WHAT CAN THE EVERGLADES LANDSCAPE EXPECT FROM CLIMATE CHANGE?

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SFWMD

Everglades is a Peatland

What this means:

Globally, peatlands form where precipitation exceeds evapotranspiration
When ET exceeds precipitation, peat does not form

- Peat forms in place by vegetation (sedentary process)
- Plants grow, leaves drop, begin to decay
- Decomposition governed by water levels, temperatures, ratio of labile vs. refractory material
- Inundation slows decay (anaerobic conditions, cooler temperatures, different microbial communities)
- Organic material accumulates, gradually loses structure and compacts (bulk density increases)
- When plant production exceeds peat decomposition, peat accumulates

When peat dries, oxidation and mineralization occurs, C as CO_2 emitted

Climate Change Scenarios

∆ ET & ∆ PPT

Temperature rise expected, affects ET in these simulations

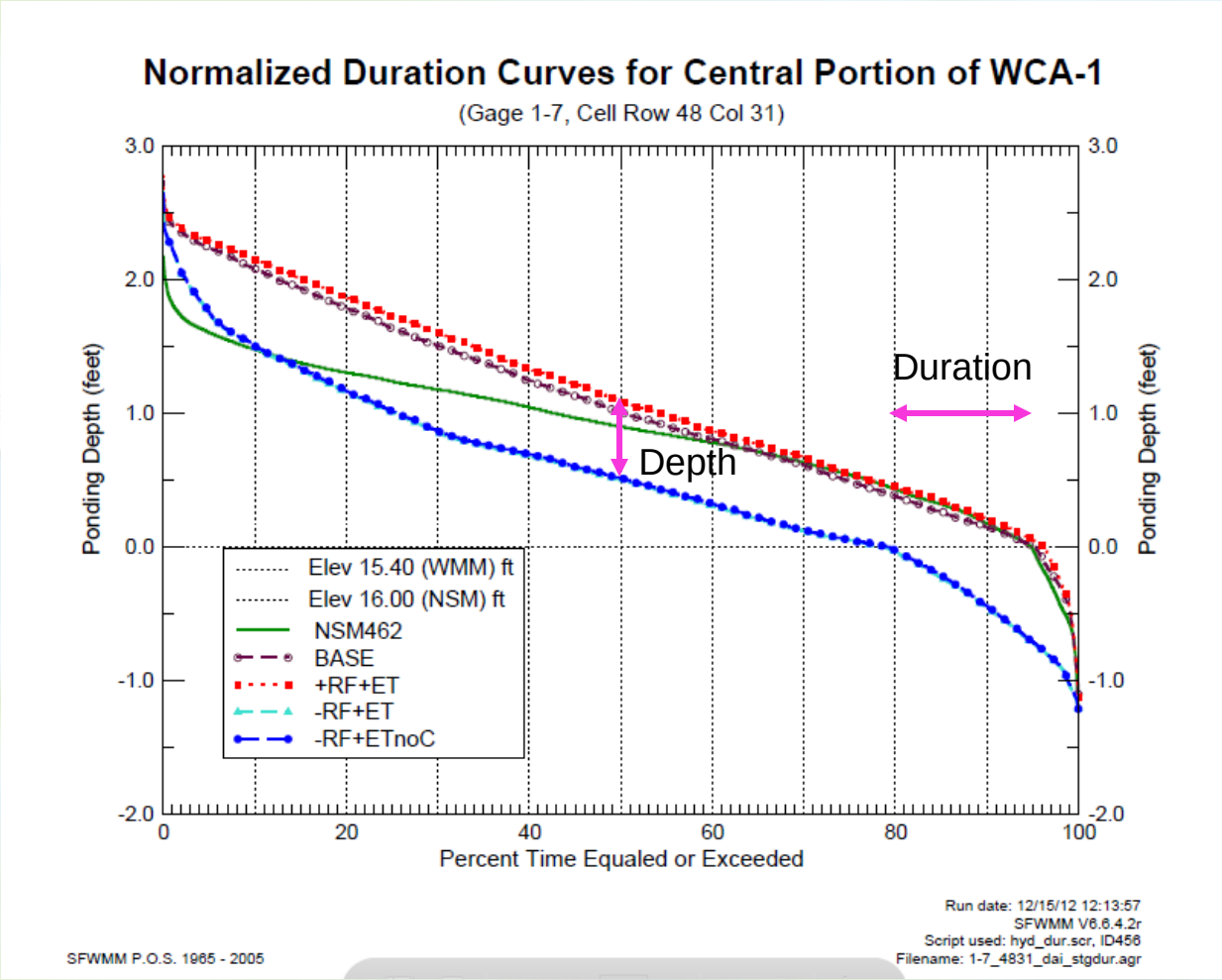
1.5 degrees C ~ 7% increase in ET
Precipitation must increase 7% to keep up
Forecasts suggest ± 10% precipitation changes

Only 7-10% increase in rainfall will allow Everglades to remain peatland, existing condition or better hydrated

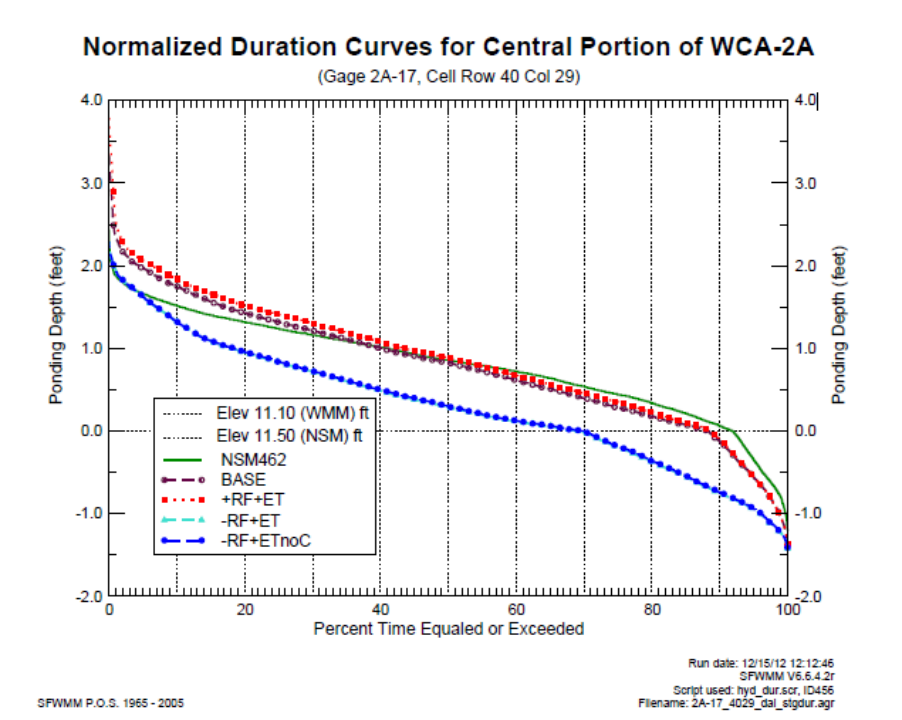
If -10% to +6% rainfall change, then ET>PPT and peatlands will degrade because of climate change

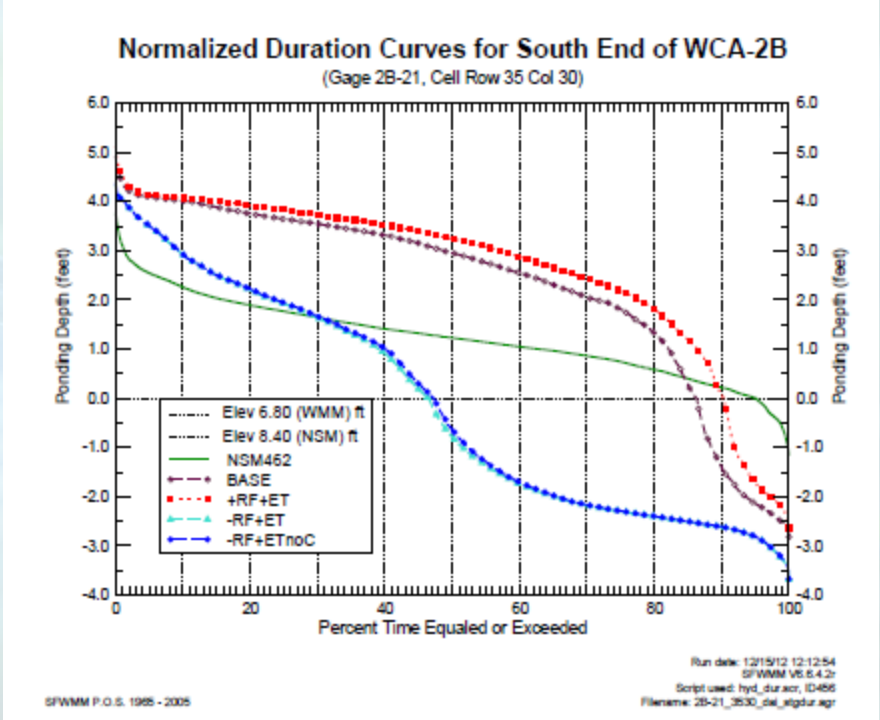
Focus on worst case scenario: elevated ET and decreased rainfall

Depth-duration hydrographs

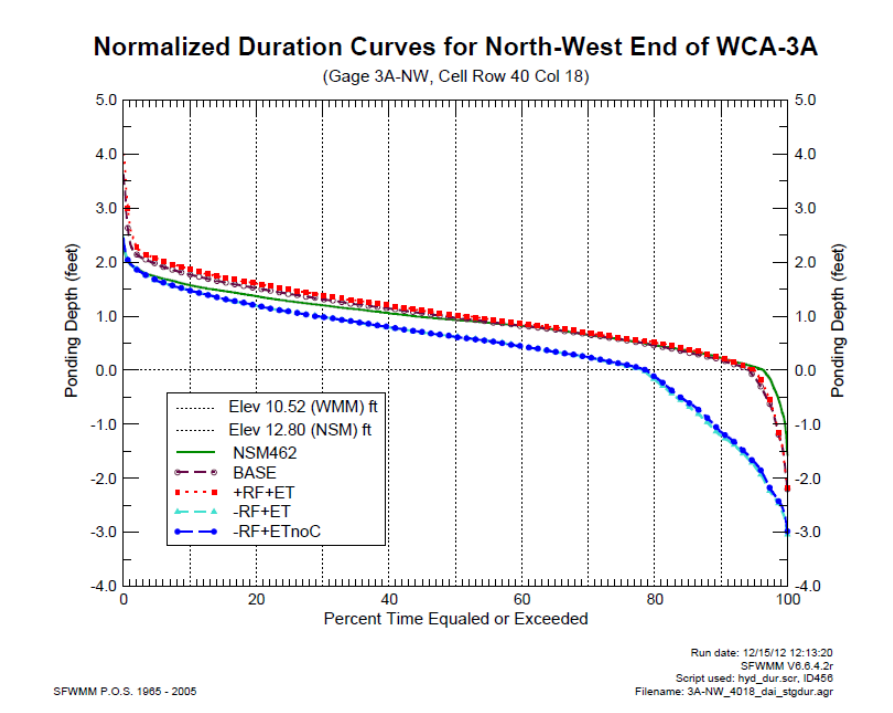


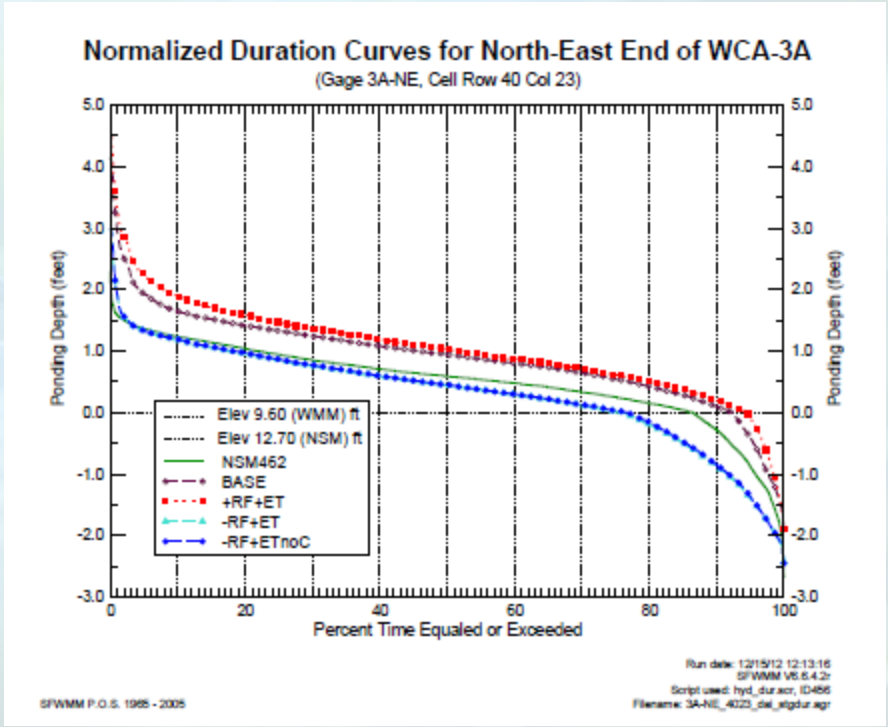
WCA-2


Normalized Duration Curves for Central Portion of WCA-2A
(Gage 2A-17, Cell Row 40 Col 29)
Ponding Depth (feet)
Percent Time Equaled or Exceeded
Elev 11.10 (WMM) ft
Elev 11.50 (NSM) ft
NSM462
BASE
+RF+ET
-RF+ET
-RF+ETnoC
SFWMM P.O.S. 1965 - 2005

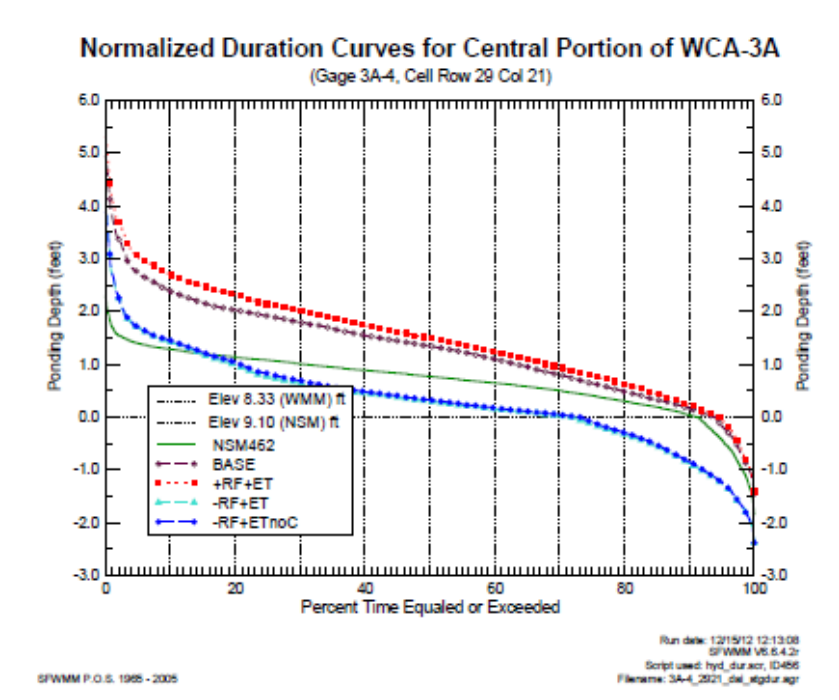

Normalized Duration Curves for South End of WCA-2B
(Gage 2B-21, Cell Row 35 Col 30)
Ponding Depth (feet)
Percent Time Equaled or Exceeded
Elev 6.80 (WMM) ft
Elev 8.40 (NSM) ft
NSM462
BASE
+RF+ET
-RF+ET
-RF+ETnoC
SFWMM P.O.S. 1965 - 2005

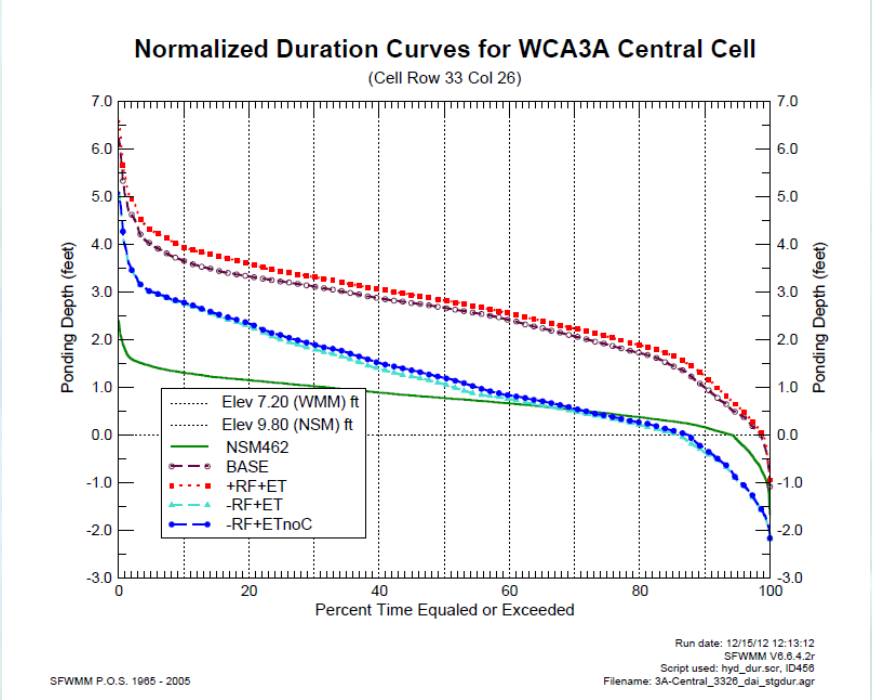
Northern WCA-3A



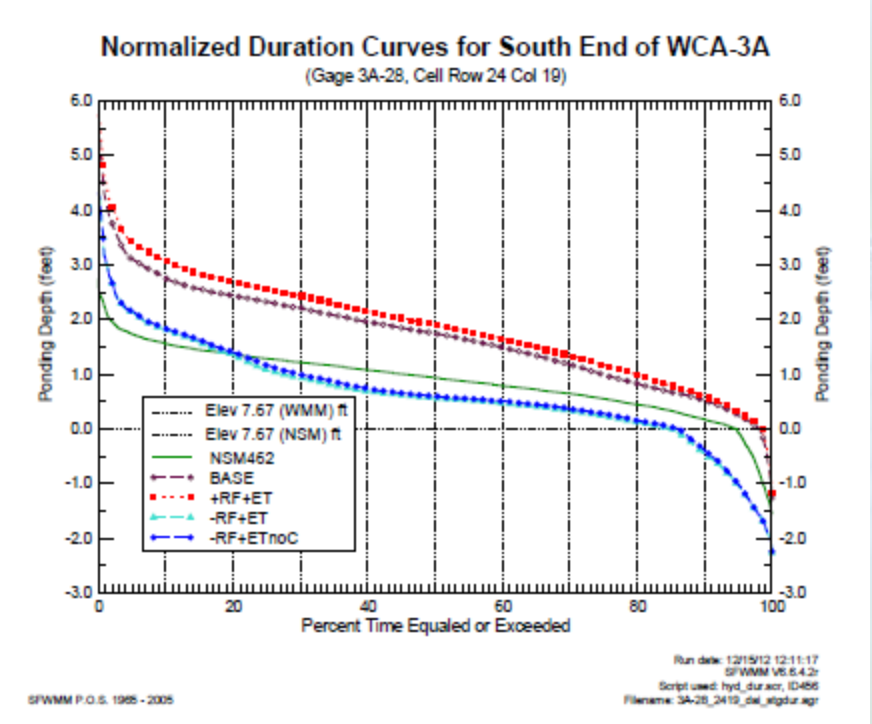


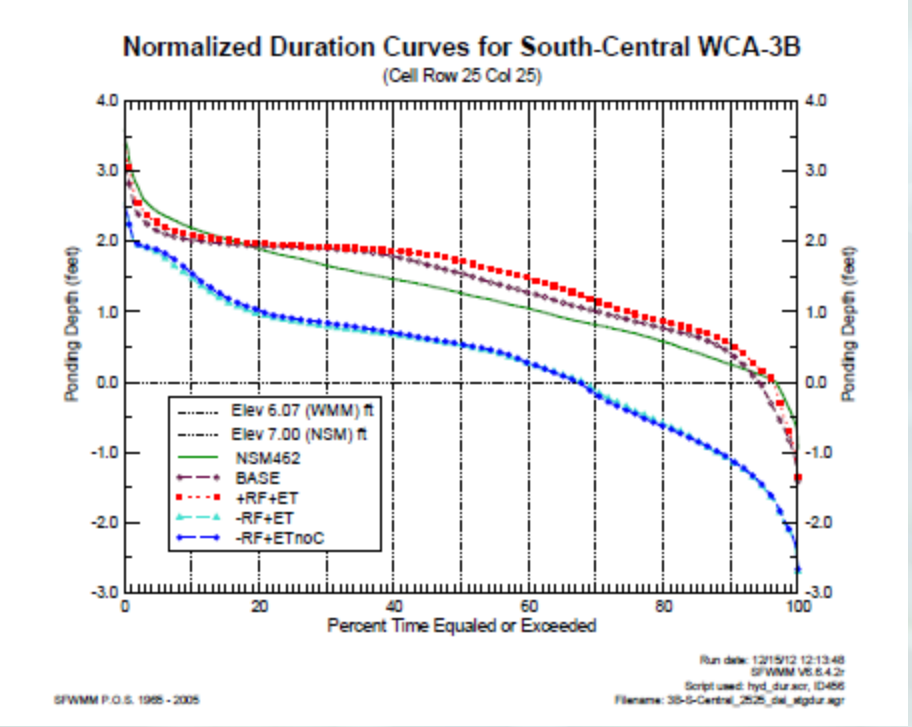
Central WCA-3A



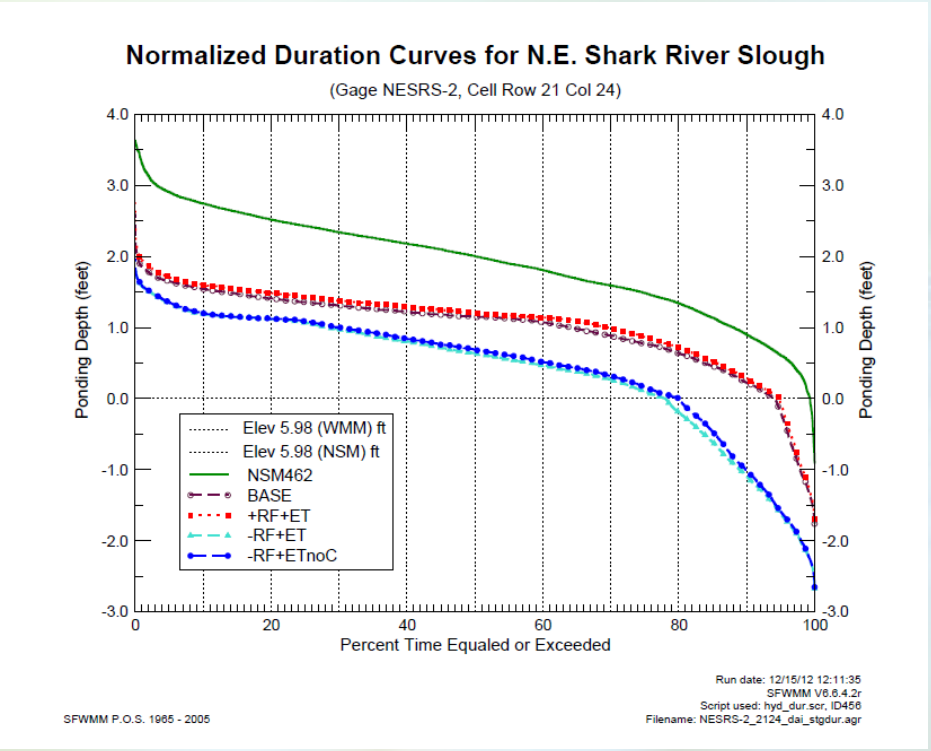


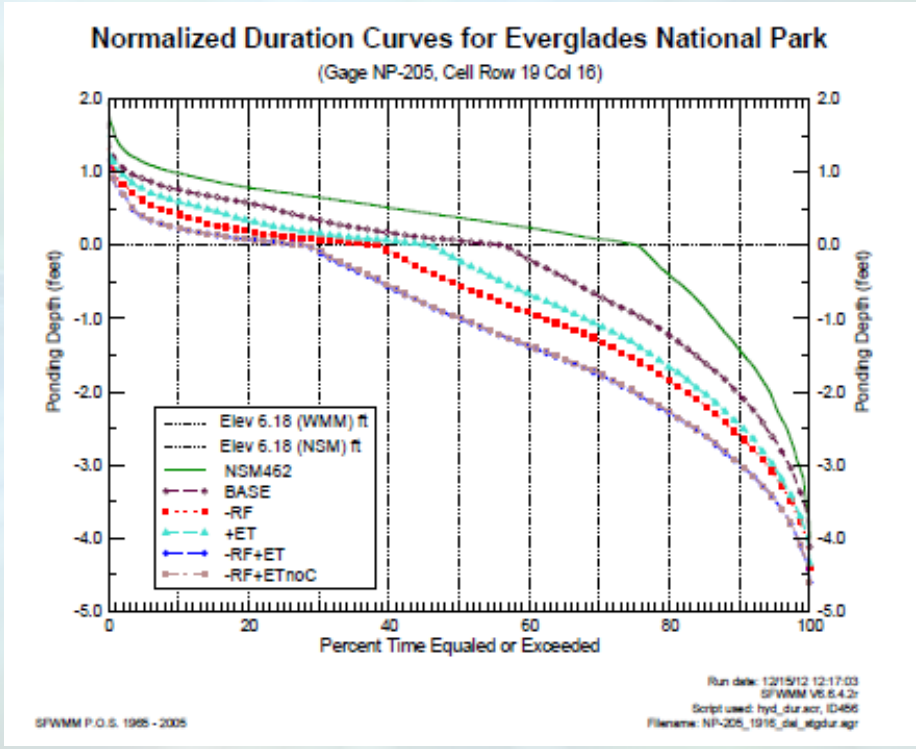
Southern WCA-3A, -3B



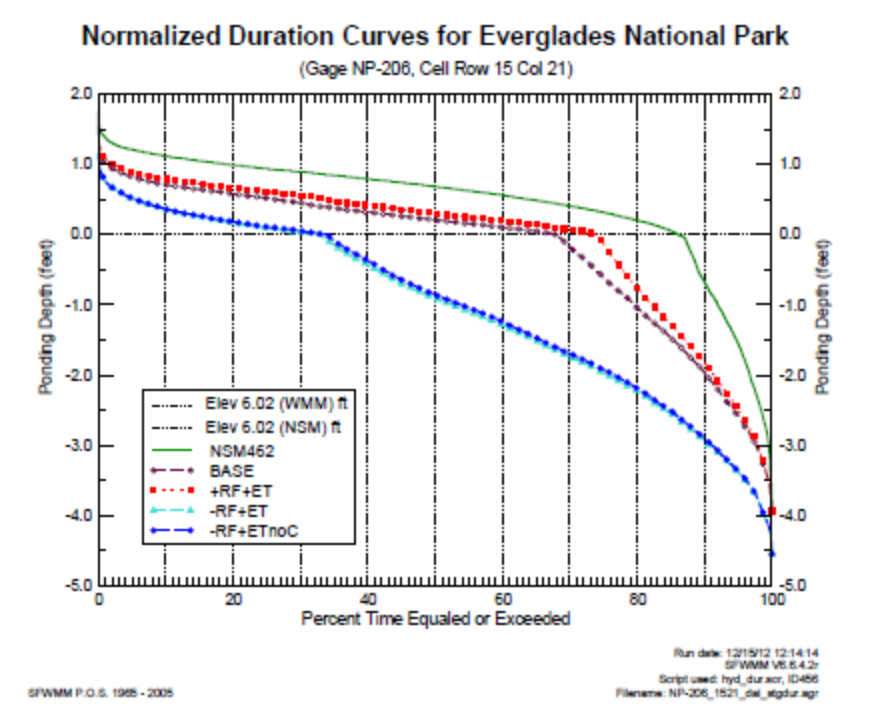


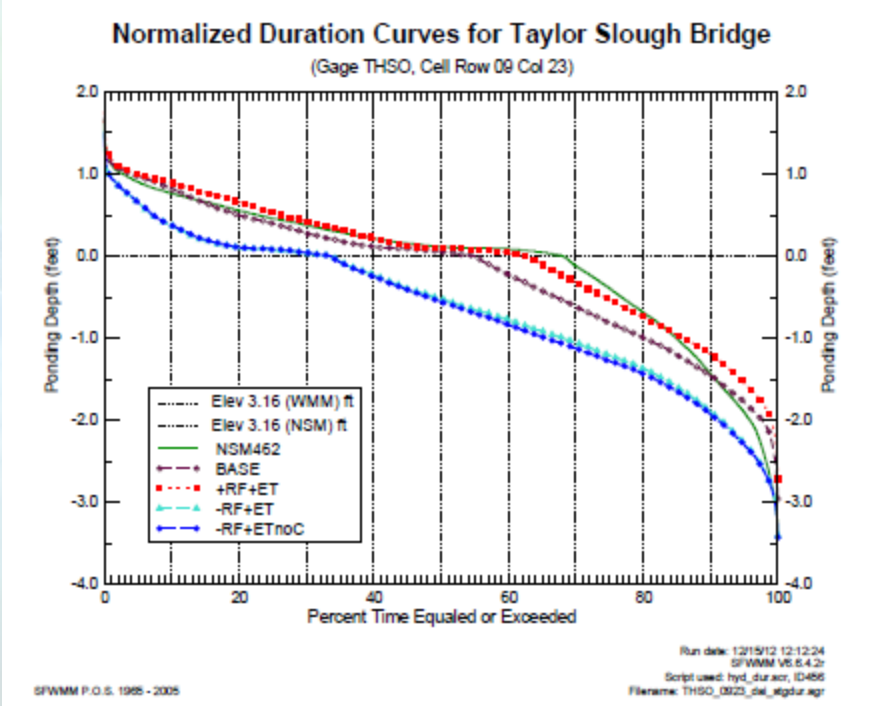
Everglades National Park





Southern ENP and Taylor Slough Bridge

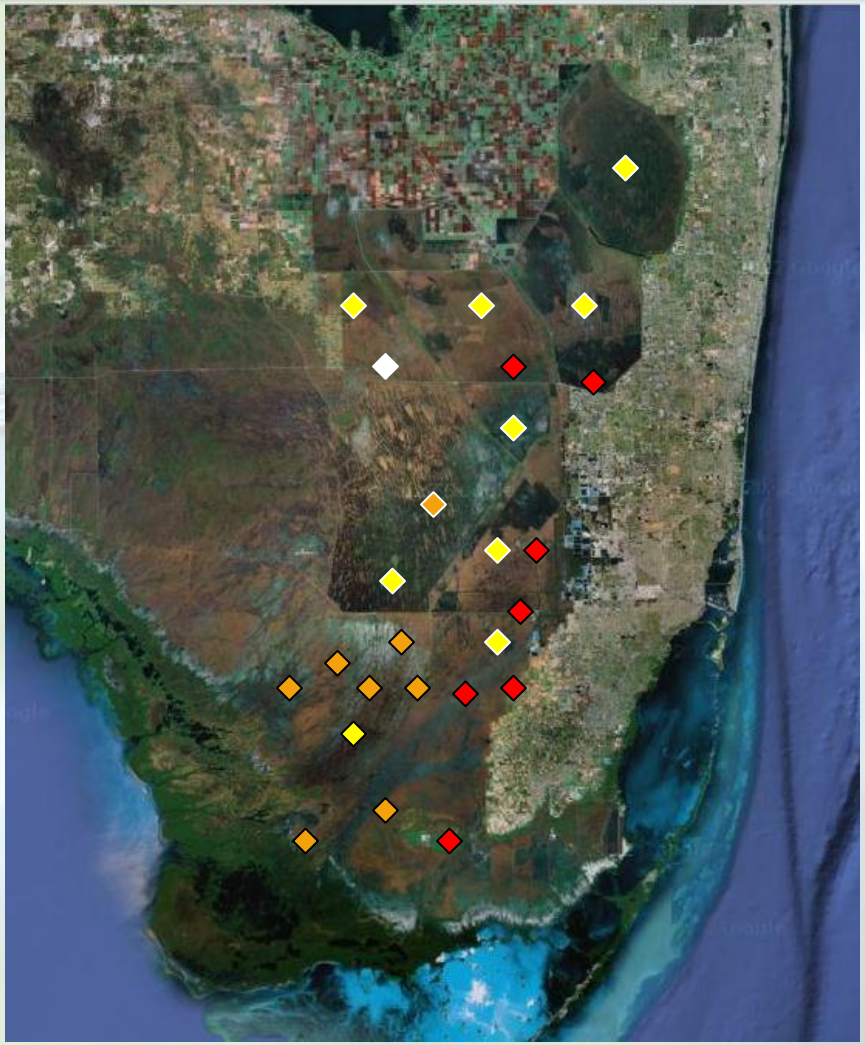




Reduction of time as surface water

% time below ground
Increase

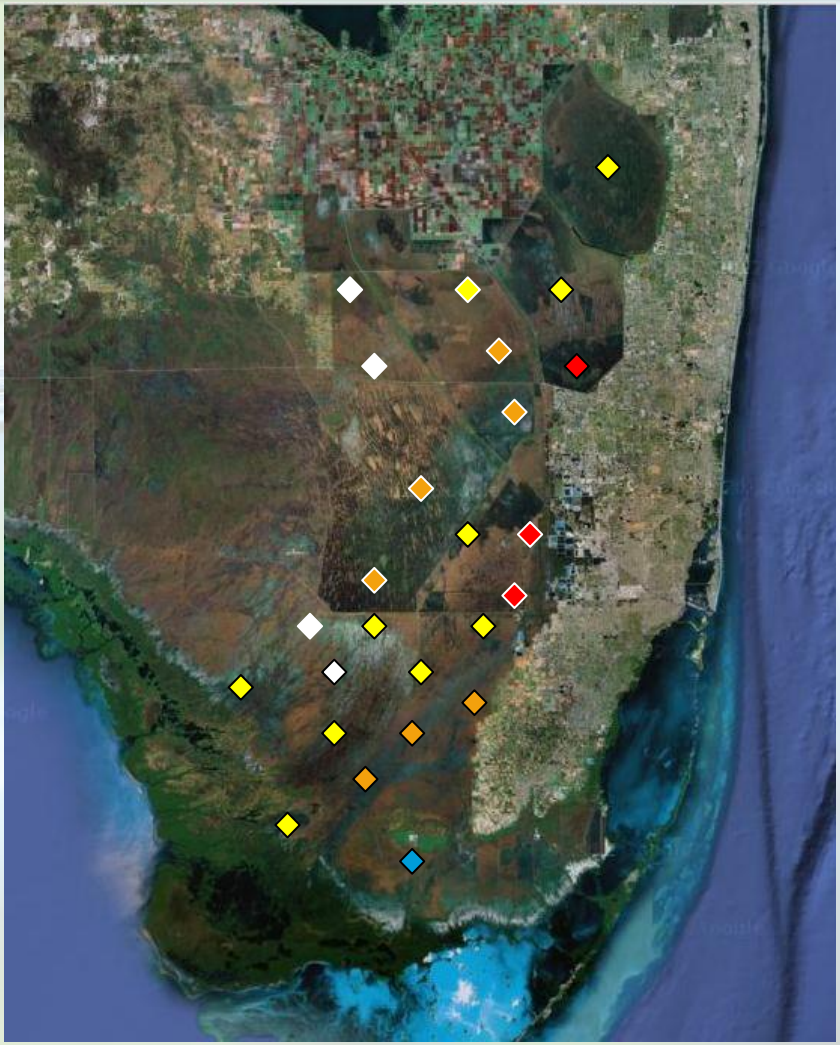
- 30-50%
- 20-30%
- 10-20%
- 0-10%



Decrease in depths

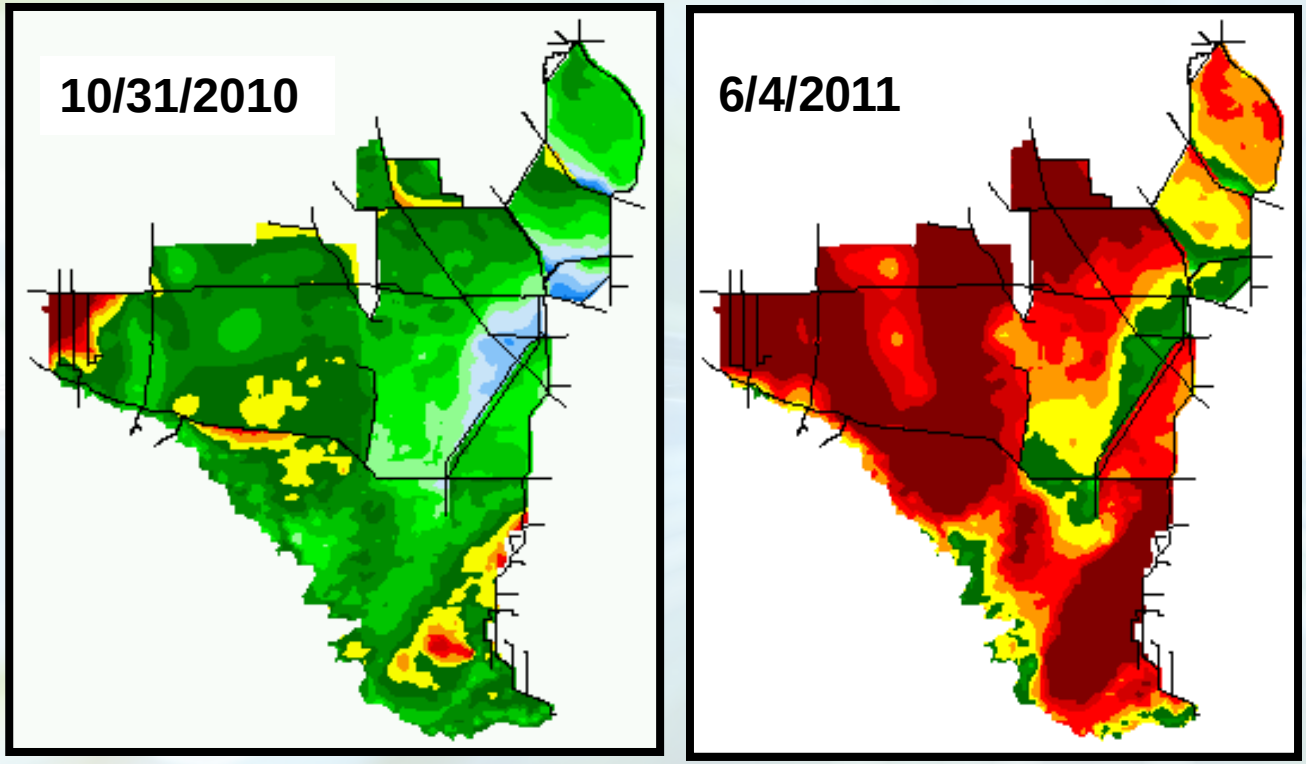
Stage reduction at 50% line (feet)

- 2.0-3.0+
- 1.0-2.0
- 0.5-1.0
- 0-0.5
- 0-+0.5



RECENT DROUGHT IN THE EVERGLADES

Drought—Spring 2011

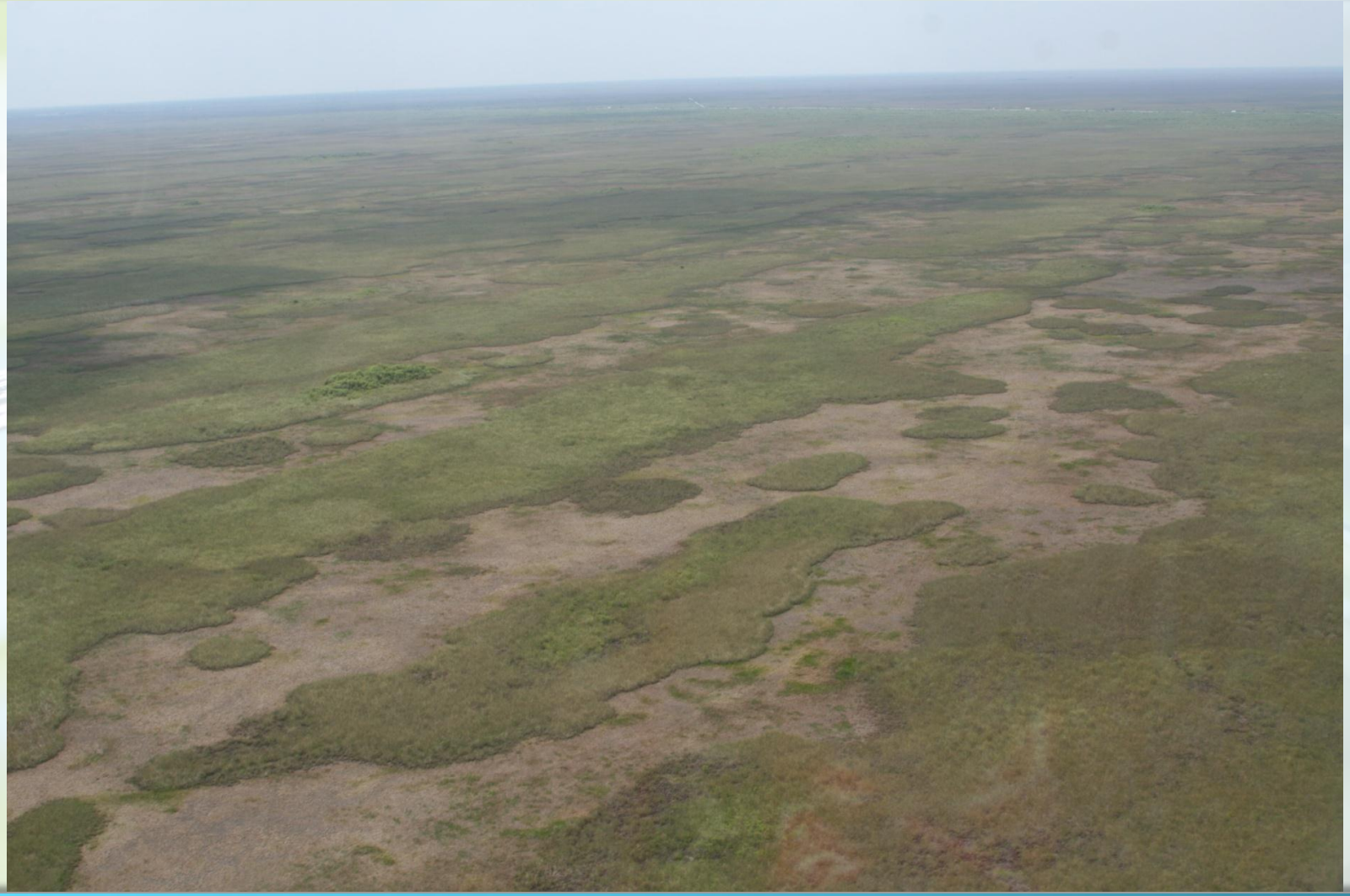


Source: SFWDAT maps, SFWMD

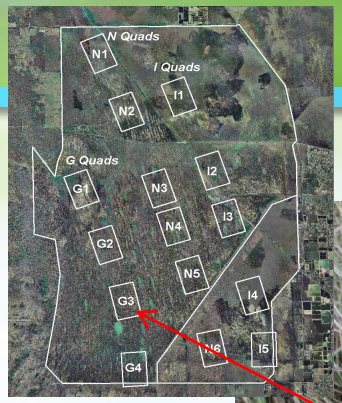
WCA-1

WCA-2A hunting camp

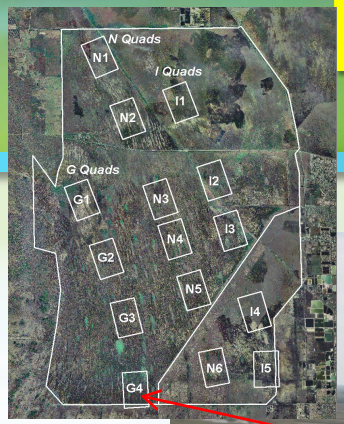
Central WCA-3A



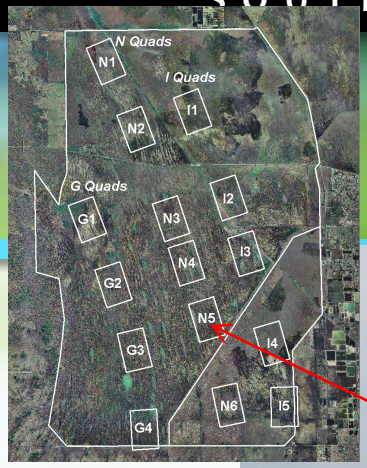
Southern WCA-3A slough



Far southern WCA-3A



Along L-67 canal



"Prairie" fire, June 2011, WCA-3B

68,300 acres
(107 sq. mi.)

DETERMINING POTENTIAL FOR WILDFIRE IN EVERGLADES

Prairie Fire Aftermath

Fire Vulnerability of Everglades Peat

- Flammability relative to peat properties across WCA-3A
- Sampled at 5 sites in June 2011 (drought)
- Peat cores up to 30 cm taken at each site except NW 3A
- Measured bulk density, ash content, moisture content (field and saturation) in cores

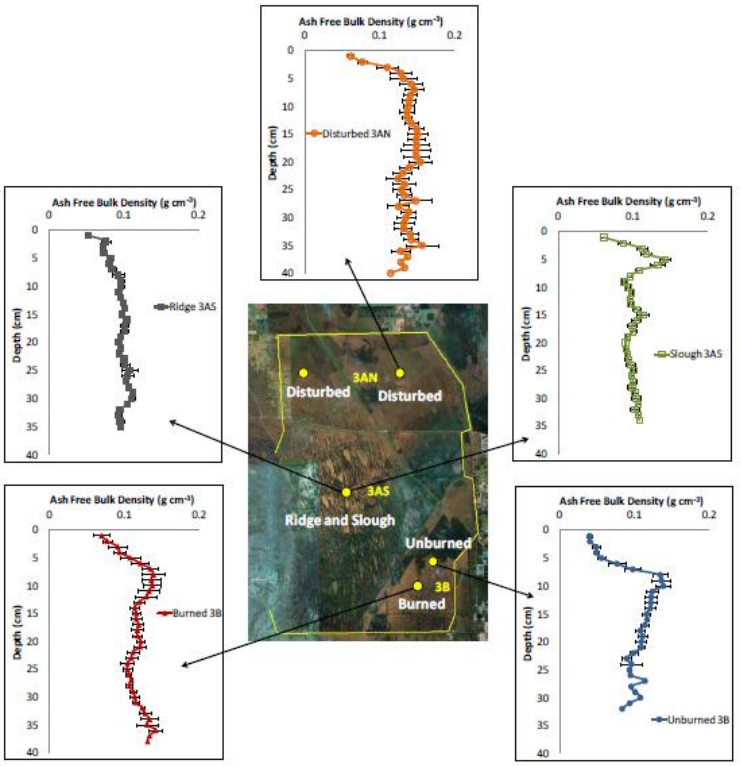


Figure A1.2 Mean ash free bulk density (g cm^{-3}; ± s.e.) with depth from full length cores (n=5) collected at the field sites. Points without error bars are represented by only one sample.

James Johnson's thesis 2013

Fire Vulnerability of Everglades Peat

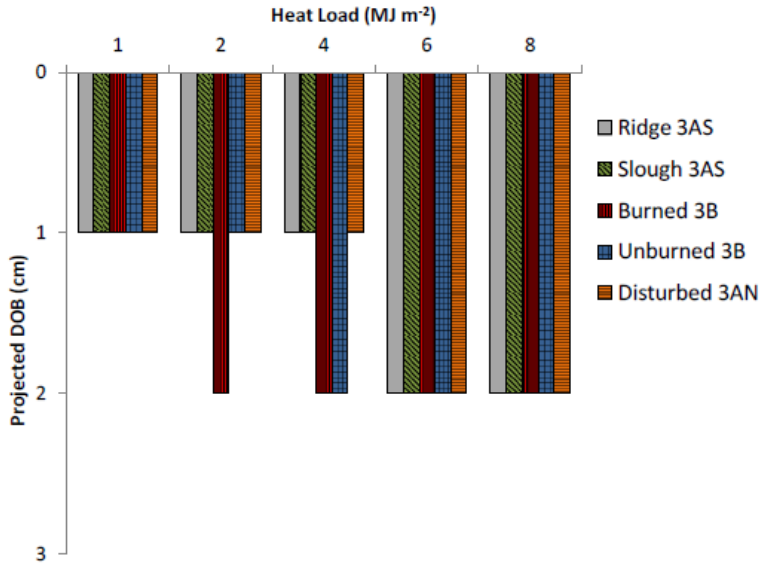


Figure 3.3 Projected depth of burn for the field sites of WCA 3 (n=5).

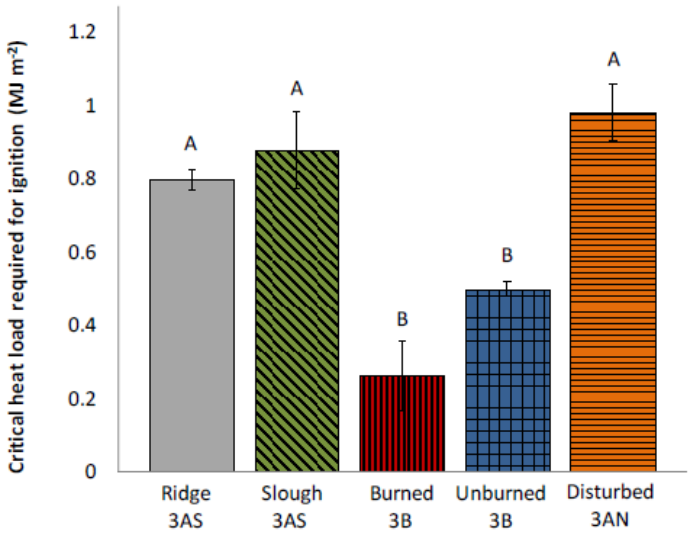
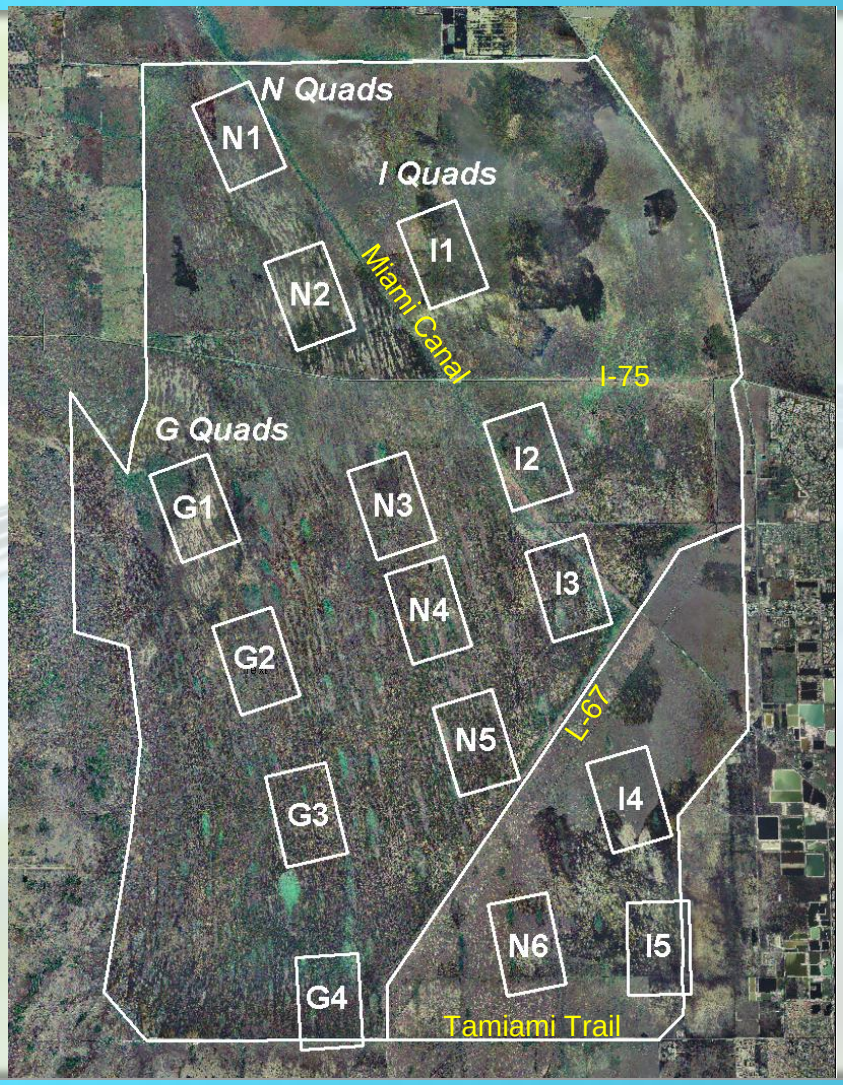


Figure 3.4 Projected critical cumulative heat load required for ignition ($H'_{ign(i)}$) (±s.e.) of the surface peat (top 3 cm) from the full length cores of the field sites (n=5). Sites with the same letters are statistically the same based on Tukey's *a-posteriori* comparisons.

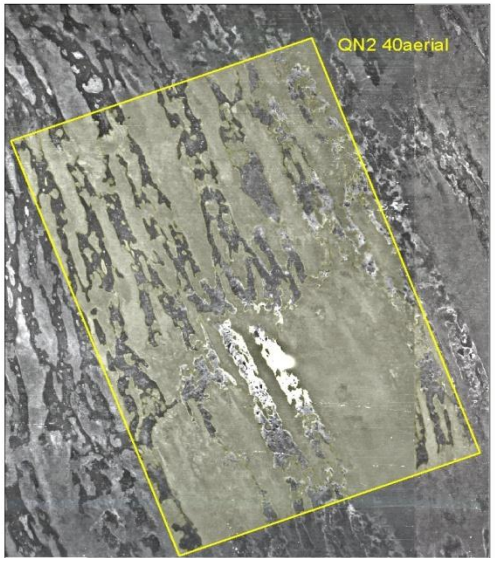
Lower organic material and dryer conditions have similar flammability as higher organic material and wetter conditions: similar potential for wildfire across landscape

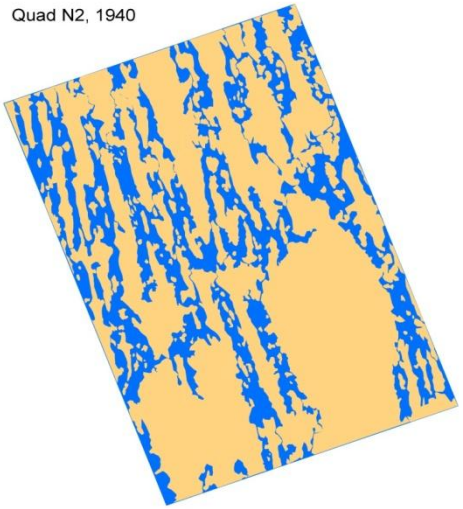
RECENT HISTORIC LANDSCAPE CHANGES 1940-2004

Historic Landscape Changes



Georectified photos from 1940, 1953, 1972, 1984, 2004. Overlaid plots on photos, digitized all ridges and tree islands.





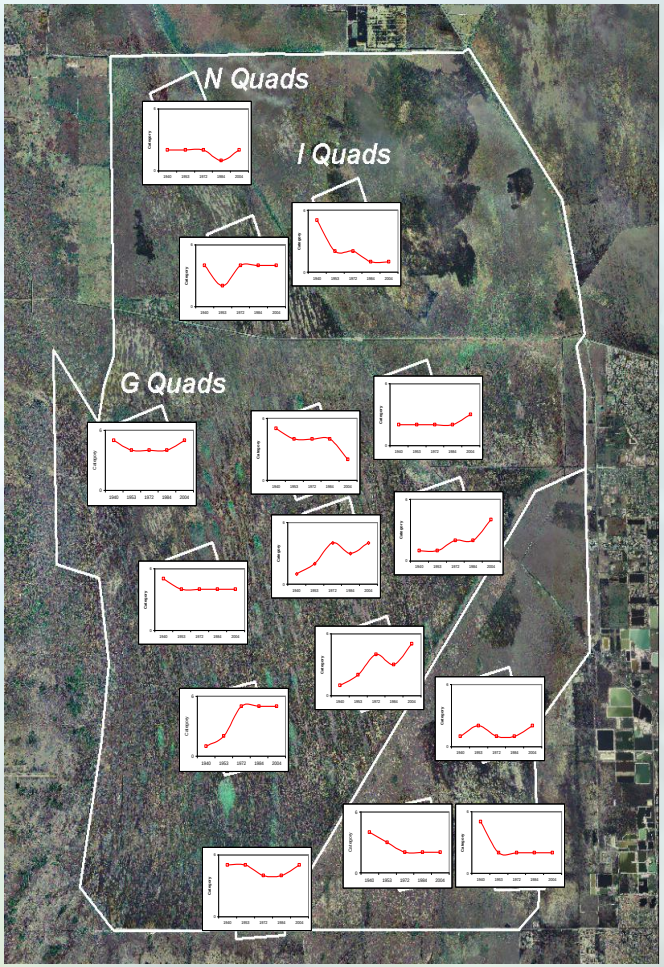
Nungesser 2011

Pattern Changes from 1940-2004

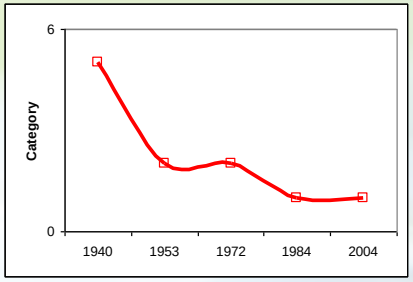
Pattern metrics of
- N > 300 m
- LW
- PA
- PAN
- LeWN

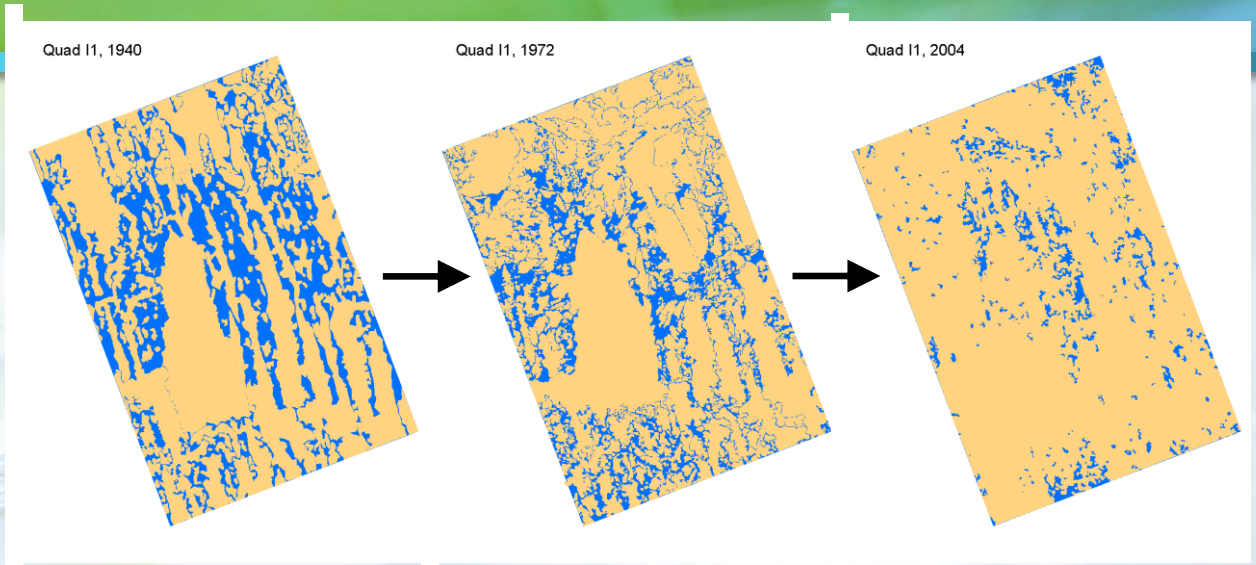
Hierarchical clustering
Nonmetric Multidimensional Scaling

Temporal trajectories of pattern quality (strong=high values to degraded=low values)

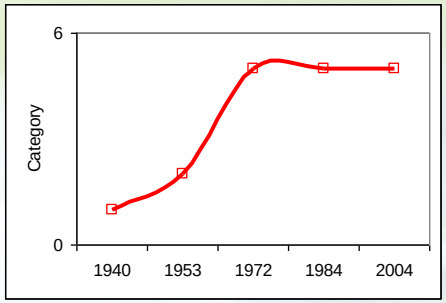


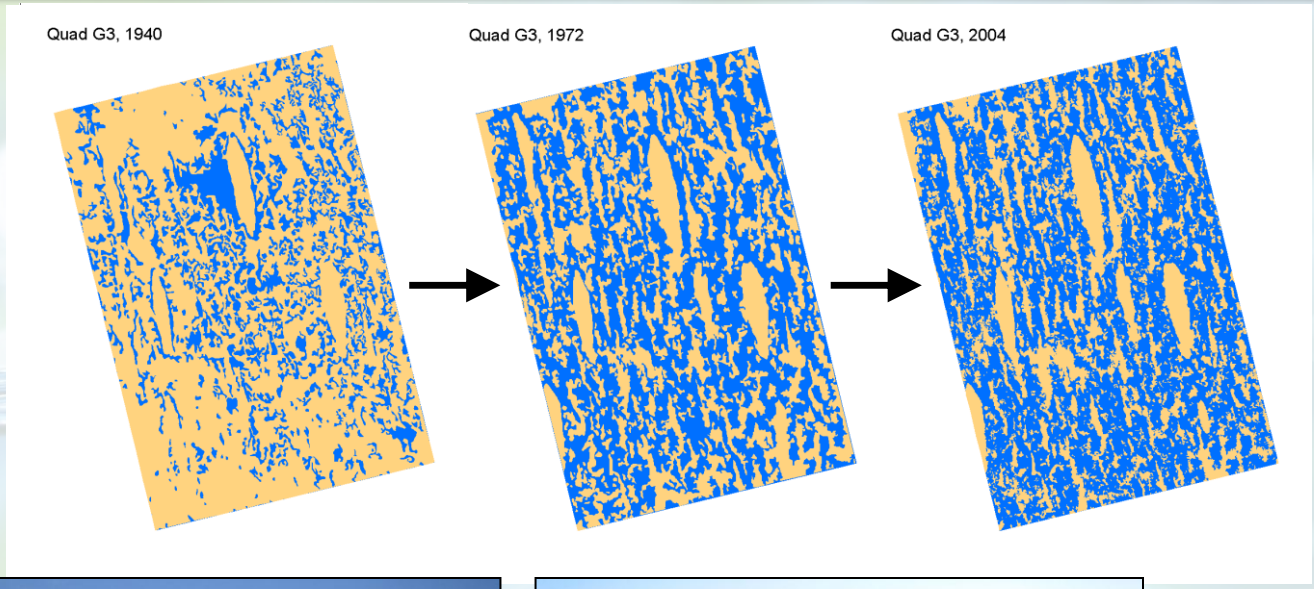
Study plot in northern WCA-3A





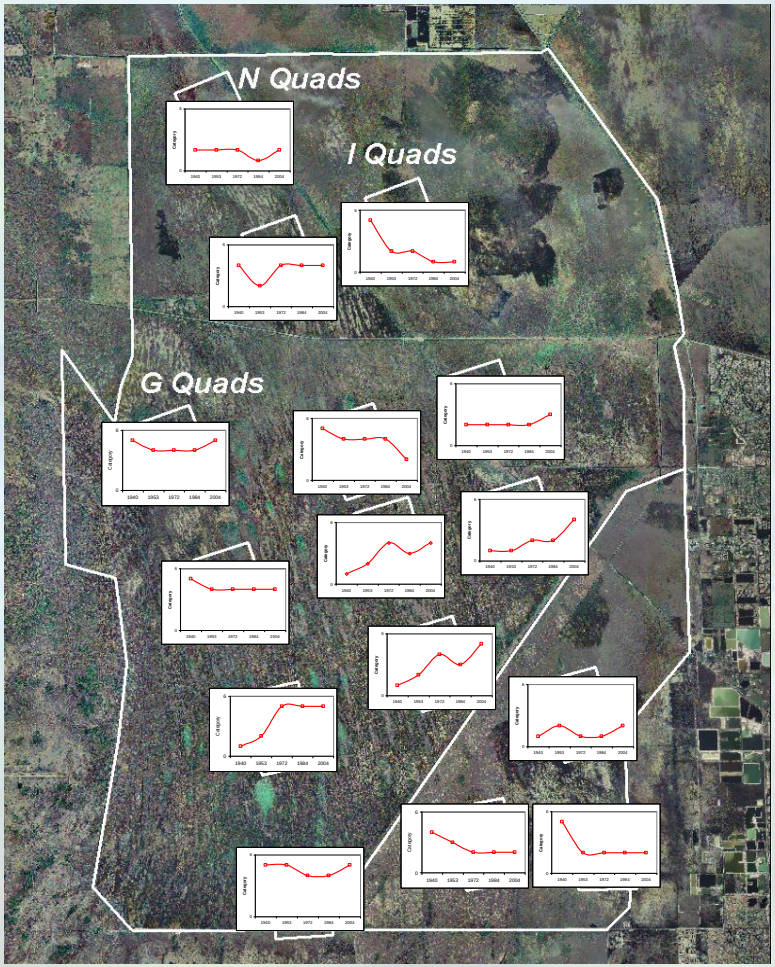
Study plot in southern WCA-3A





Historic Pattern Changes

- General Observations:
- Trajectories vary temporally and spatially
- Patterns were dynamic
- Dry conditions degrade patterns



EVERGLADES PEAT LOSS

Peat loss in Everglades

1930

1990

In this 1951 photo Dr. Victor Green shows 25 years of subsidence at the Everglades Experiment Station.

Peat loss since pre-drainage period

- Peat loss from 1875 to 2005 in EAA, WCAs, ENP based on original depths to present
- Estimated total loss of C as CO2: 3.5 billion tons since 1875
- Temporal/spatial history unknown
- Annual average of 27 million tons CO2
- Transportation sector emits 30 million tons CO2 annually in S. Fl. (Regional Compact GHG Inventory Working Group 2011)

Source	m^3 of Peat volume lost (ft^3)	WCAs: Grams lost per square meter per hour (using data from Snyder, 1994 for bulk density and carbon content)	Total Metric tons of CO_2 lost (using data from Snyder, 1994 for bulk density and carbon content)	Average Subsidence in m (ft) from the m^3 of Peat volume lost and the area of the region.
WCA-1	2.2×10^8 (7.9×10^9)	0.18 (1.5)	1.1×10^8	0.4 (1.3)
WCA-2A	2.1×10^8 (7.7×10^9)	0.23(2.0)	1.1×10^8	0.5 (1.7)
WCA-2B	1.1×10^8 (3.6×10^9)	0.41(3.5)	4.9×10^7	0.9 (3.0)
WCA-3A	1.3×10^9 (4.6×10^{10})	0.30 (2.6)	6.2×10^8	0.6 (2.1)
WCA-3B	2.5×10^8 (4.4×10^8)	0.30 (2.6)	1.2×10^8	0.6 (2.2)
ENP	1.2×10^8 (4.4×10^9)	0.02 (0.2)	6.1×10^7	0.01 (0.1)
EAA	4.9×10^9 (1.7×10^{11})	0.9 (7.8)	2.3×10^9	1.7 (5.5)

Aich and Dreschel 2011

PALEOECOLOGY

CONCLUSIONS

Climate change scenarios suggest increased ET and -10% rainfall:
- Water levels decrease -0.5 to -3.0+ feet
- Duration of surface water decreases by 10-50% across Everglades

Drought will lead to:
- Reduced peat production
- Increased loss of peat
- Increasing rate of peat loss
- Increased risk of fire
- Major shifts in plant (and animal) communities
- Catastrophic loss of peat from lack of water

Climate change can lead to massive disruption of habitat
Major impacts to soils, vegetation, fish, wildlife, invasive species