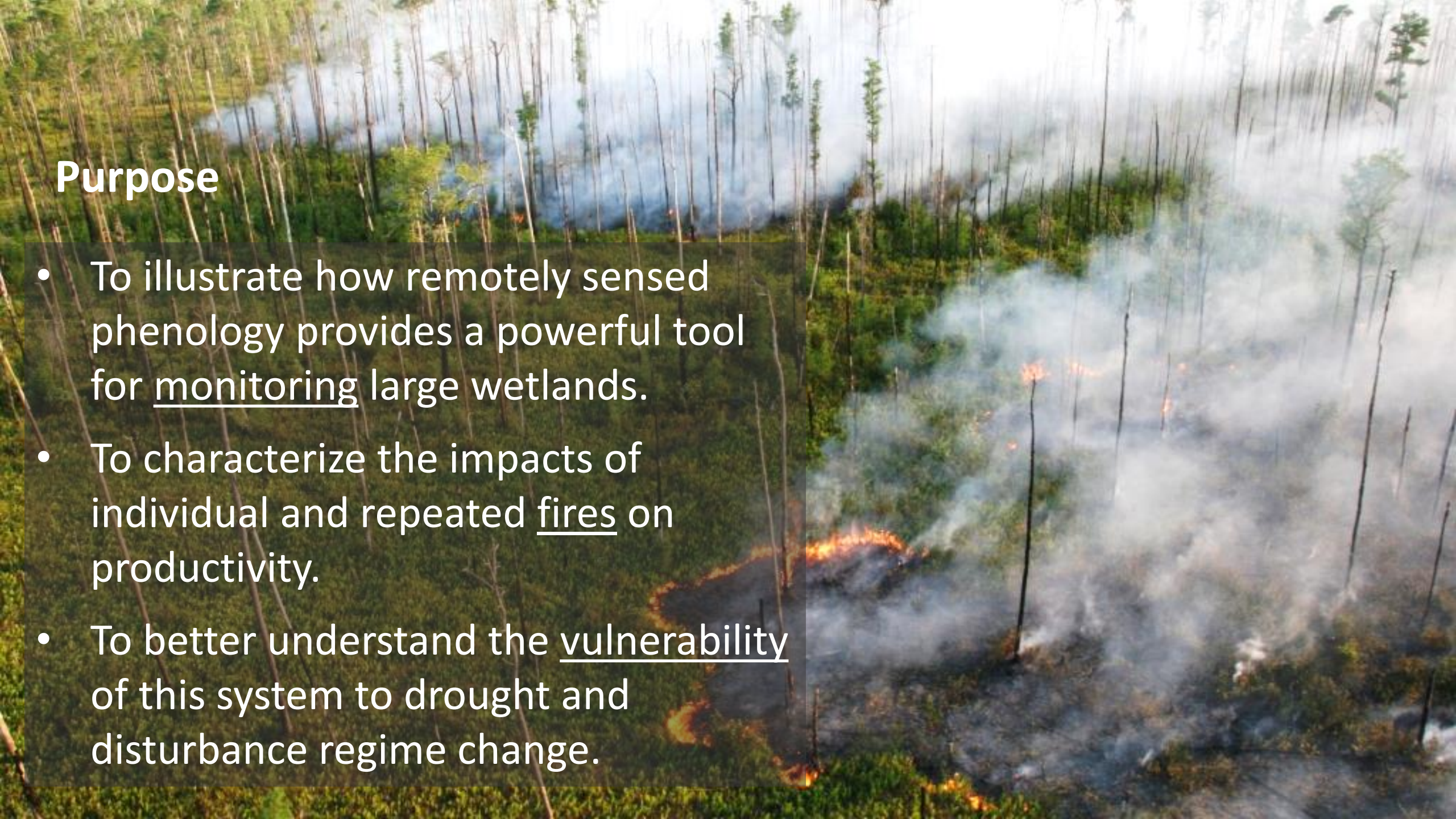
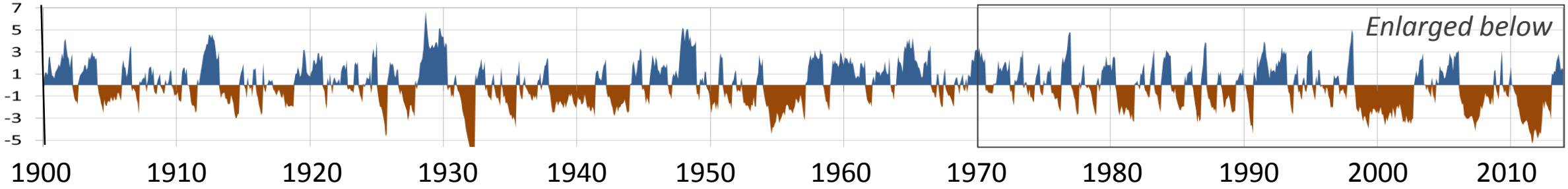
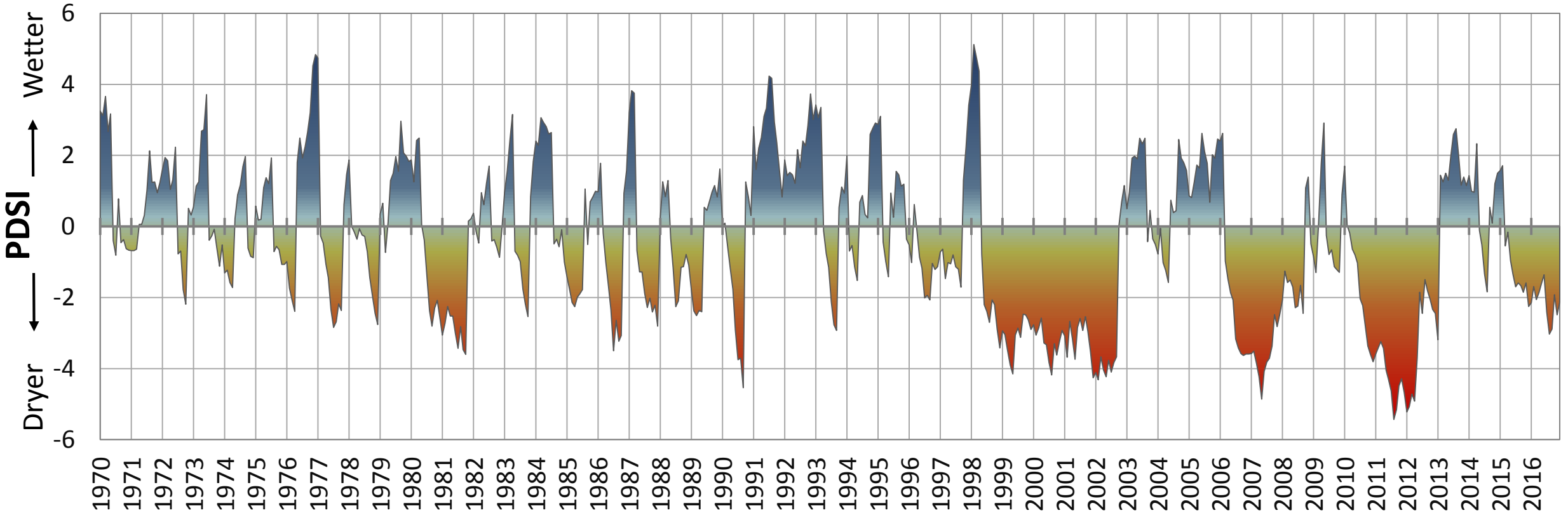


Purpose

- To illustrate how remotely sensed phenology provides a powerful tool for monitoring large wetlands.
- To characterize the impacts of individual and repeated fires on productivity.
- To better understand the vulnerability of this system to drought and disturbance regime change.

Monthly Palmer Drought Severity Index (PDSI) for Southeastern Georgia (NOAA NCEI Climate Division Georgia #9)





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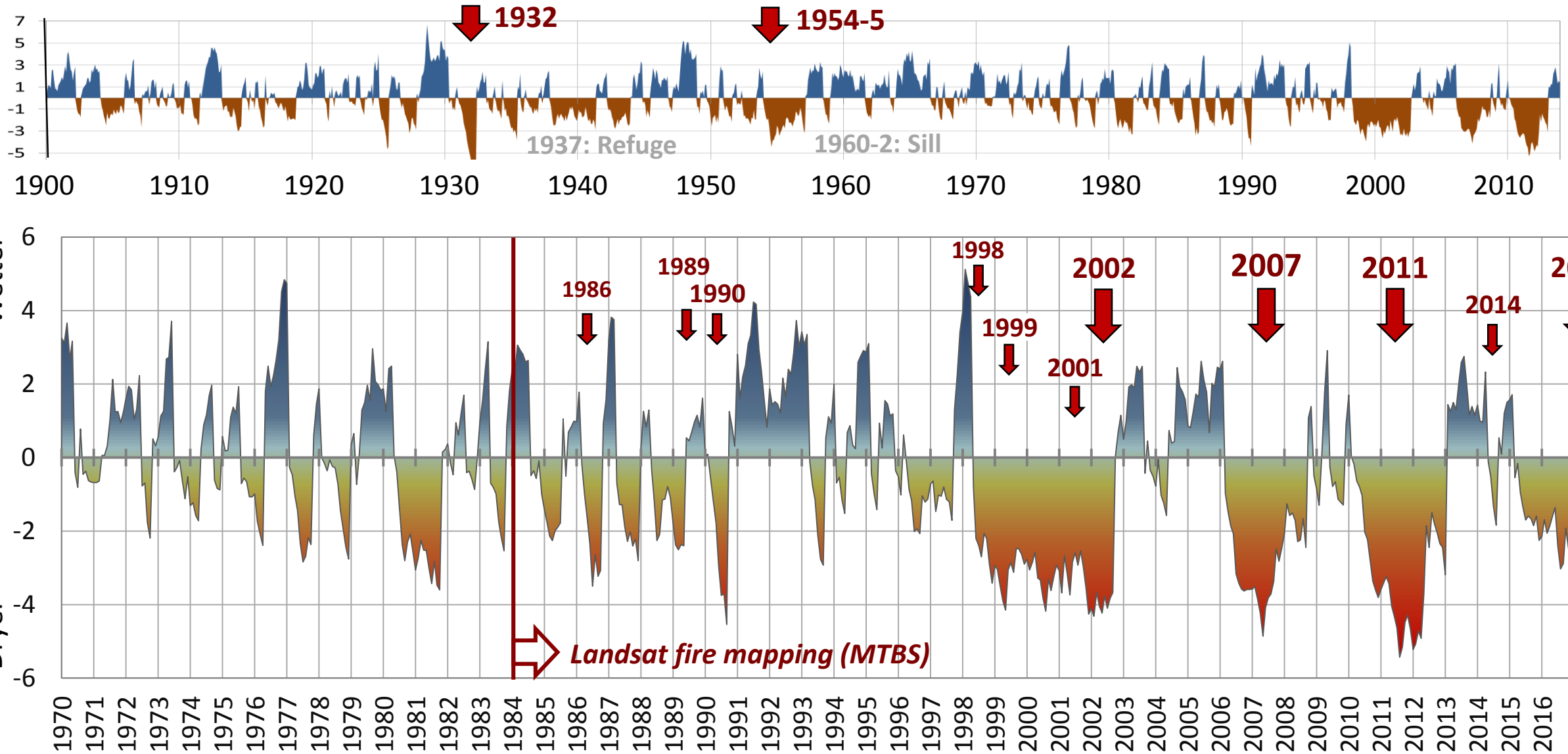
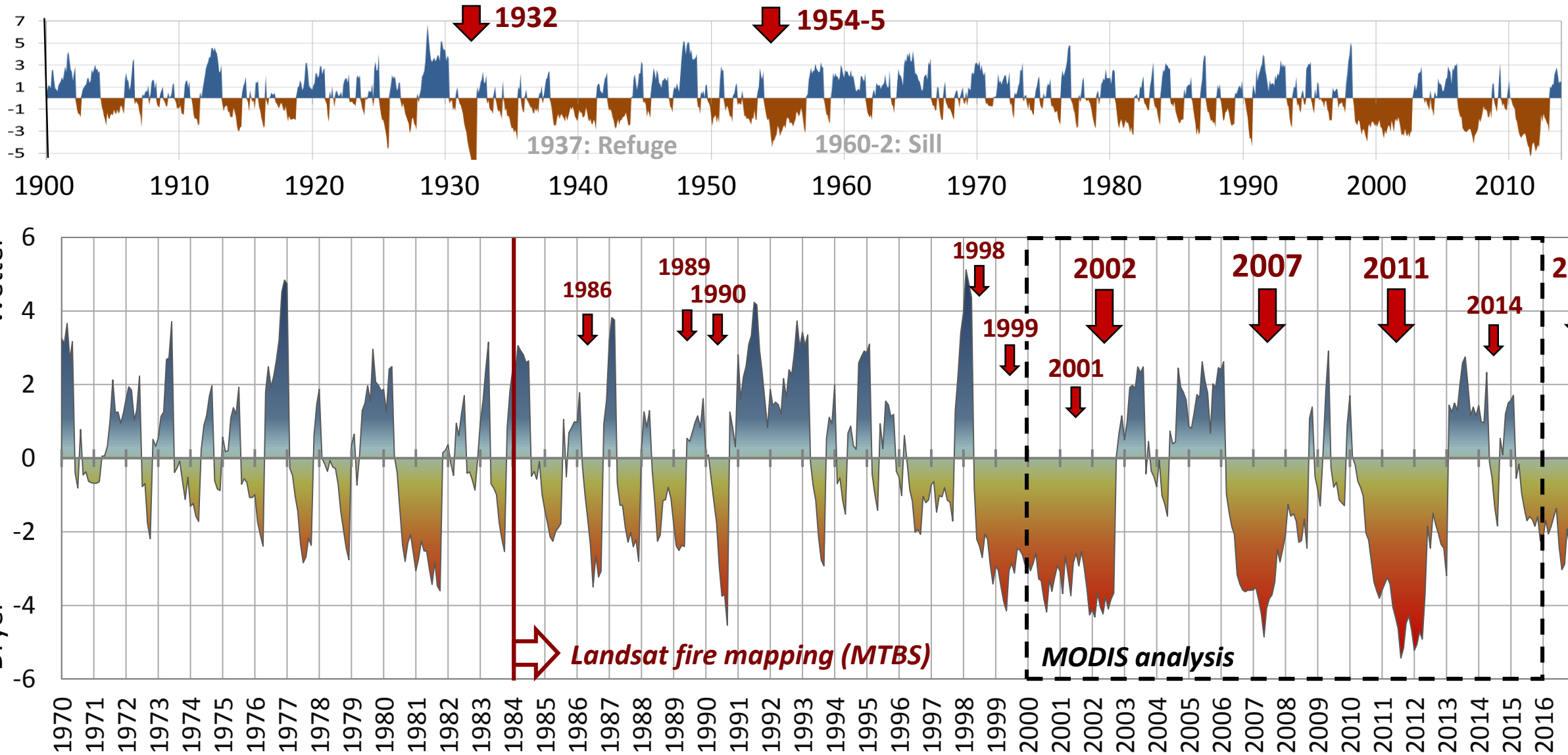


Monthly Palmer Drought Severity Index (PDSI) for Southeastern Georgia (NOAA NCEI Climate Division Georgia #9)

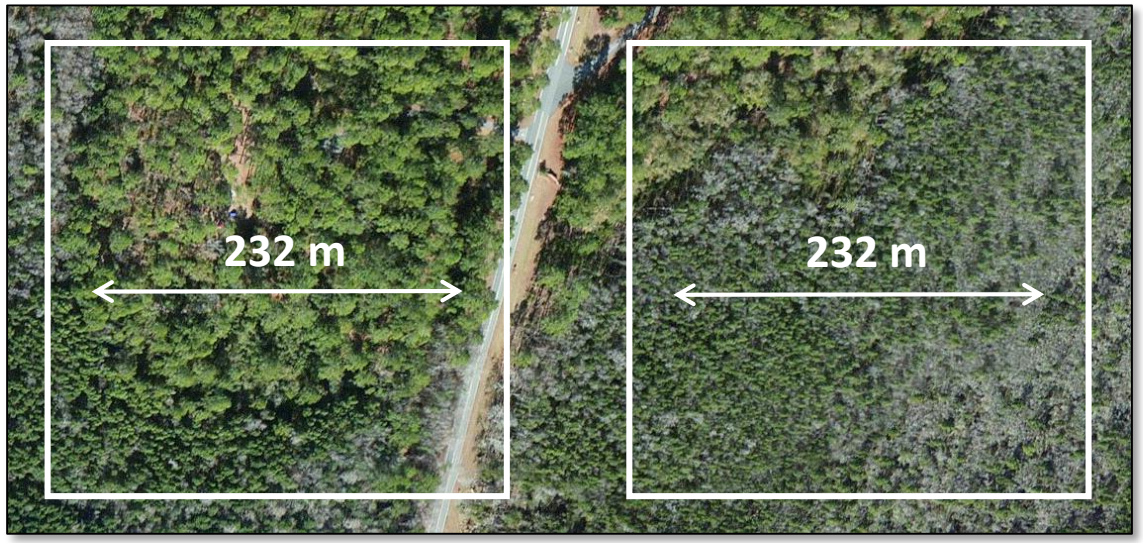


The *ForWarn* Dataset

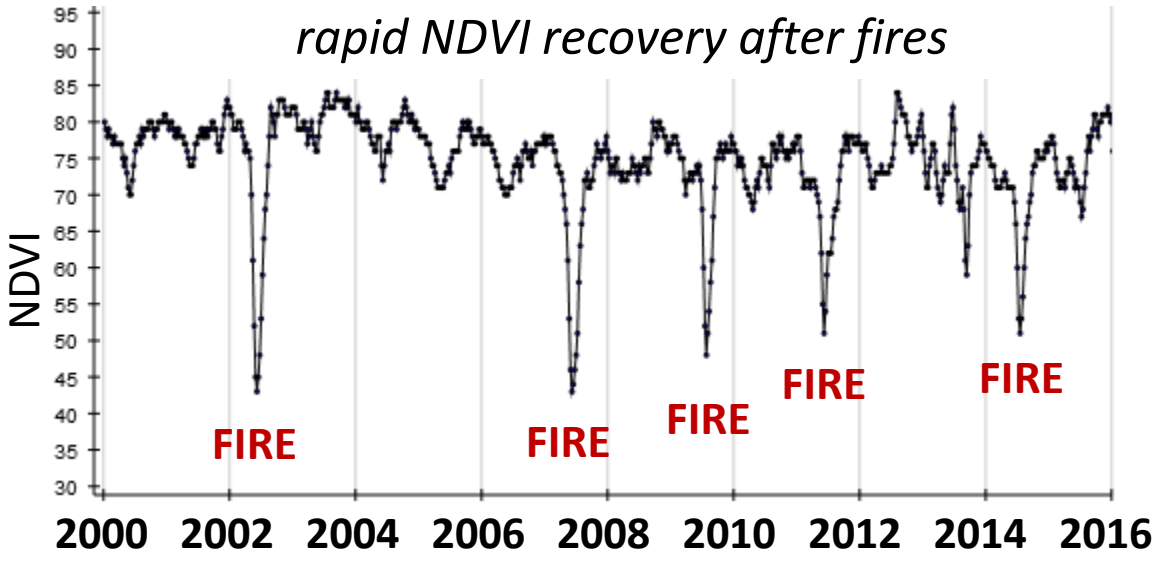
http://forwarn.forestthreats.org

- Based on daily MODIS observations from the Terra and Aqua satellites (CONUS coverage).
- Uses the Normalized Difference Vegetation Index (NDVI).
- Grid cells are 232m resolution (13.3 ac.; 5.4 ha.).
- Highly processed to remove clouds and other image quality issues.
- Calculated at 8-day time steps (46 periods per year) from 2000 through a year ago.
- Provides a consistent record of disturbance magnitude and duration, cumulative impacts, vegetation recovery, and seasonal phenology.

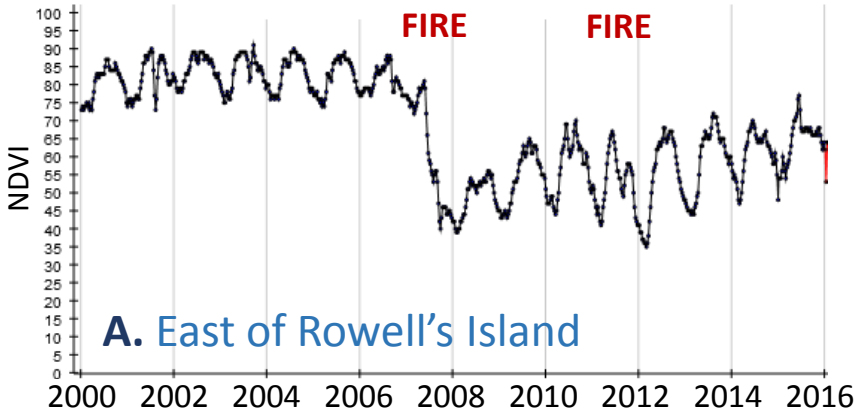
Jones Island (Stephen Foster State Park) showing MODIS grid resolution and mixed vegetation

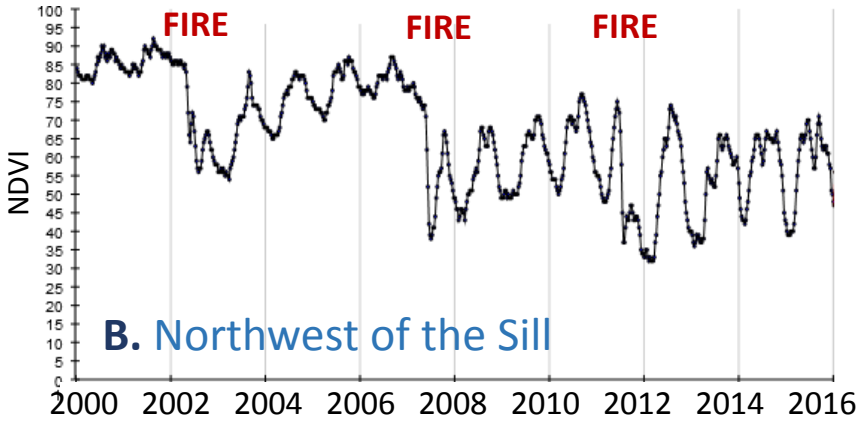


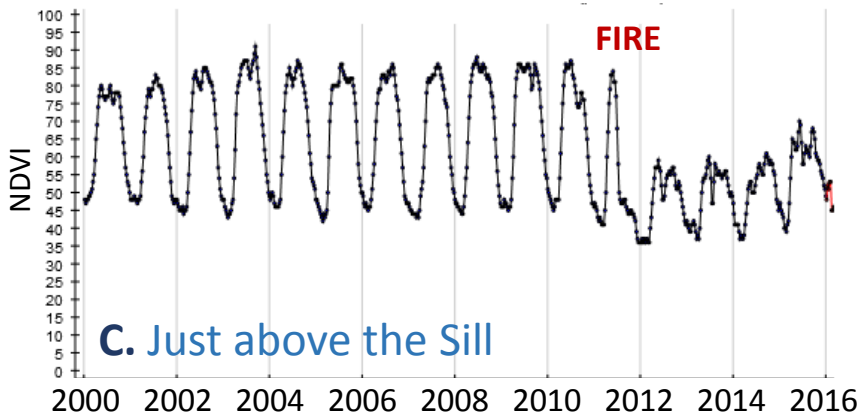
One grid cell from Honey Island showing rapid NDVI recovery after fires

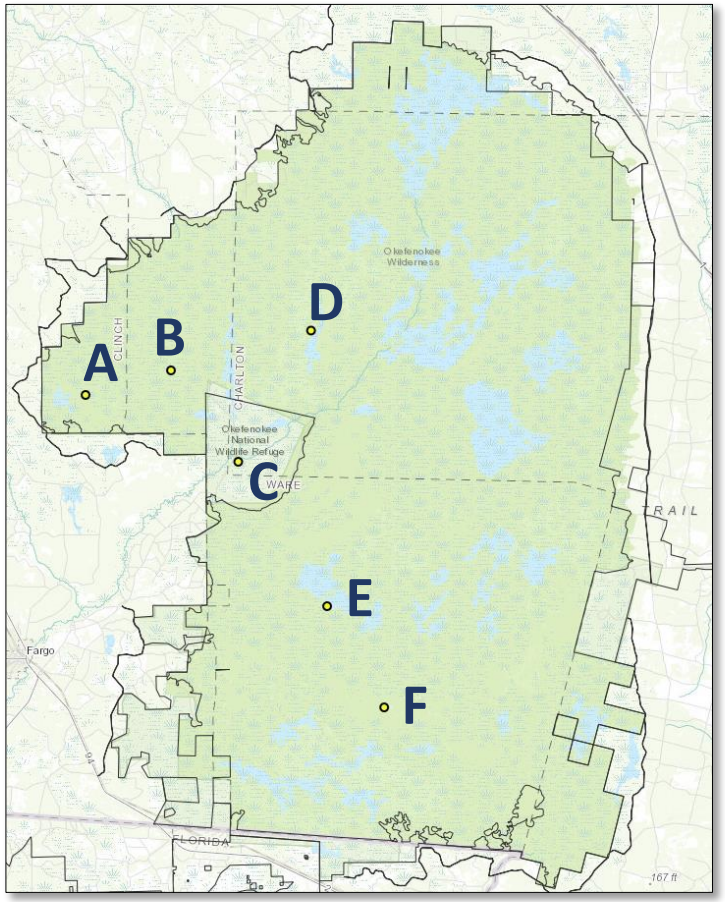


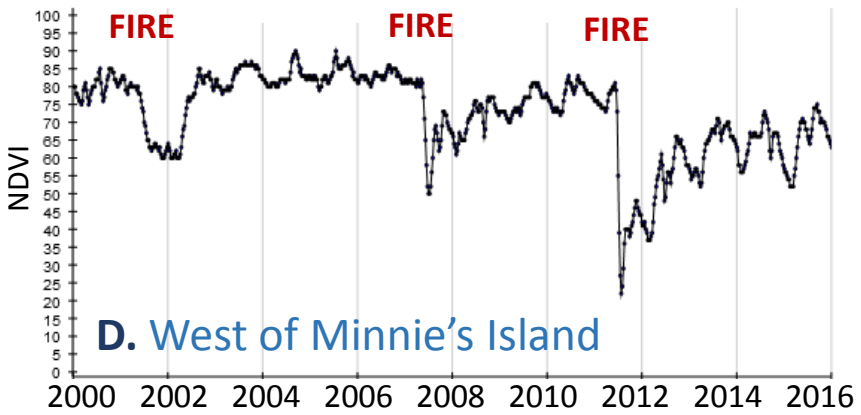
Tour de Okefenokee

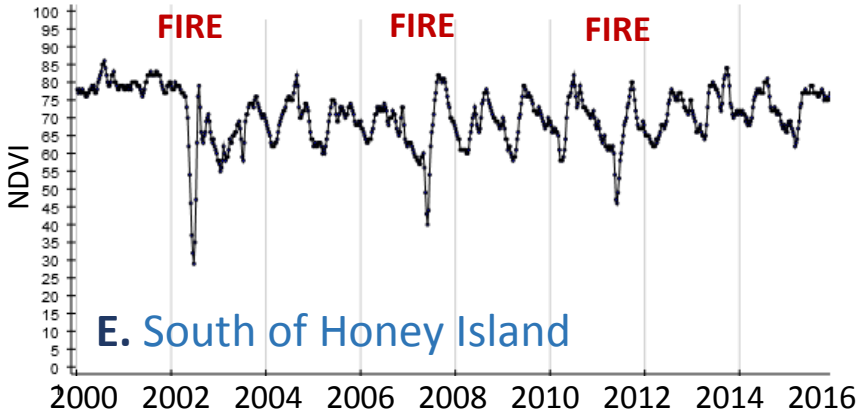


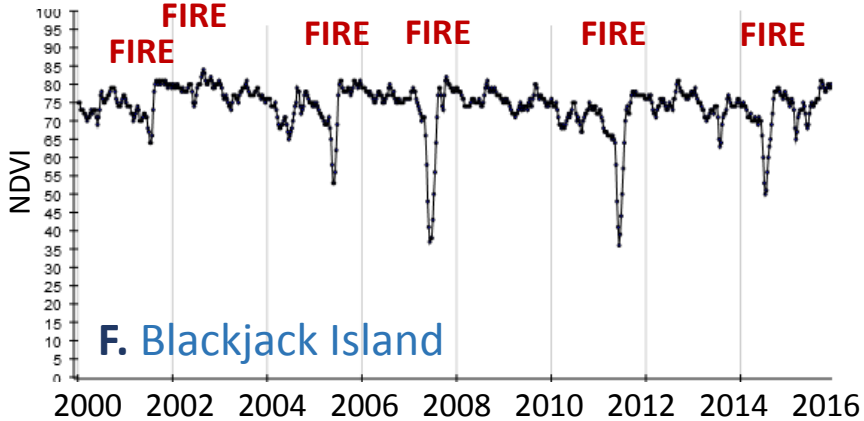




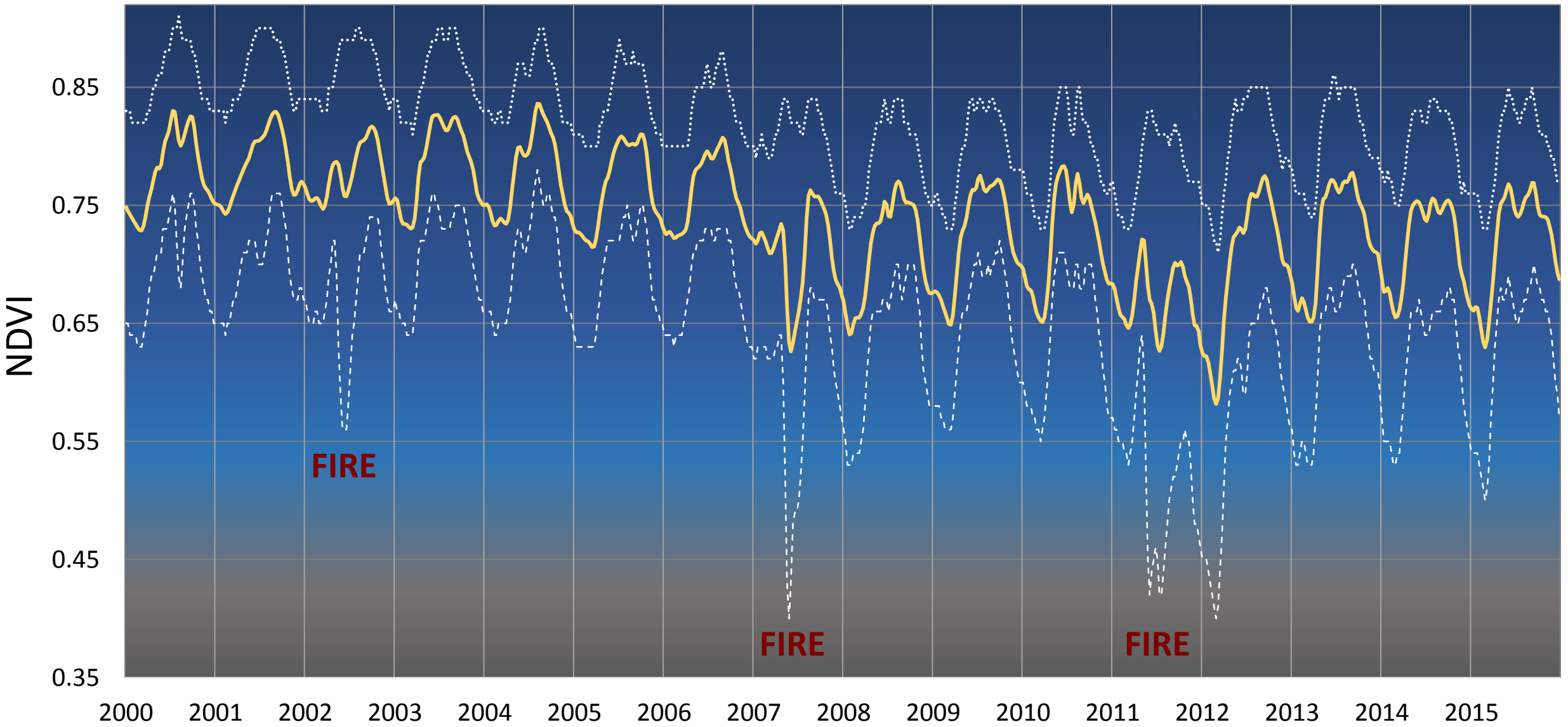






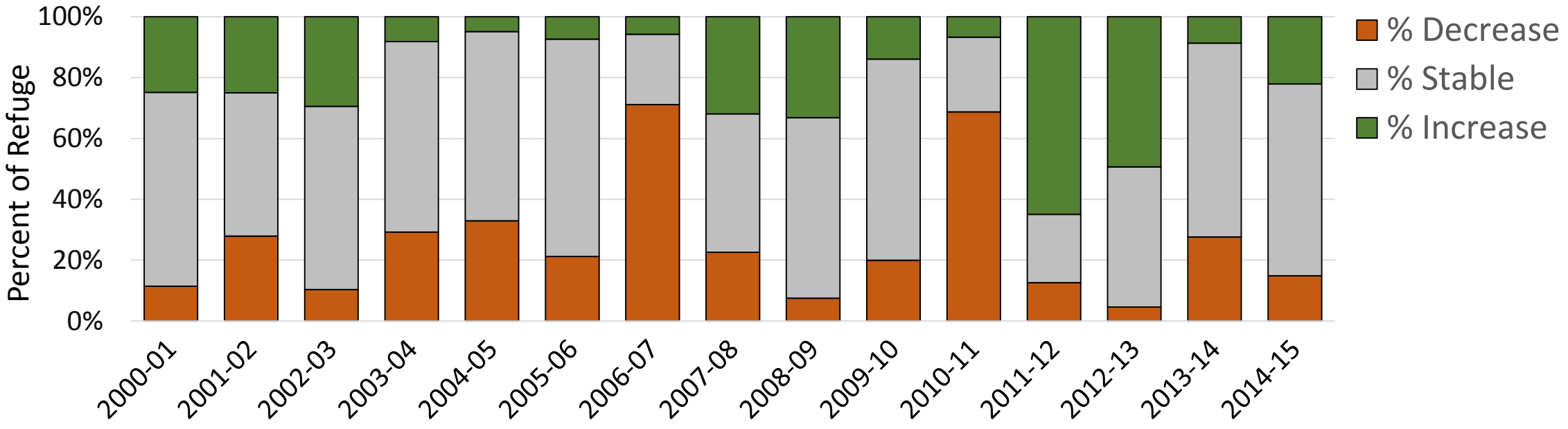


Weekly change in Average, 10th and 90th Percentile NDVI for the Okefenokee National Wildlife Refuge

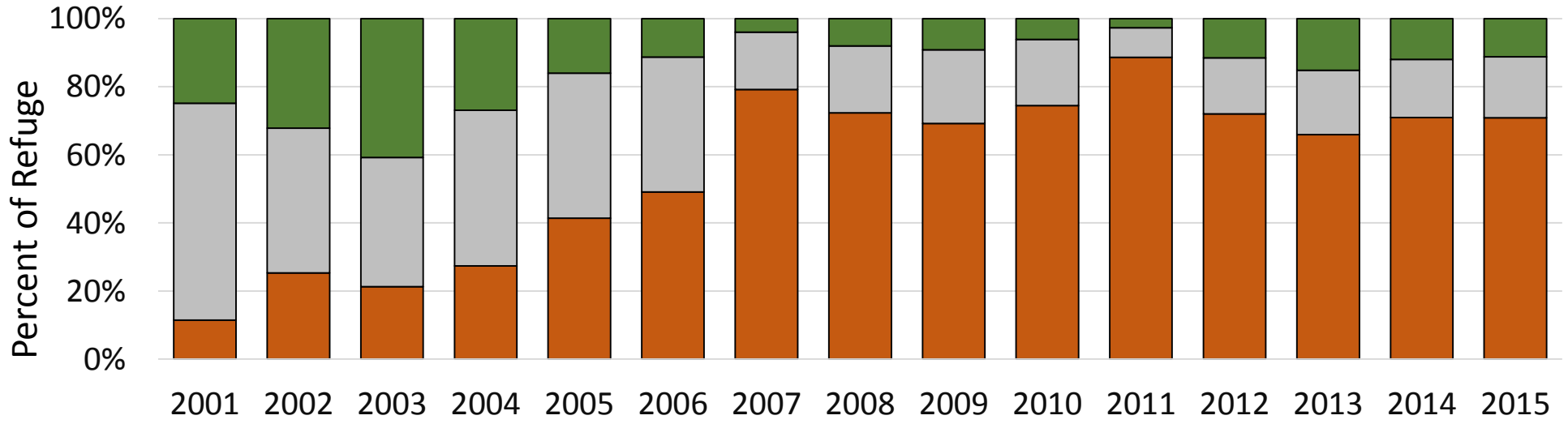


Change in productivity (mean NDVI) for the Okefenokee showing the influence of drought and wildfire

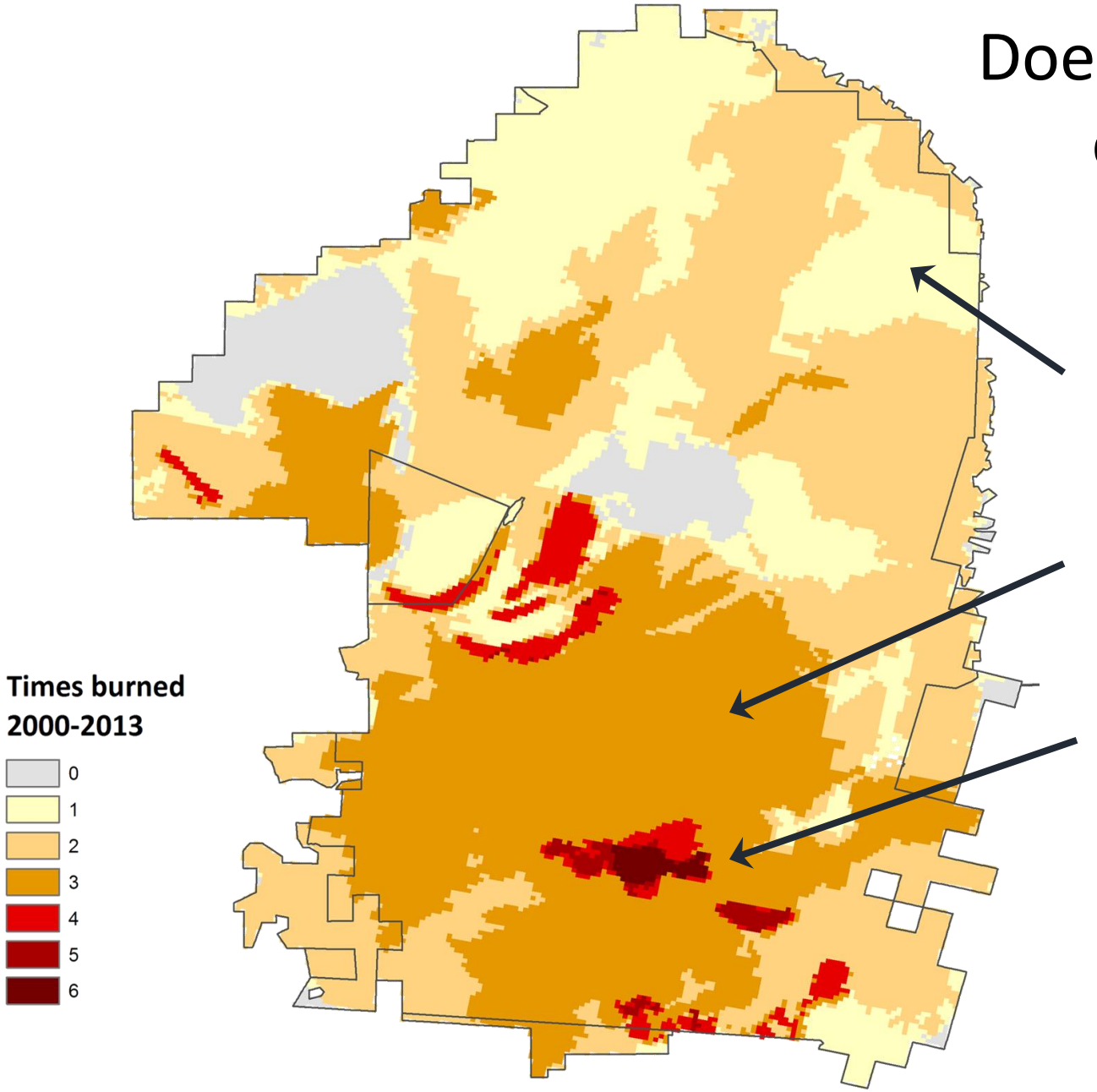
Year-to-year change



Cumulative change since 2000



Does fire frequency explain change in productivity?



Most areas in yellow (that burned once) did so in 2011 or 2007.

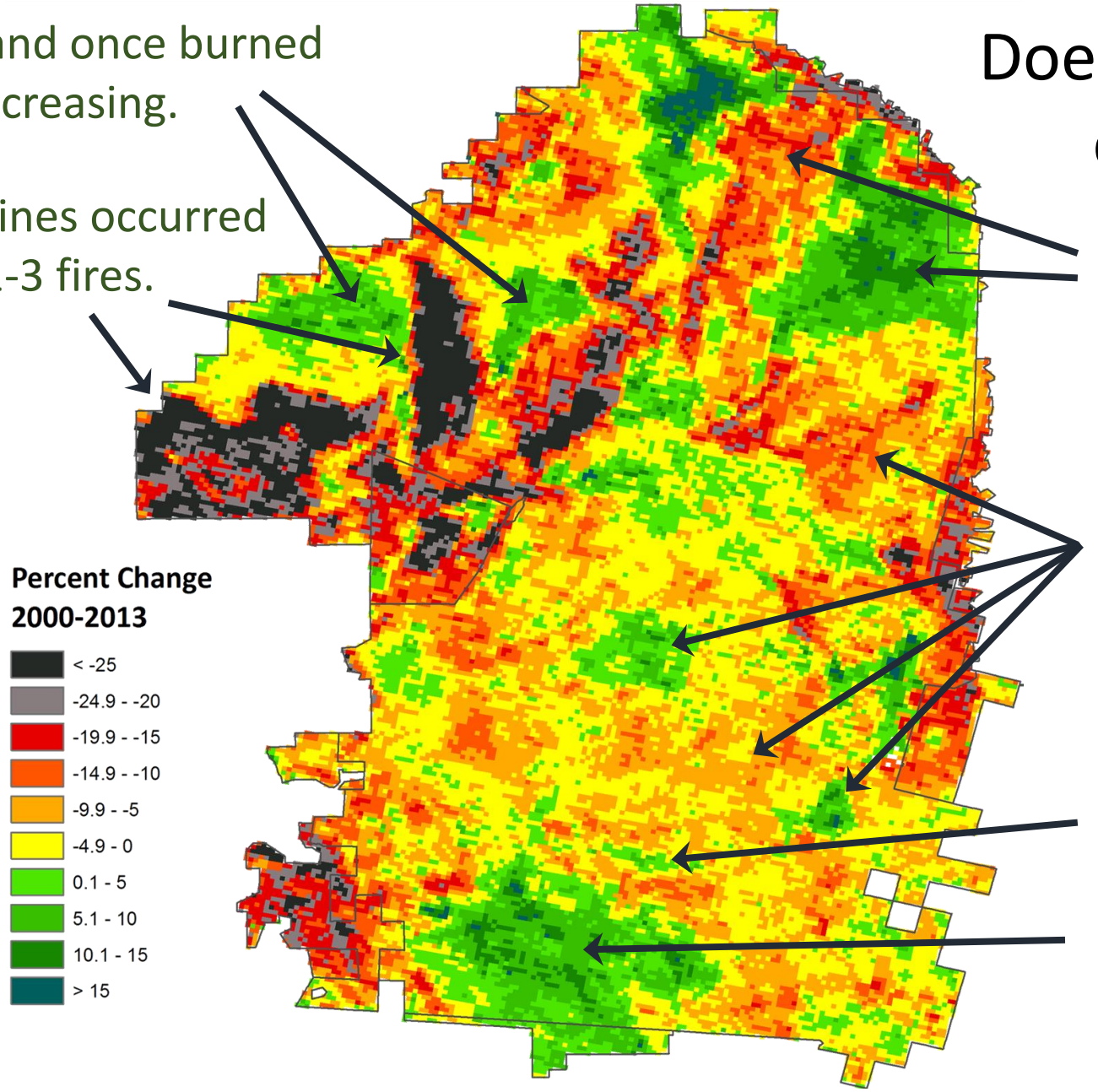
Most areas in dark orange burned in 2001/2, 2007 and 2011.

Areas in red reflect both wildfire and prescribed fire.

Does fire frequency explain change in productivity?

Unburned and once burned areas are increasing.

Severe declines occurred here after 1-3 fires.



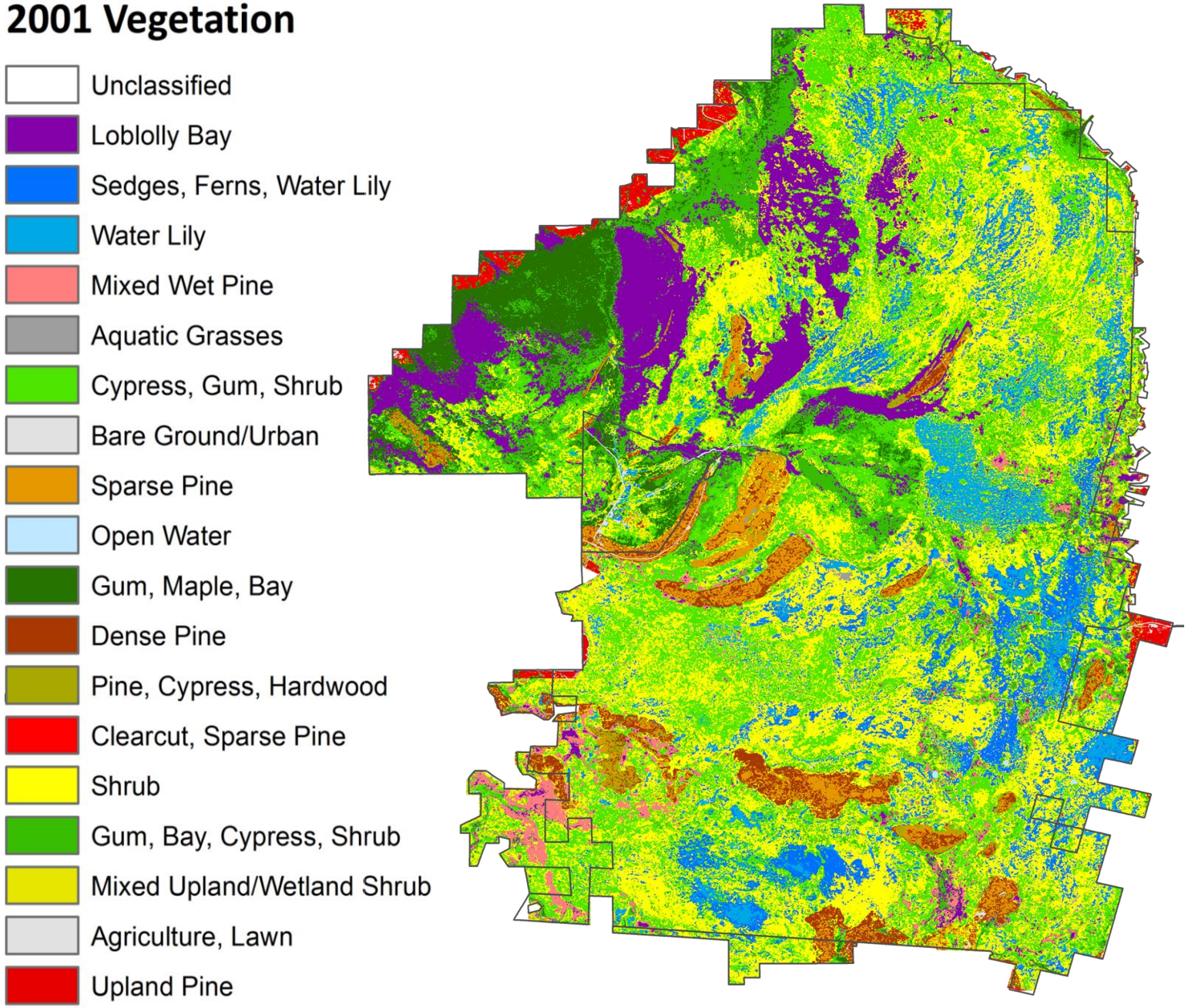
This area of higher decline burned twice, while areas to the east and west burned just once and are increasing.

Responses are of finer scale than fire frequency from site factors (hydrology, vegetation or nuances of fire behavior).

Frequently burned pine islands are often stable.

3x burned, but NDVI is increasing where trees are less common (this area had burned in 1999).

2001 Vegetation



Distribution of grid cell productivities for starting vegetation in **2000**

NDVI group →

Majority 2001 Vegetation Type

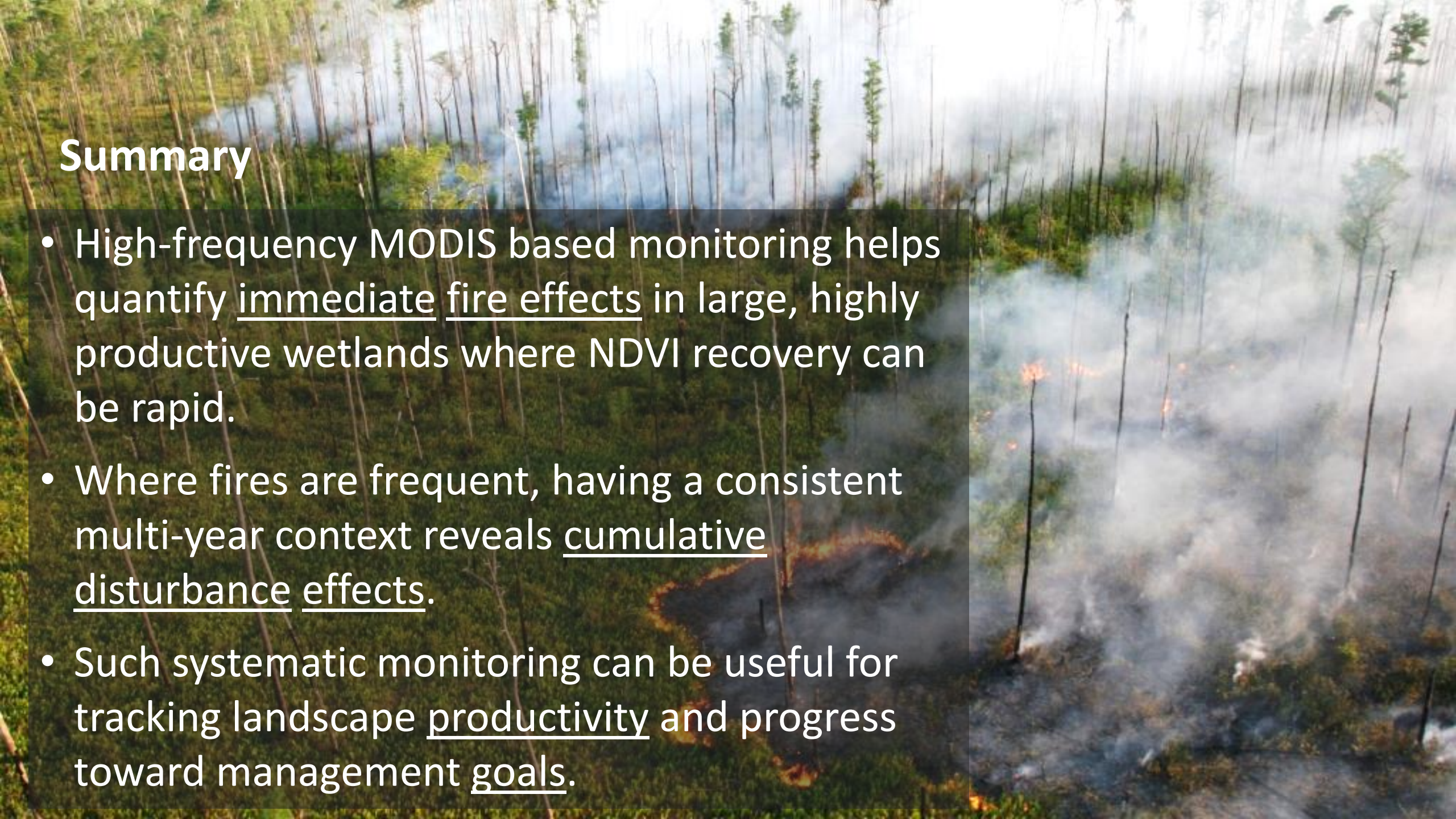
2000 NDVI	0.56	0.60	0.64	0.68	0.72	0.76	0.80	0.84	0.88	0.92	Grand Total
Bare Ground/Urban	0.0%	0.0%	8.0%	20.0%	24.0%	28.0%	20.0%	0.0%	0.0%	0.0%	100.0%
Water Lily	0.0%	0.4%	3.2%	28.2%	36.1%	21.5%	9.4%	1.2%	0.0%	0.0%	100.0%
Sedges, Ferns, Water Lily	0.0%	1.8%	4.9%	17.4%	27.5%	27.8%	17.1%	3.3%	0.2%	0.0%	100.0%
Open Water	0.0%	0.0%	0.0%	19.0%	14.3%	28.6%	23.8%	14.3%	0.0%	0.0%	100.0%
Shrub	0.0%	0.0%	0.2%	2.9%	14.9%	26.7%	35.3%	18.6%	1.4%	0.0%	100.0%
Mixed Upland/Wetland Shrub	0.0%	0.0%	0.0%	0.0%	1.1%	23.4%	64.9%	10.6%	0.0%	0.0%	100.0%
Clearcut, Sparse Pine	0.0%	1.7%	0.0%	6.7%	23.3%	33.3%	31.7%	3.3%	0.0%	0.0%	100.0%
Sparse Pine	0.0%	0.0%	0.1%	1.0%	6.9%	27.1%	53.2%	11.2%	0.6%	0.0%	100.0%
Upland Pine	0.0%	0.0%	0.3%	1.1%	9.7%	24.4%	51.0%	13.2%	0.3%	0.0%	100.0%
Dense Pine	0.0%	0.0%	0.0%	0.3%	6.5%	25.8%	50.1%	16.7%	0.7%	0.0%	100.0%
Mixed Wet Pine	0.0%	0.0%	0.0%	0.0%	0.3%	3.4%	19.1%	53.4%	23.0%	0.7%	100.0%
Pine, Cypress, Hardwood	0.0%	0.0%	0.0%	0.0%	3.8%	19.1%	40.7%	28.0%	8.1%	0.4%	100.0%
Cypress, Gum, Shrub	0.0%	0.0%	0.2%	2.7%	10.0%	19.1%	35.6%	27.7%	4.6%	0.0%	100.0%
Gum, Bay, Cypress, Shrub	0.0%	0.0%	0.0%	0.2%	2.1%	9.9%	32.8%	37.2%	17.5%	0.3%	100.0%
Gum, Maple, Bay	0.0%	0.0%	0.0%	0.2%	4.0%	11.7%	24.8%	44.6%	14.7%	0.0%	100.0%
Loblolly Bay	0.0%	0.0%	0.0%	0.0%	0.0%	1.0%	6.2%	27.2%	50.0%	15.5%	100.0%

Distribution of grid cell productivities for starting vegetation by **2015**

NDVI group →

Majority 2001 Vegetation Type* \ 2015 NDVI	0.56	0.60	0.64	0.68	0.72	0.76	0.80	0.84	0.88	0.92	Grand Total
Bare Ground/Urban	0.0%	20.0%	8.0%	32.0%	24.0%	16.0%	0.0%	0.0%	0.0%	0.0%	100.0%
Water Lily	0.0%	1.9%	9.7%	27.4%	36.9%	22.1%	2.0%	0.0%	0.0%	0.0%	100.0%
Sedges, Ferns, Water Lily	0.0%	1.1%	7.8%	16.9%	37.9%	32.6%	3.5%	0.2%	0.0%	0.0%	100.0%
Open Water	0.0%	0.0%	4.8%	14.3%	28.6%	33.3%	19.0%	0.0%	0.0%	0.0%	100.0%
Shrub	0.0%	2.5%	6.4%	9.3%	24.3%	38.8%	16.1%	2.4%	0.1%	0.0%	100.0%
Mixed Upland/Wetland Shrub	0.0%	0.0%	4.3%	16.0%	29.8%	46.8%	3.2%	0.0%	0.0%	0.0%	100.0%
Clearcut, Sparse Pine	0.0%	0.0%	3.3%	20.0%	46.7%	18.3%	11.7%	0.0%	0.0%	0.0%	100.0%
Sparse Pine	0.0%	1.8%	3.8%	8.8%	25.7%	53.4%	6.5%	0.0%	0.0%	0.0%	100.0%
Upland Pine	0.0%	0.6%	1.7%	24.4%	35.0%	27.5%	10.9%	0.0%	0.0%	0.0%	100.0%
Dense Pine	0.0%	1.7%	2.7%	6.5%	34.1%	47.0%	8.0%	0.0%	0.0%	0.0%	100.0%
Mixed Wet Pine	0.0%	2.2%	7.2%	17.9%	23.5%	34.6%	12.1%	2.4%	0.0%	0.0%	100.0%
Pine, Cypress, Hardwood	0.0%	3.4%	6.8%	16.1%	35.6%	27.5%	9.3%	0.4%	0.8%	0.0%	100.0%
Cypress, Gum, Shrub	0.0%	3.4%	8.1%	12.9%	26.2%	30.4%	14.1%	4.8%	0.0%	0.0%	100.0%
Gum, Bay, Cypress, Shrub	0.0%	9.0%	7.8%	12.0%	14.2%	25.6%	20.1%	11.0%	0.4%	0.0%	100.0%
Gum, Maple, Bay	0.0%	9.2%	6.5%	6.2%	5.8%	10.7%	33.5%	28.0%	0.0%	0.0%	100.0%
Loblolly Bay	0.1%	14.0%	13.8%	11.8%	11.9%	13.5%	16.6%	12.8%	5.3%	0.0%	100.0%

**Actual vegetation types have often changed by 2015*



Summary

- High-frequency MODIS based monitoring helps quantify immediate fire effects in large, highly productive wetlands where NDVI recovery can be rapid.
- Where fires are frequent, having a consistent multi-year context reveals cumulative disturbance effects.
- Such systematic monitoring can be useful for tracking landscape productivity and progress toward management goals.