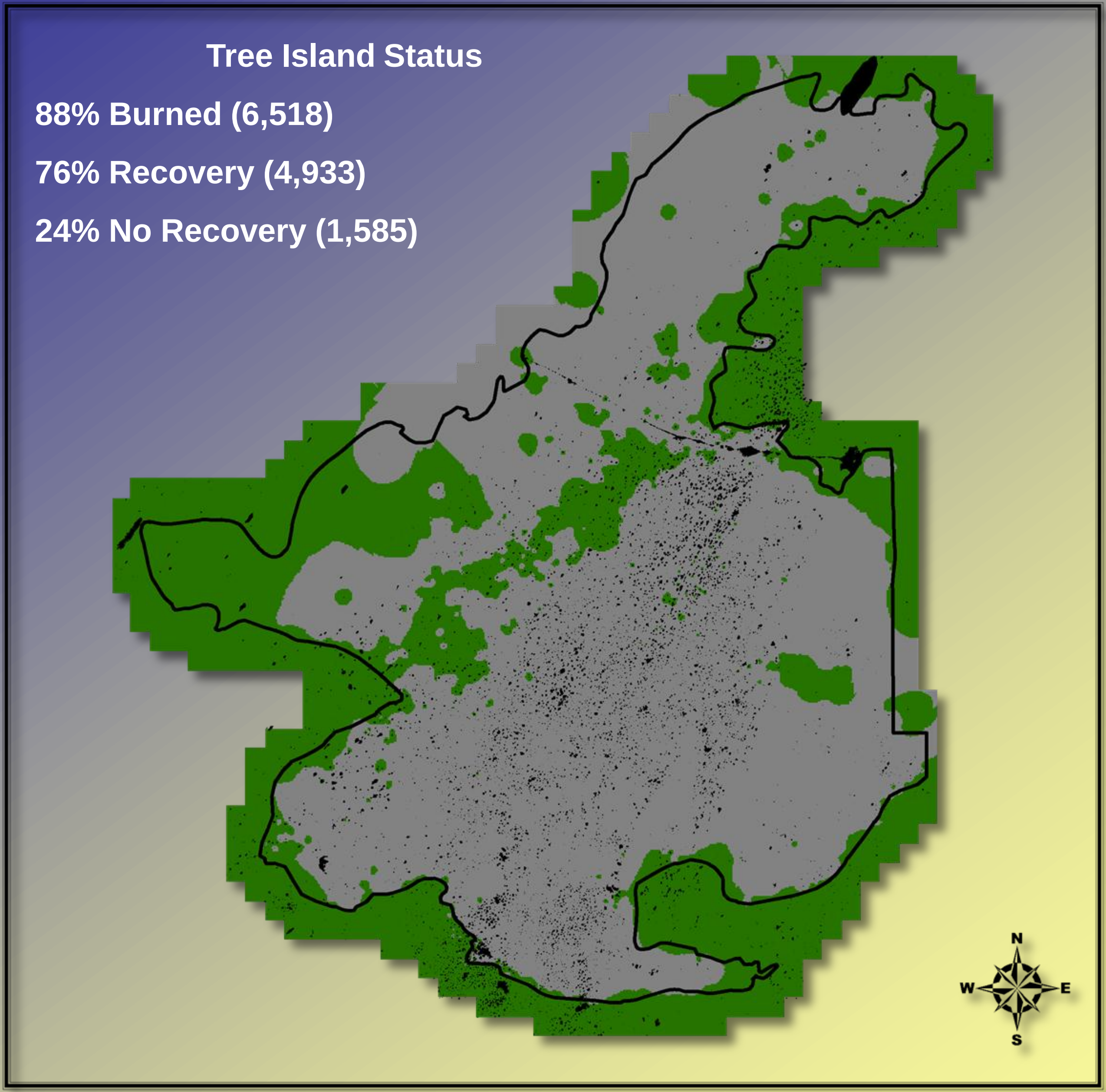
change in tree island area:

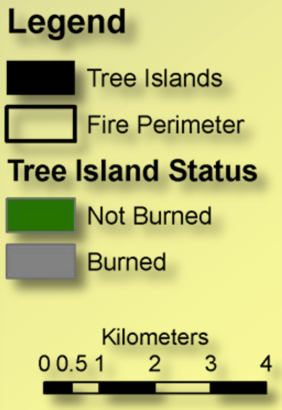
ΔTI Area = Area$_{NDVI04}$ – Area$_{NDVI09}$

Tree Island Burned Category:

- Not Burned: < 30% change in total area
- Burned: > 30% change in total area
  1) Burned with recovery: 30-99% change in total area
  2) Burned with no recovery: 100% change in total area

2009 Post-fire Tree Island Burn Status Map



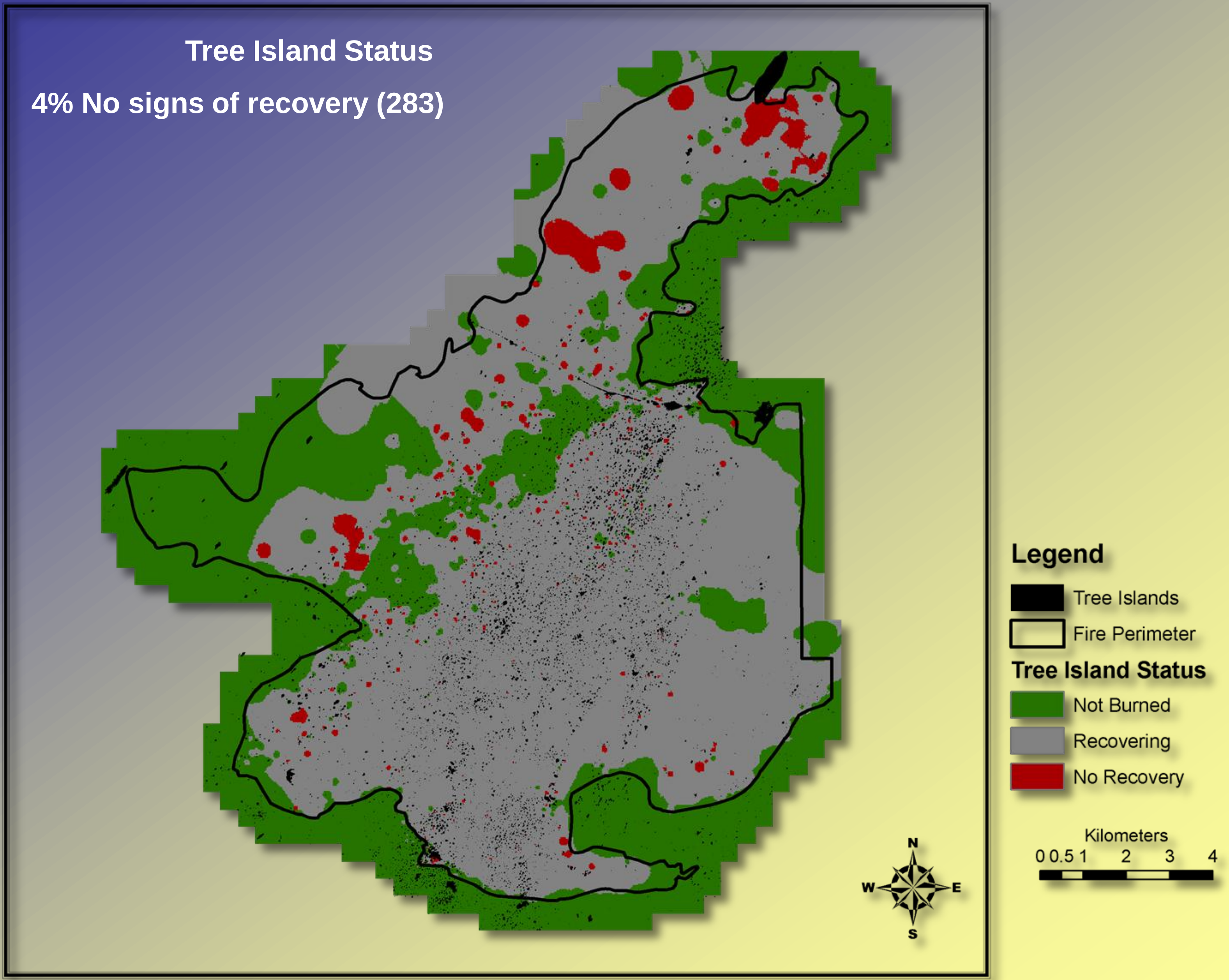


2011 Post-fire Tree Island Burn Status

1. **Exported the 2009 classified burned with no recovery tree islands to Google Earth (kml file).**
2. **Visually reclassified them into recovering or not recovering.**

Image Date: March 26, 2011

2011 Post-fire Tree Island Burn Status Map



Questions:

1. Why did some tree islands burn and yet others did not?

2. Why have some tree islands recovered while others have not?

We addressed these questions through the use of logistic regression.

1) To determine why some tree island initially burned and others did not we looked at the role of the water table at the time of fire, tree island size, and its shape (circularity ratio).

$$P(m) = 1 / (1 + e^{-(\beta_0 + \beta_1 WTable + \beta_2 Rc + \beta_3 TIa)})$$

2) To determine why some tree islands have not recovered we looked at the role of the post-fire marsh hydroperiod, tree island area and its shape (circularity ratio).

$$P(m) = 1 / (1 + e^{-(\beta_0 + \beta_1 TIa + \beta_2 HPeriod + \beta_3 Rc)})$$

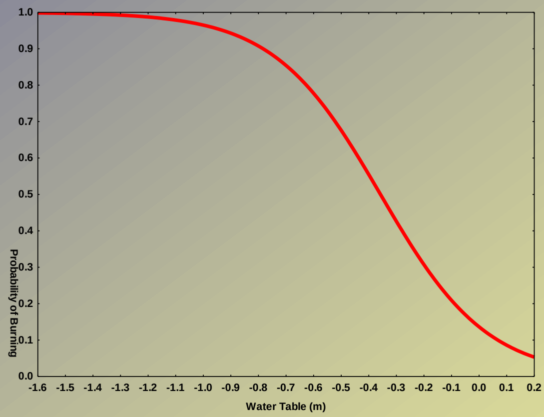
Jan 2009

Logistic Regression Results (2008): Not Burned vs Burned

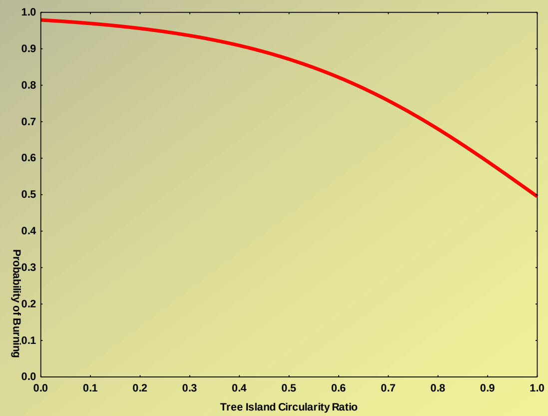
$$P(m) = 1 / (1 + e^{-(\beta_0 + \beta_1 WTable + \beta_2 Rc + \beta_3 TIa)})$$

Variable	Coefficient(ß)	S.E.	Wald Statistic	df	Significance	Exp(ß)
Intercept	2.019	0.423	22.753	1	< 0.001	7.527
Water Table (m)	-5.075	0.202	628.545	1	$\boxed{< 0.001}$	0.006
Circularity Ratio	-4.046	0.472	73.420	1	$\boxed{< 0.001}$	0.018
Tree Island Log(Area)	-0.395	0.048	66.753	1	$\boxed{< 0.001}$	0.674

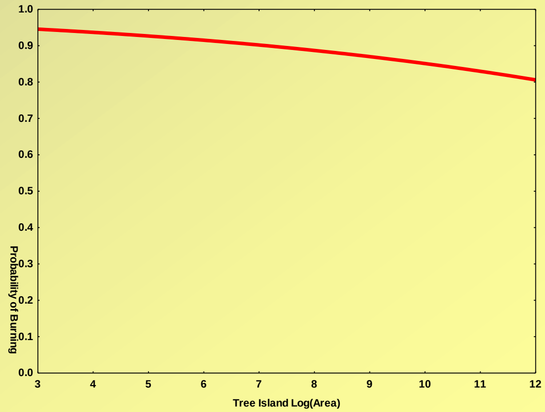
Probability of Burning



Water Table Depth (m)



Circularity Ratio

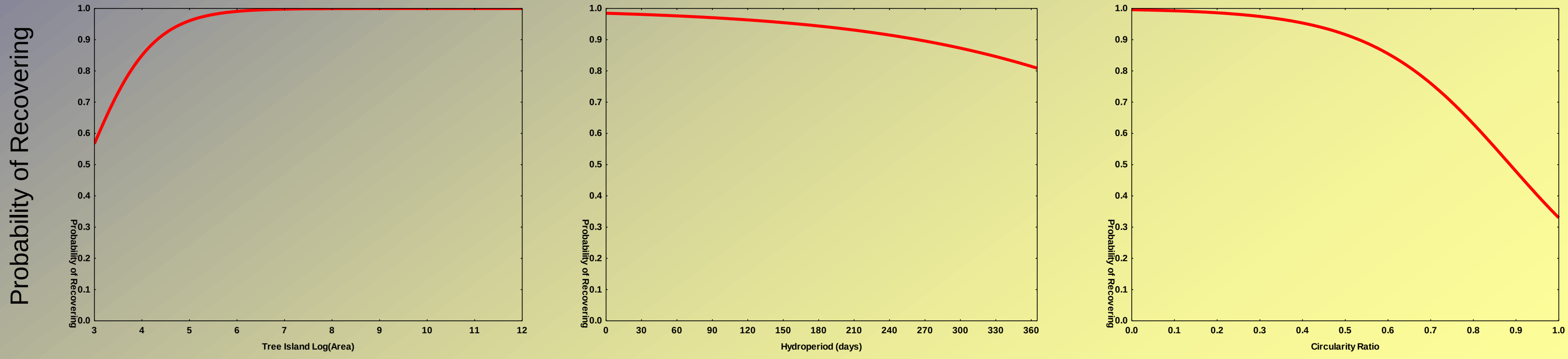


Area

Logistic Regression Results (2011): Not Recovering vs Recovering

$$P(m) = 1 / (1 + e^{-(\beta_0 + \beta_1 TIa + \beta_2 HPeriod + \beta_3 Rc)})$$

Variable	Coefficient(ß)	S.E.	Wald Statistic	df	Significance	Exp(ß)
Intercept	-2.041	0.575	12.576	1	< 0.001	0.130
Tree Island Log(Area)	1.379	0.096	207.492	1	< 0.001	3.969
Hydroperiod (Days)	-0.007	0.001	36.651	1	< 0.001	0.993
Circularity Ratio	-1.890	0.631	8.964	1	0.003	0.151



Area

Hydroperiod

Circularity Ratio

Conclusions:

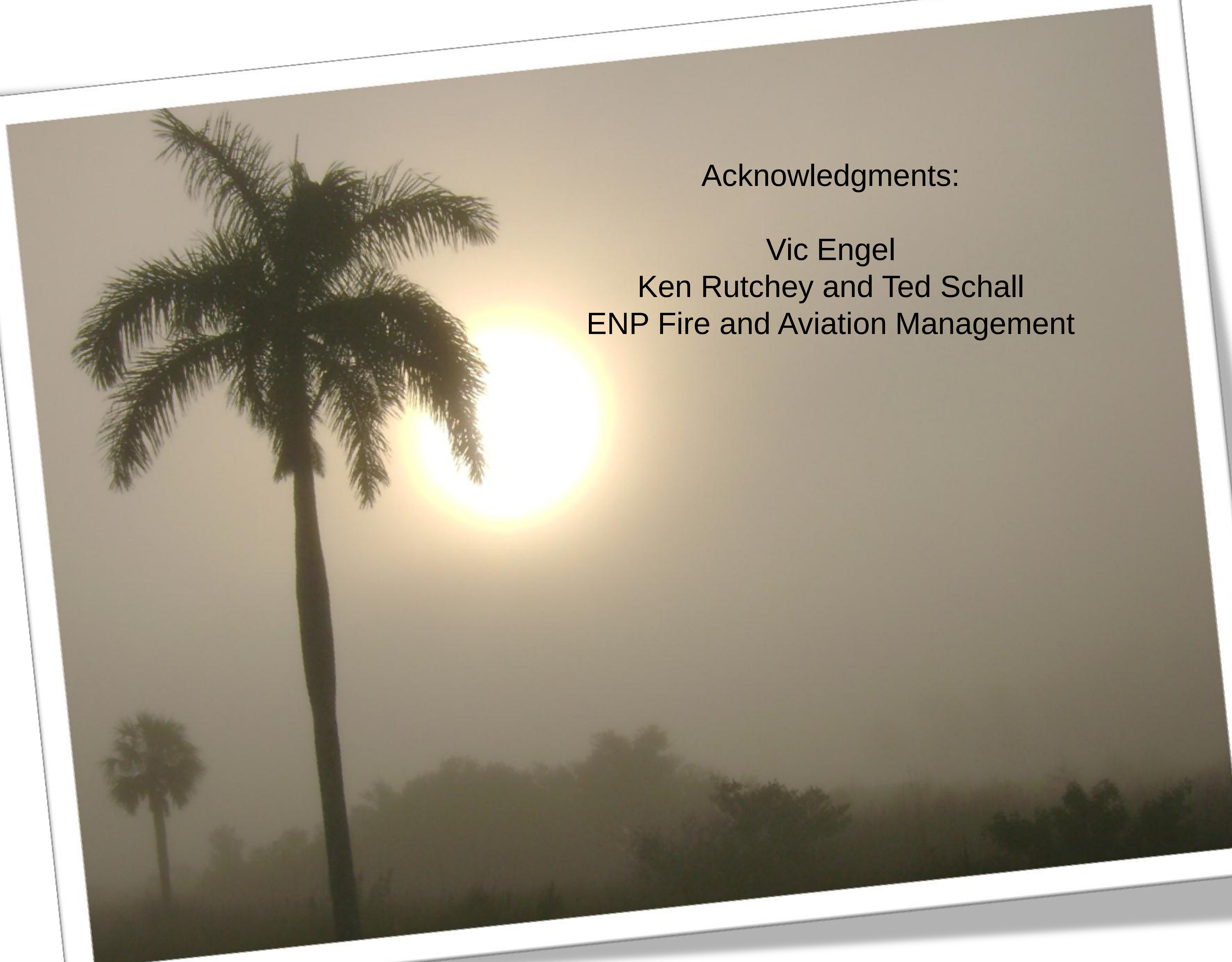
1. Tree islands within the short-hydroperiod marl prairies of the Everglades tend to be small but numerous and are a major component of the landscape.

2. Severe landscape fires can burn through these tree islands causing significant damage as well as possible tree island loss.

3. Post-fire tree island recovery appears to be slow and driven by herbaceous and early successional species, e.g., ferns (bracken fern), woody shrubs, and root sprouts.

4. Water table, tree island size, and hydroperiod are important parameters that determine the probability of a tree island burning and recovering from a fire.

Question: Are the many sparsely to non-vegetative rock outcrops scattered throughout the marl prairies relic tree islands (skeleton islands) resulting from repeated fires?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