

# GAP

*Keeping common species common*

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## Modeling Peak Fire Season in the Pre-settlement Range of Longleaf

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*9 August 2006*

# Longleaf Pine Ecosystem

- Critically Endangered (98% range-wide loss).
- A Southeastern endemic with extremely high plant species diversities.
- Since 1975 bird species dependent on this habitat have been declining.
- Fire is a critical component for maintenance of the ecosystem



[www.longleafalliance.org](http://www.longleafalliance.org)

Photographer : John McGuire

# Birds of the longleaf pine assemblage

Brown-headed  
Nuthatch



© Isidere Jeklin

Bachman's Sparrow



© Brian E. Small

Prairie Warbler



© Marie Read

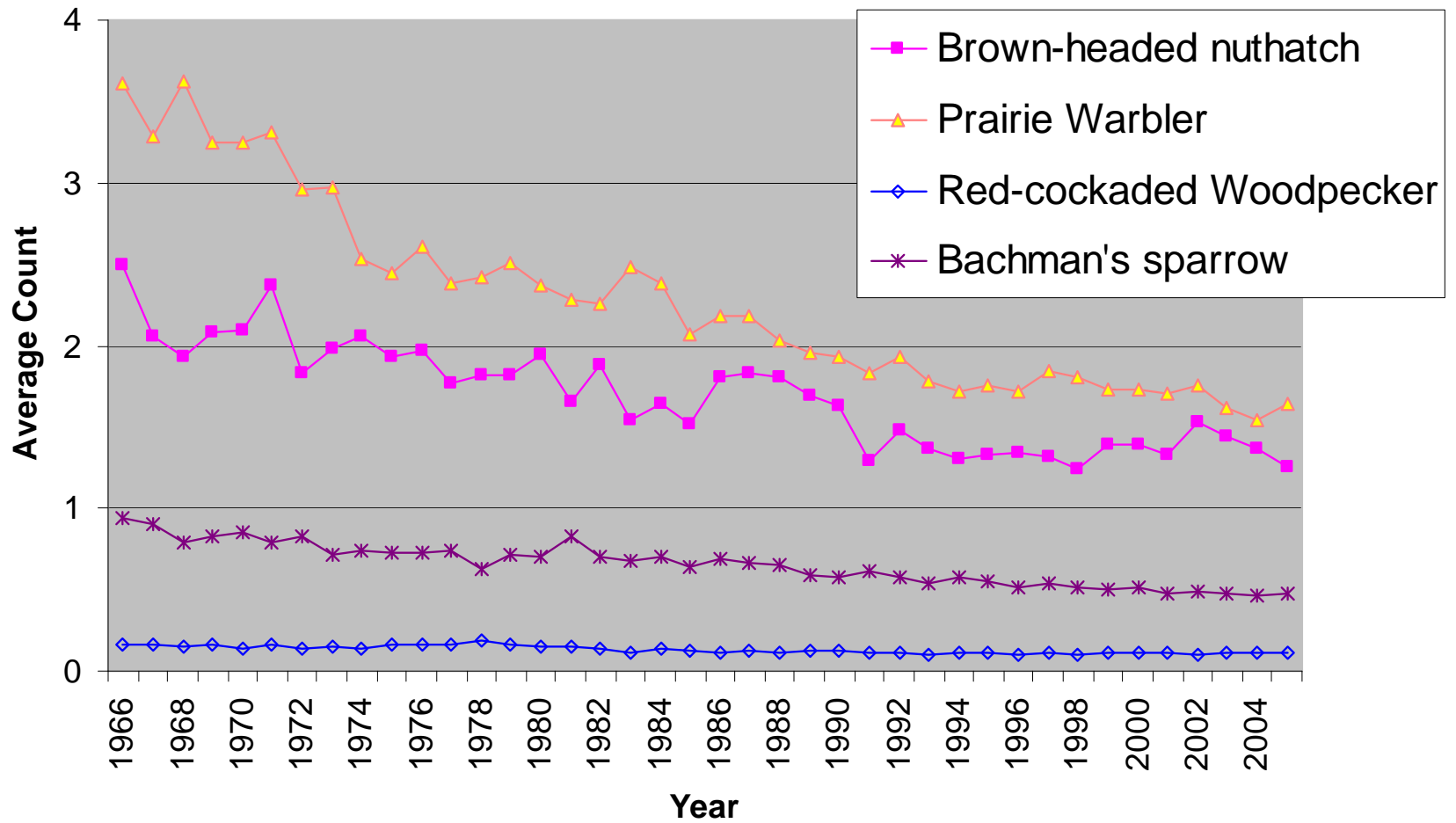
Red-cockaded  
Woodpecker



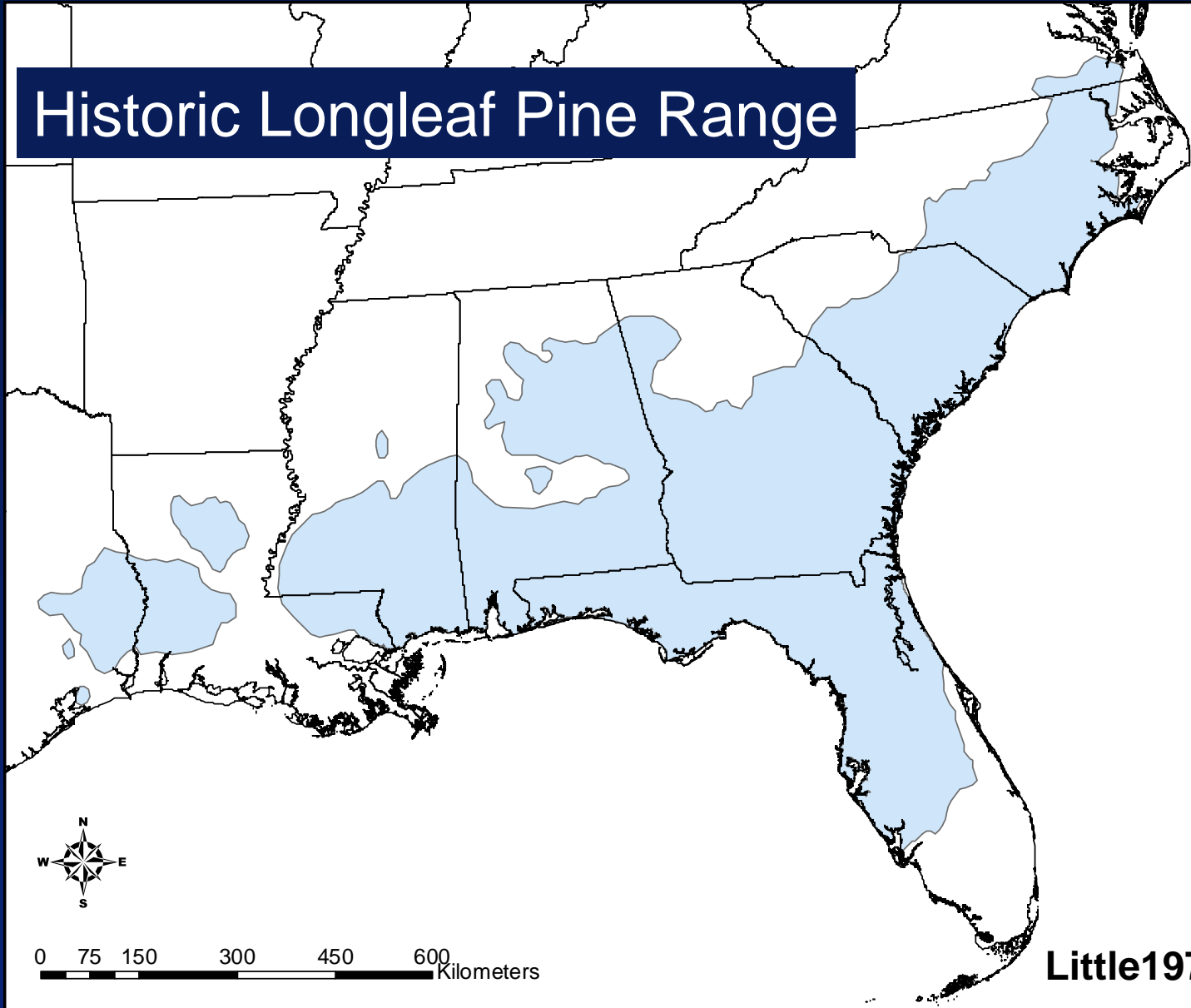
© T. Engstrom

# Population Trends in the Southeast Region

## Breeding Bird Survey Data



# Historic Longleaf Pine Range



0 75 150 300 450 600 Kilometers

Little1971

# Purpose

To inform restoration efforts by modeling pre-settlement longleaf at a high spatial resolution (fire block size).

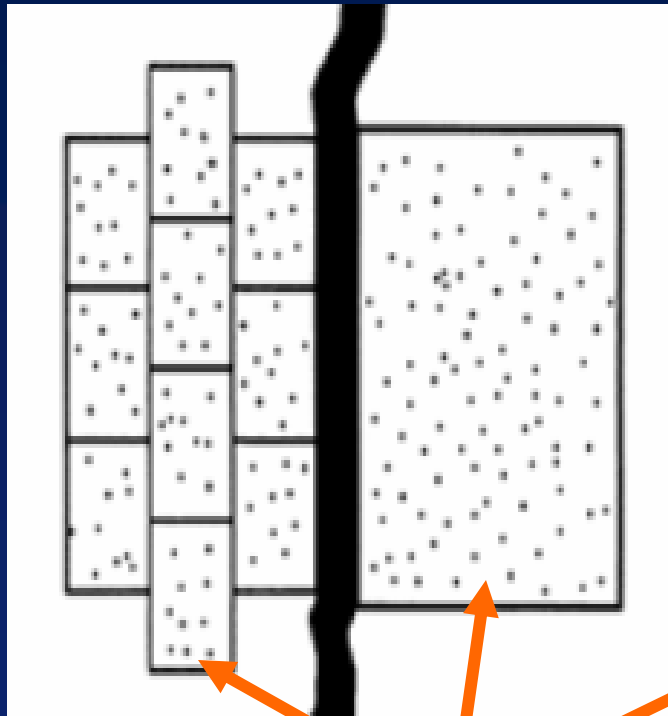
# Goals

- Model historical fire season throughout the Southeast.
- Use results to identify predominant wind-direction for modeling probable longleaf pine (*Pinus palustris*) sites at the block level.
- Ultimately, compare pre-settlement sites with existing vegetation data for restoration planning.

# Assumptions

- At the local level Longleaf is dependent on
  - High fire frequency (Large block size (Frost 1998))
  - Soils
- Fire season in a block is dependent on
  - Climate (Ignitions, Temp, Precip, Clouds, Relative Humidity, Wind)
  - Vegetation (Fuel availability)

# Influence of block size and dominant wind direction on local fire frequency



Ignition sites



Modified from Langley (2000); Frost (1998).

# Fire Season Model

Fire Season =  $f$ (Dryness, Fuel, Ignitions )

- Dryness - Dead Fuel Moisture Content (MC)
- Fuel – Normalized Difference Vegetation Index
- Ignitions – Lightning Frequency

# Dryness and Fuel

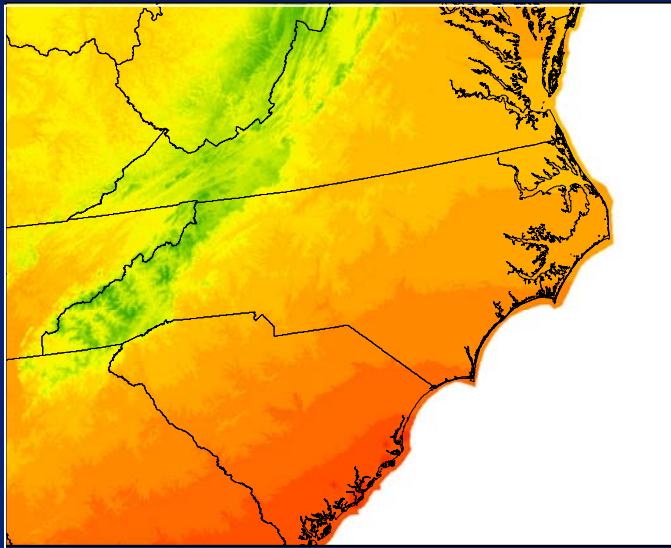
## Fire Potential Index (Burgan et al. 1998)

- Stand-alone model used to integrate climatic conditions with vegetation status
- Data widely available, no field measurements needed
- Runs on a daily time step
- Tested well in California and Nevada
- Specifically designed to accommodate humid SE

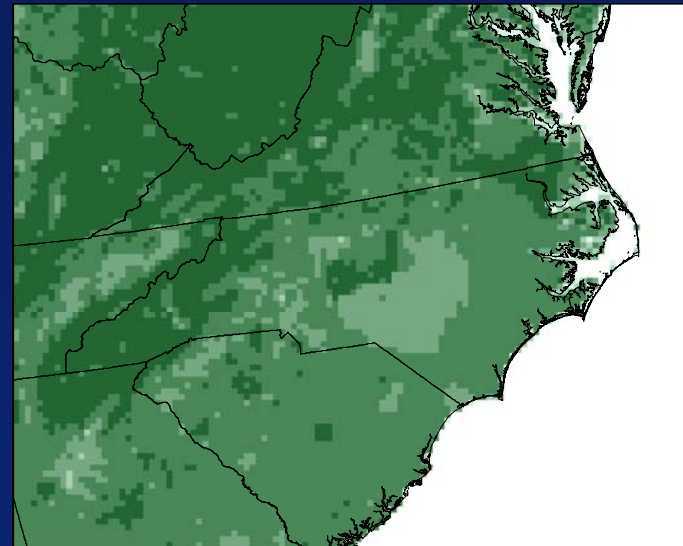
# FPI

## Two Types of Data Required

Climate



Vegetation "Greenness"



## Climate

Daily Weather

Equilibrium Moisture Content

10 Hour Fuel Moisture Content

## Vegetation

Bi-Monthly NDVI

Max and Min Historical NDVI

Maximum Live Fuel Ratio

Relative Greenness



**Fire Potential Index (FPI)**

$$FPI = \text{Dryness} * \text{Deadness}$$

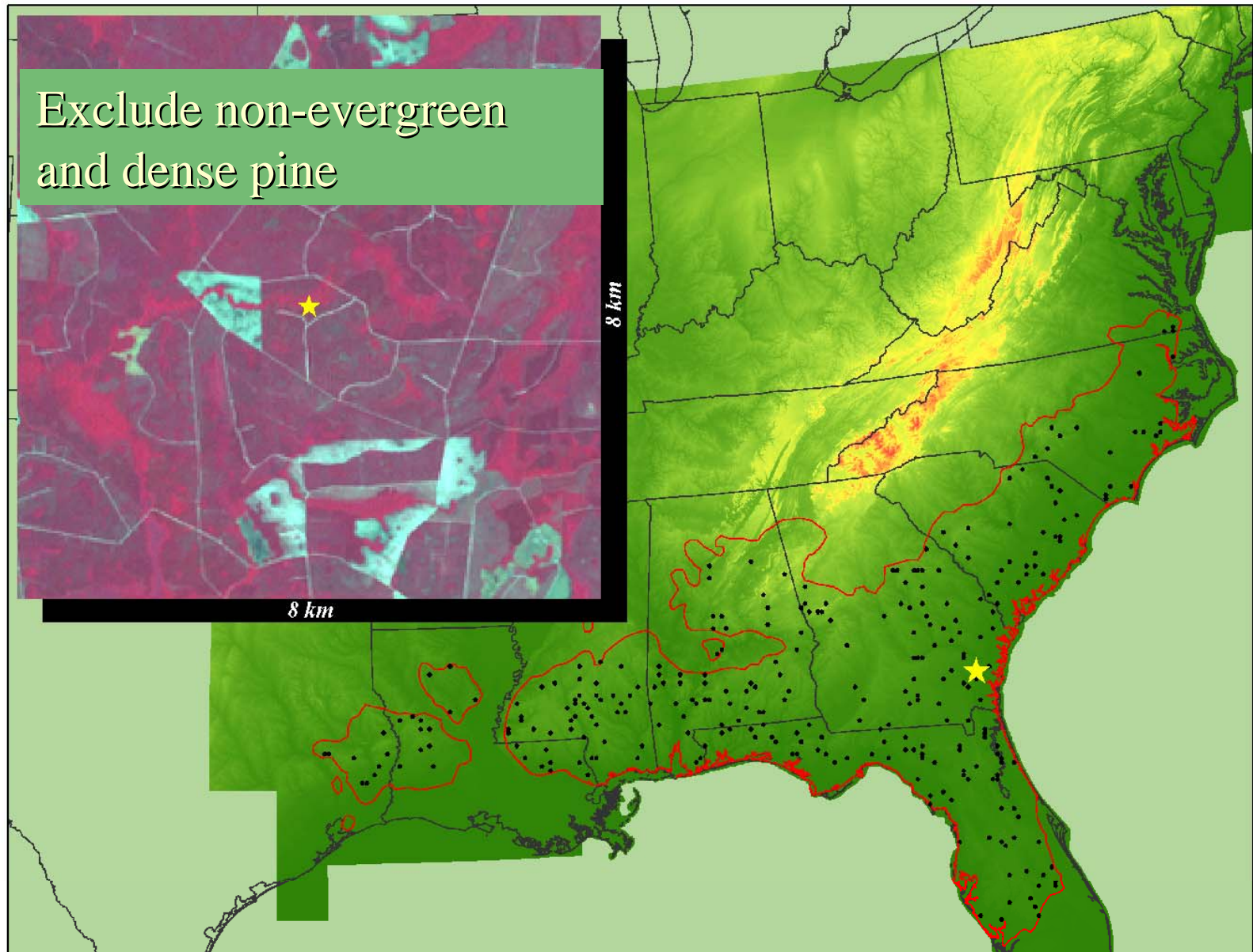
$$\text{Dryness Fraction} = 1 - (\text{MC} / \text{Extinction MC})$$

$$\text{Deadness Fraction} = 1 - (\text{Relative "Greenness"} * \text{Max "Greenness"})$$

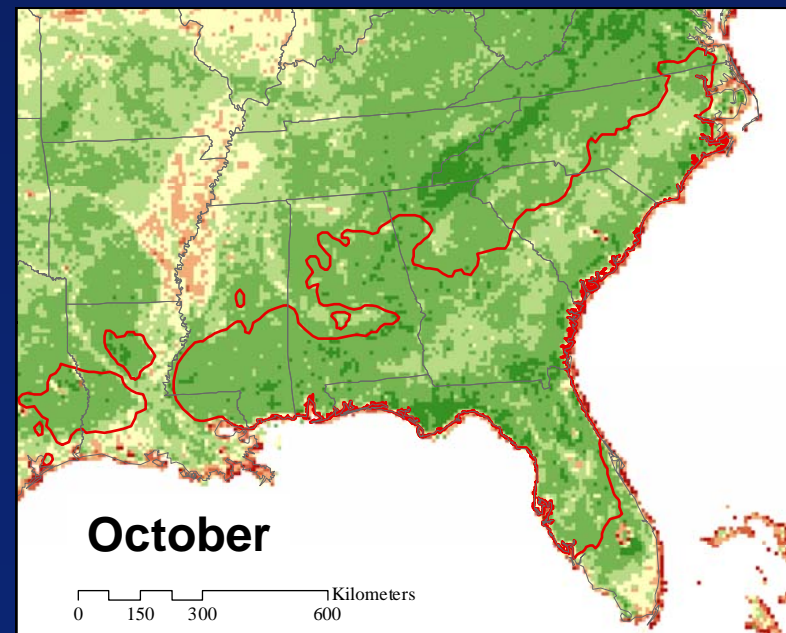
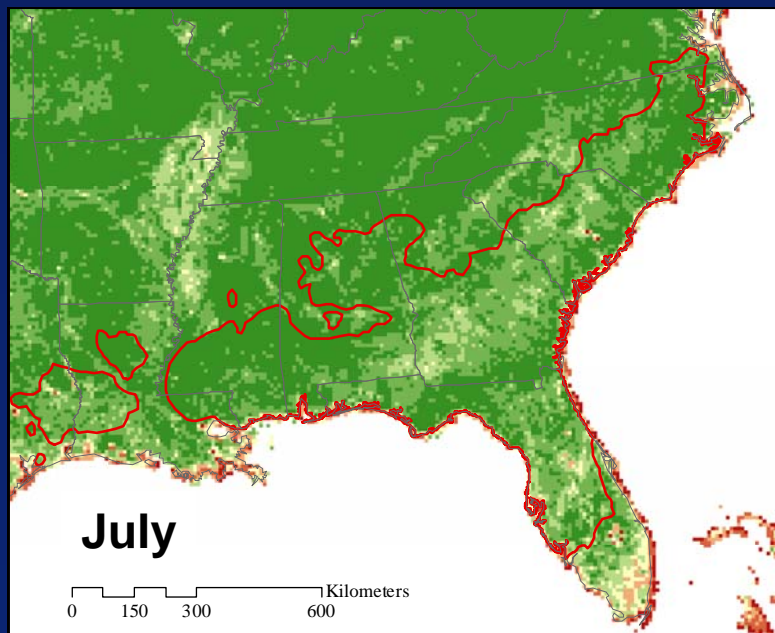
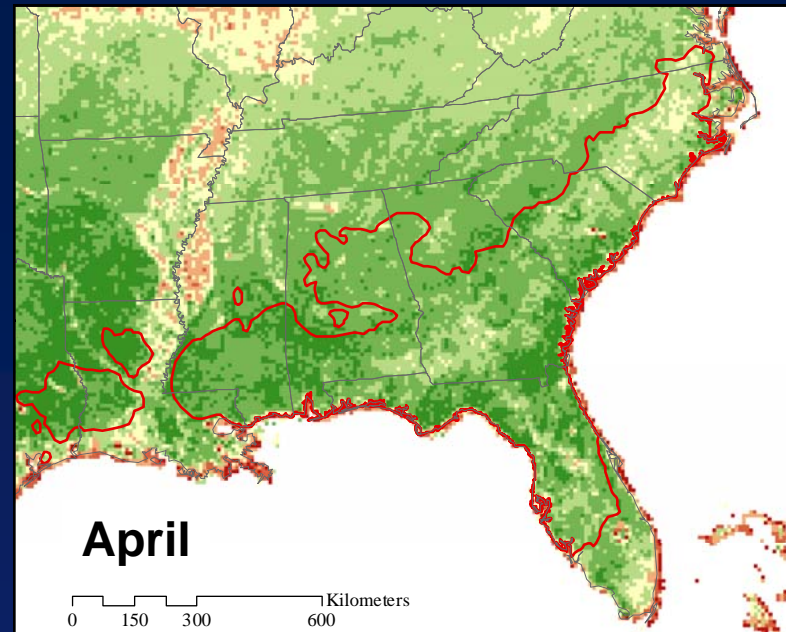
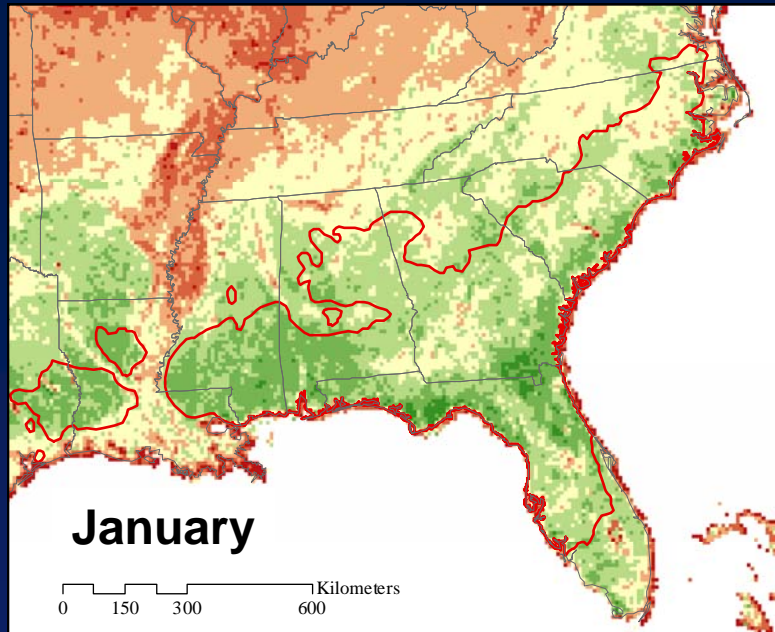
# NDVI

- 21 years of data (1982 – 2002) available
- Data are for *present* land cover (including urban and intensive agriculture)
- Interested in *presettlement* land cover
- Sampled points that best represented pre-settlement vegetation and interpolate across range

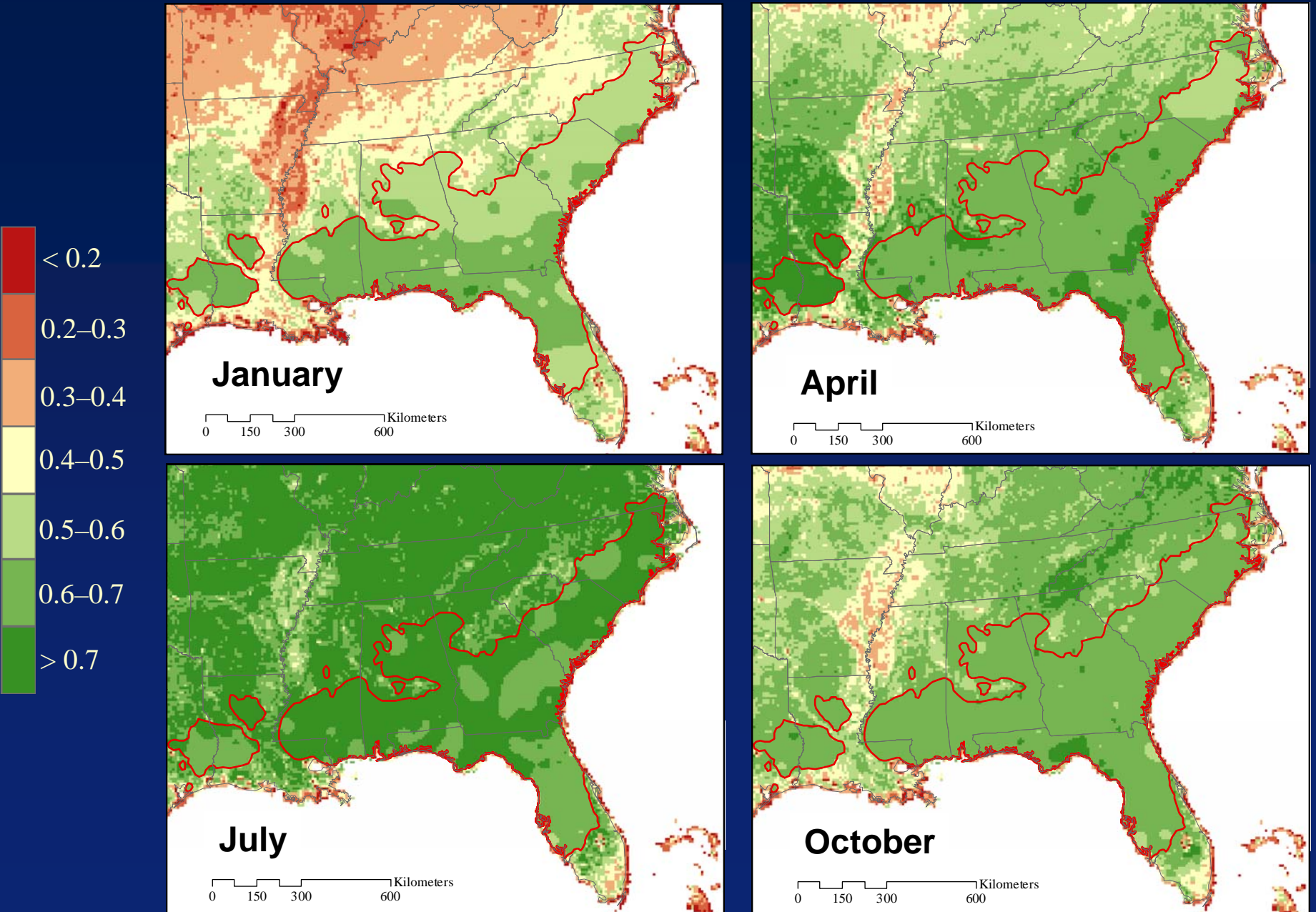
# 175 Points Used to Interpolate



# Original NDVI



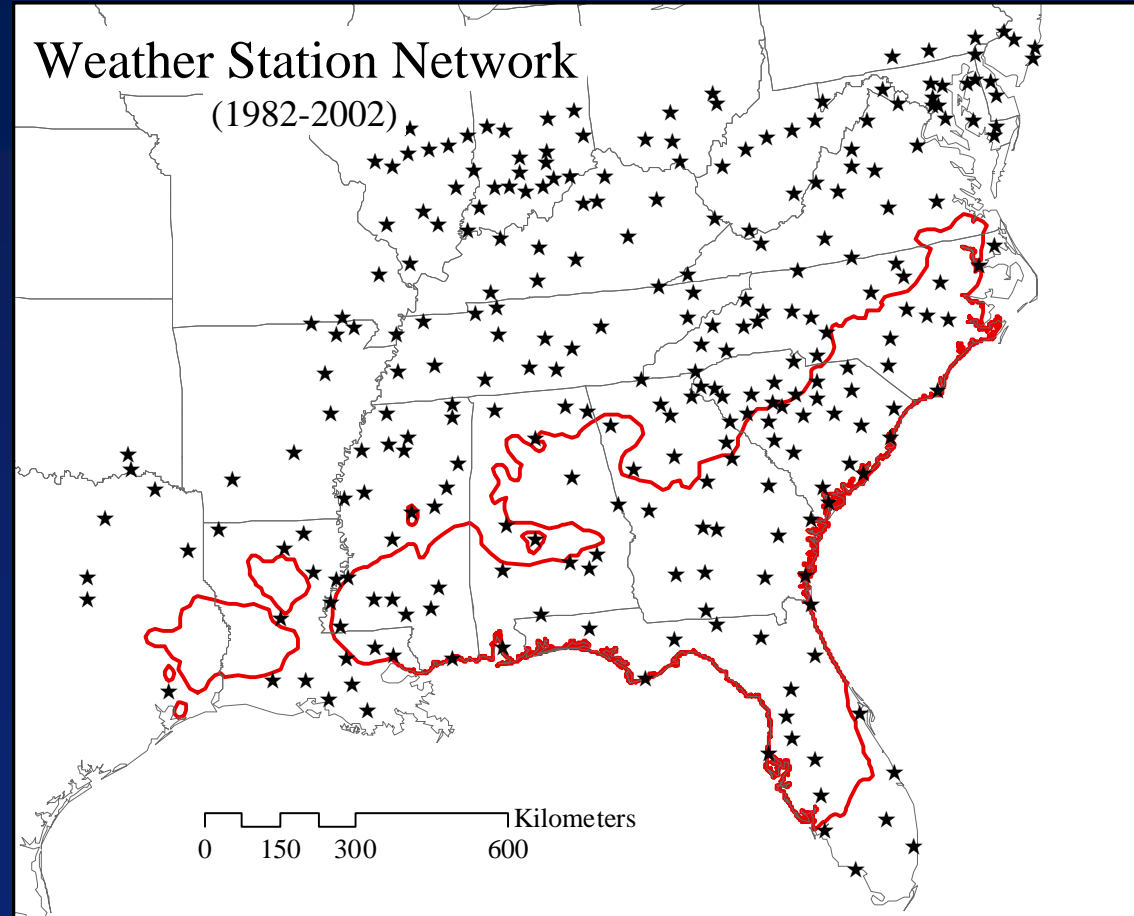
# After Interpolation



# US Historical Climate Data

## INPUT

- Daily max and min temp and daily precip
  - Extensive Quality Control Measures
  - Best Data at Highest Resolution Available
- Use topographic data to interpolate daily weather data to grid
- Thiessen polygons to delineate presence/absence of precipitation



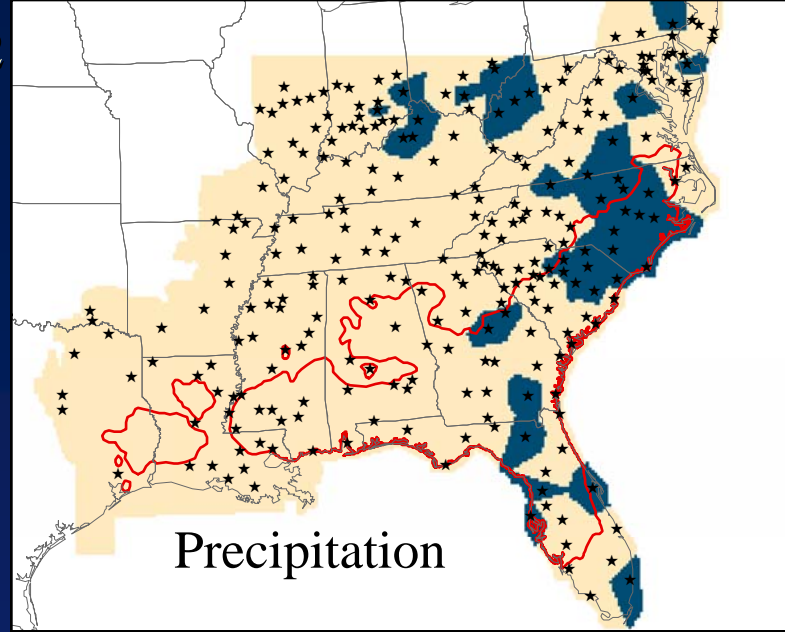
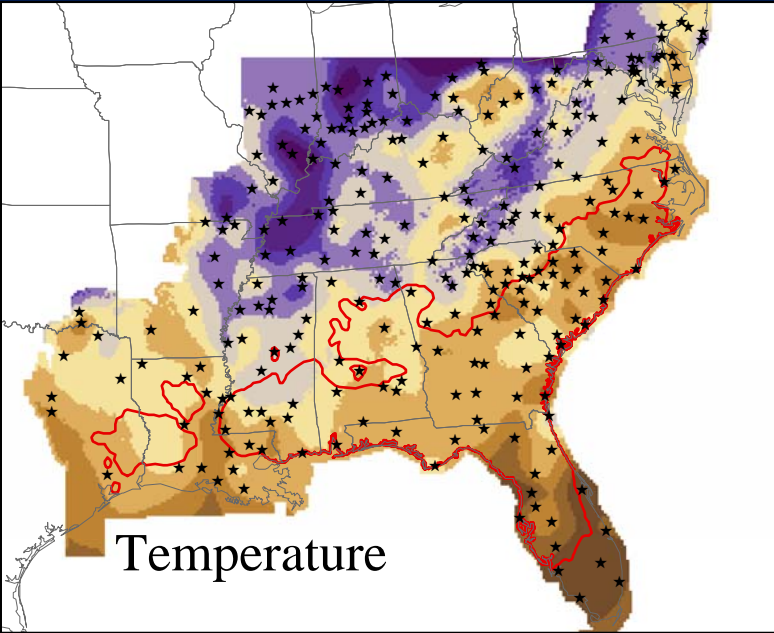
# US Historical Climate Data

## Output

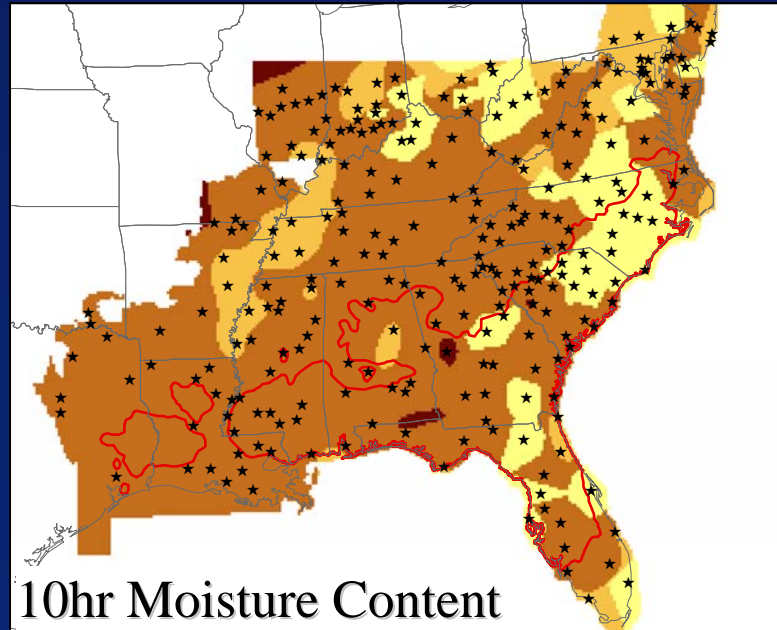
- Gridded daily temperatures
- Gridded Estimates of relative humidity and cloudiness
- Presence/absence of precipitation
- ***10 hr Dead Fuels Moisture Content (MC)***

# Sample Input

January 5, 1982



# Sample Output



# Results

# Seasonal FPI

FPI  
Values



< 25



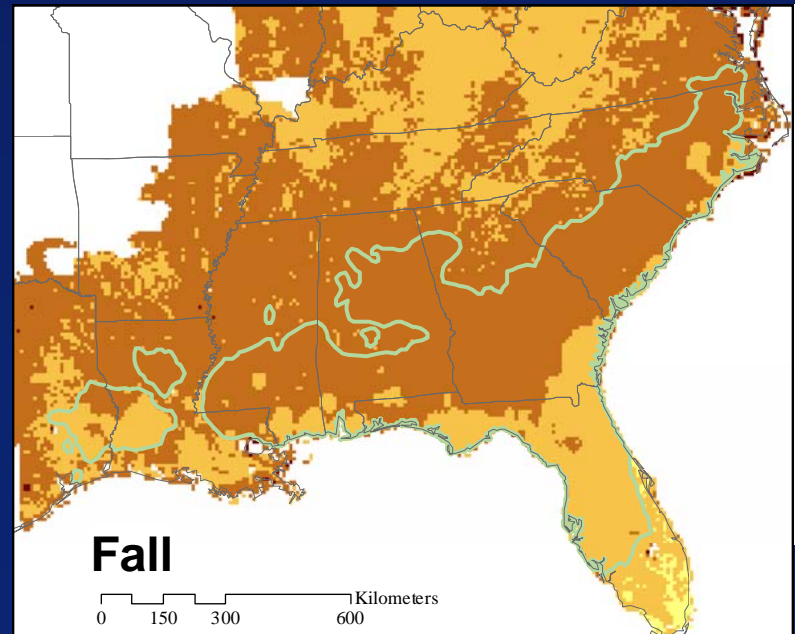
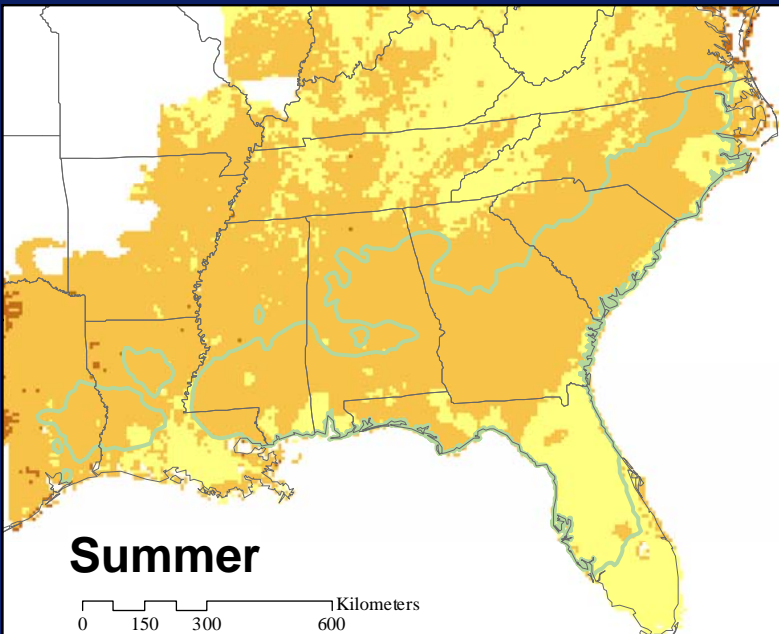
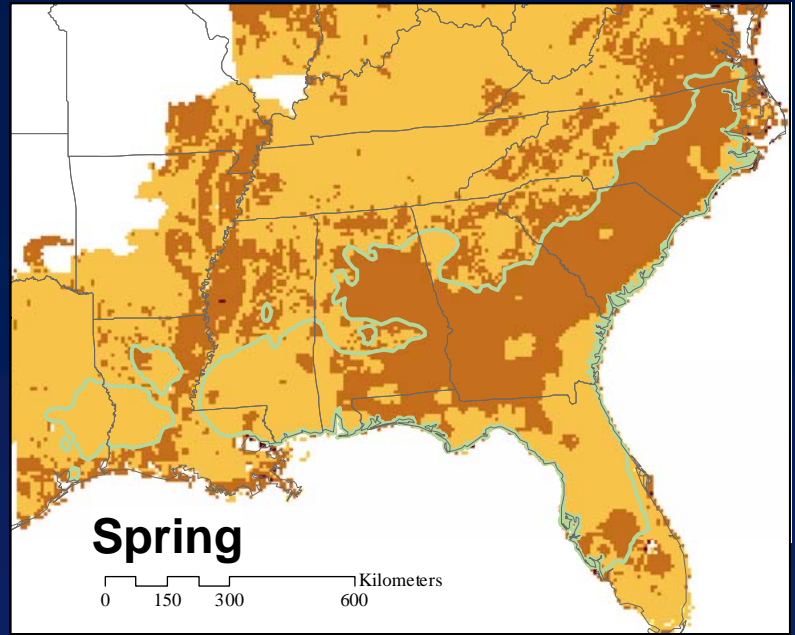
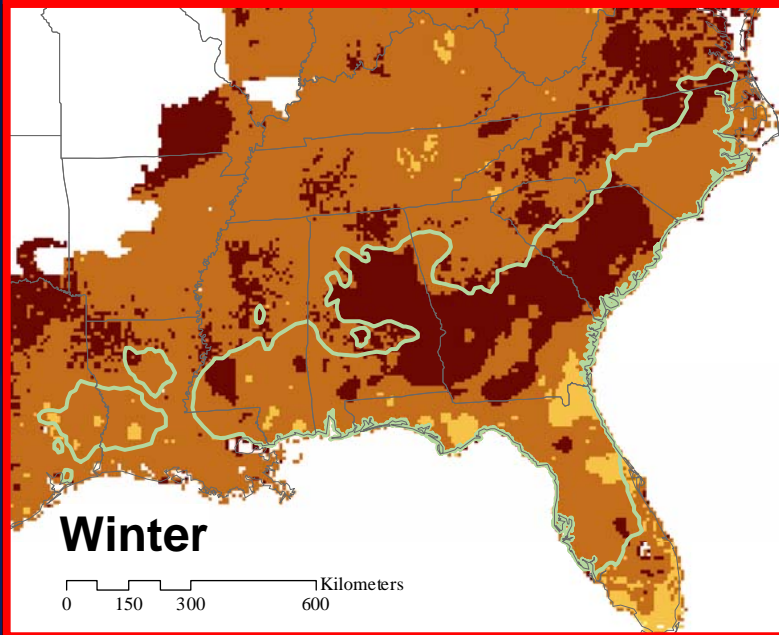
25-35



35-45



> 45



# Seasonal MC

MC  
% Dry Matter



< 12



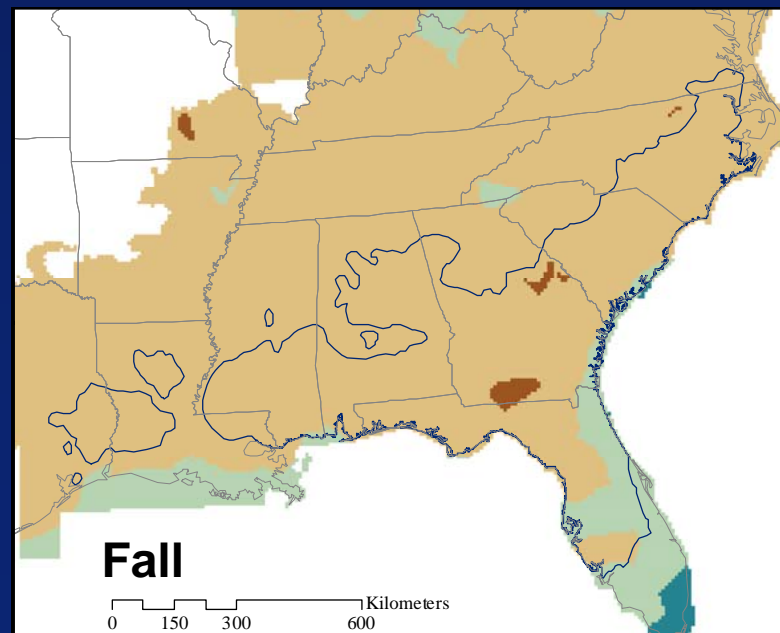
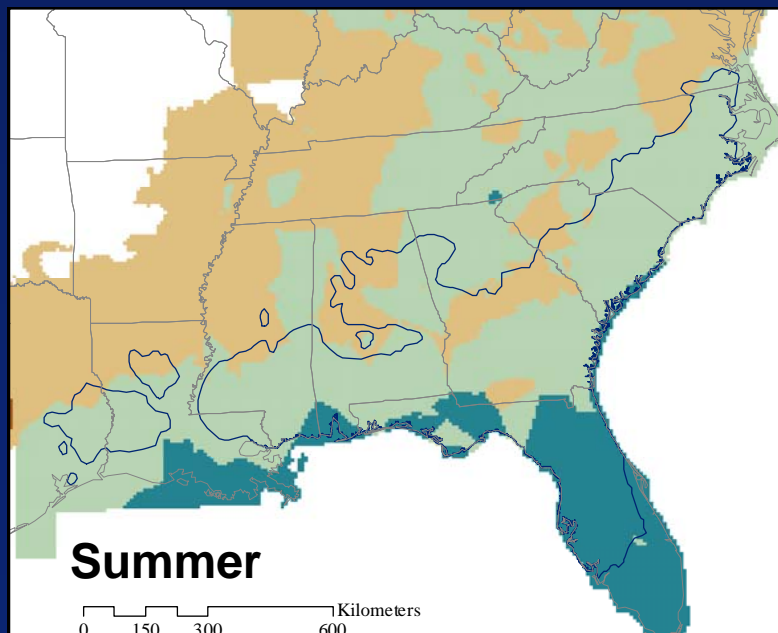
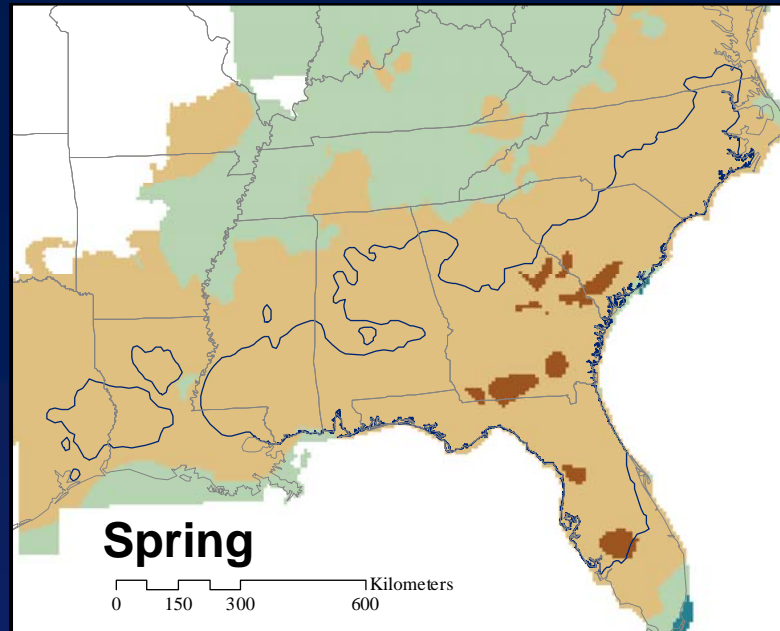
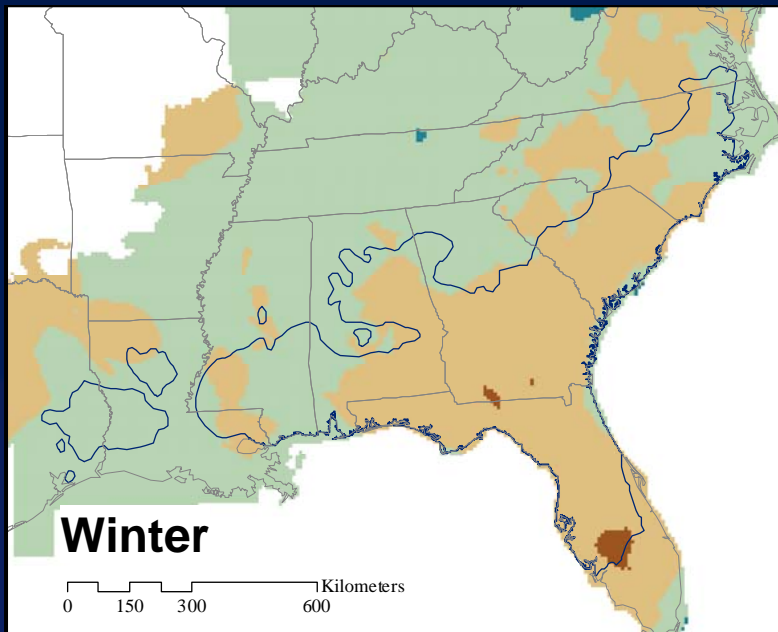
12-15



15-18

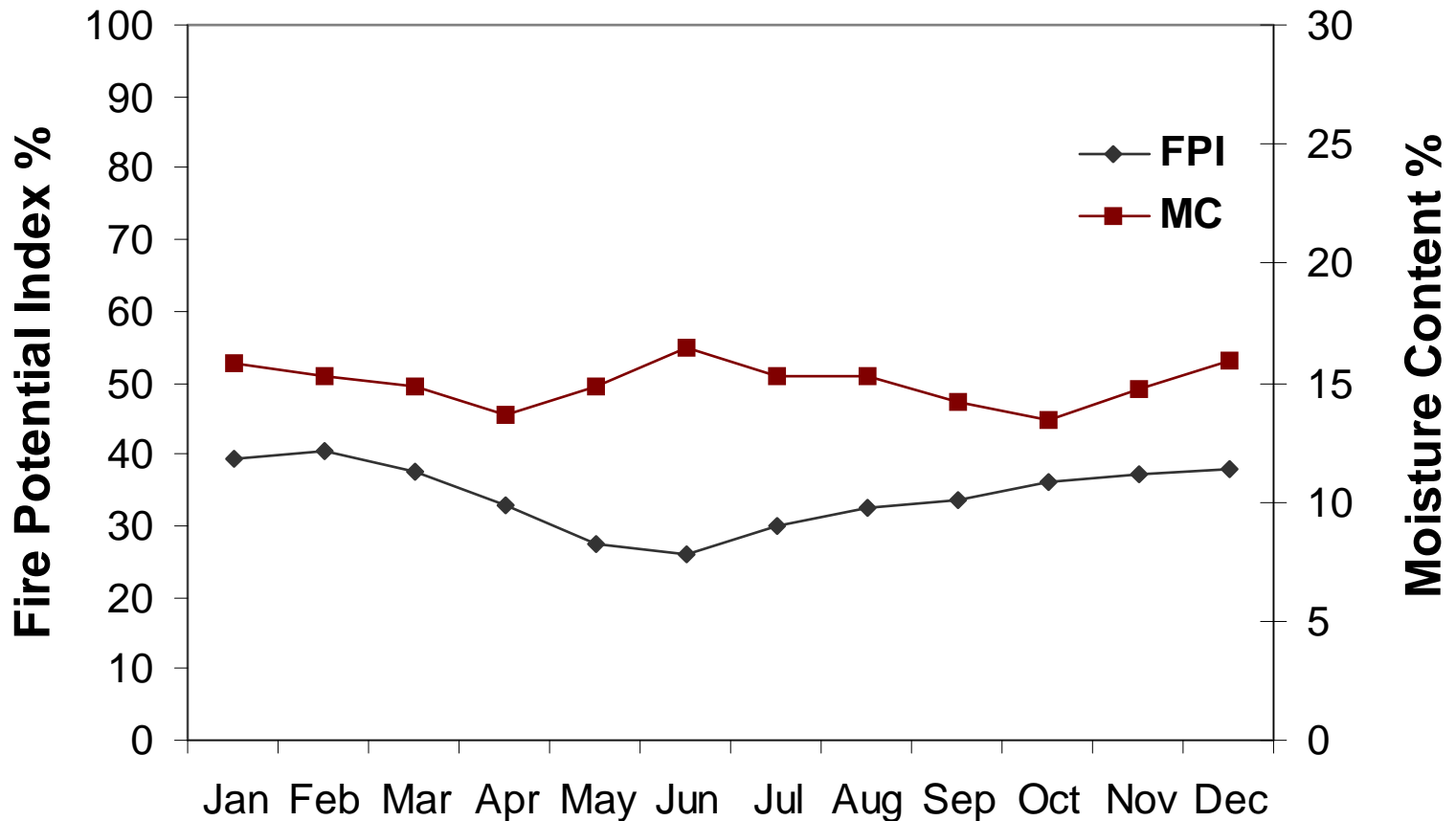


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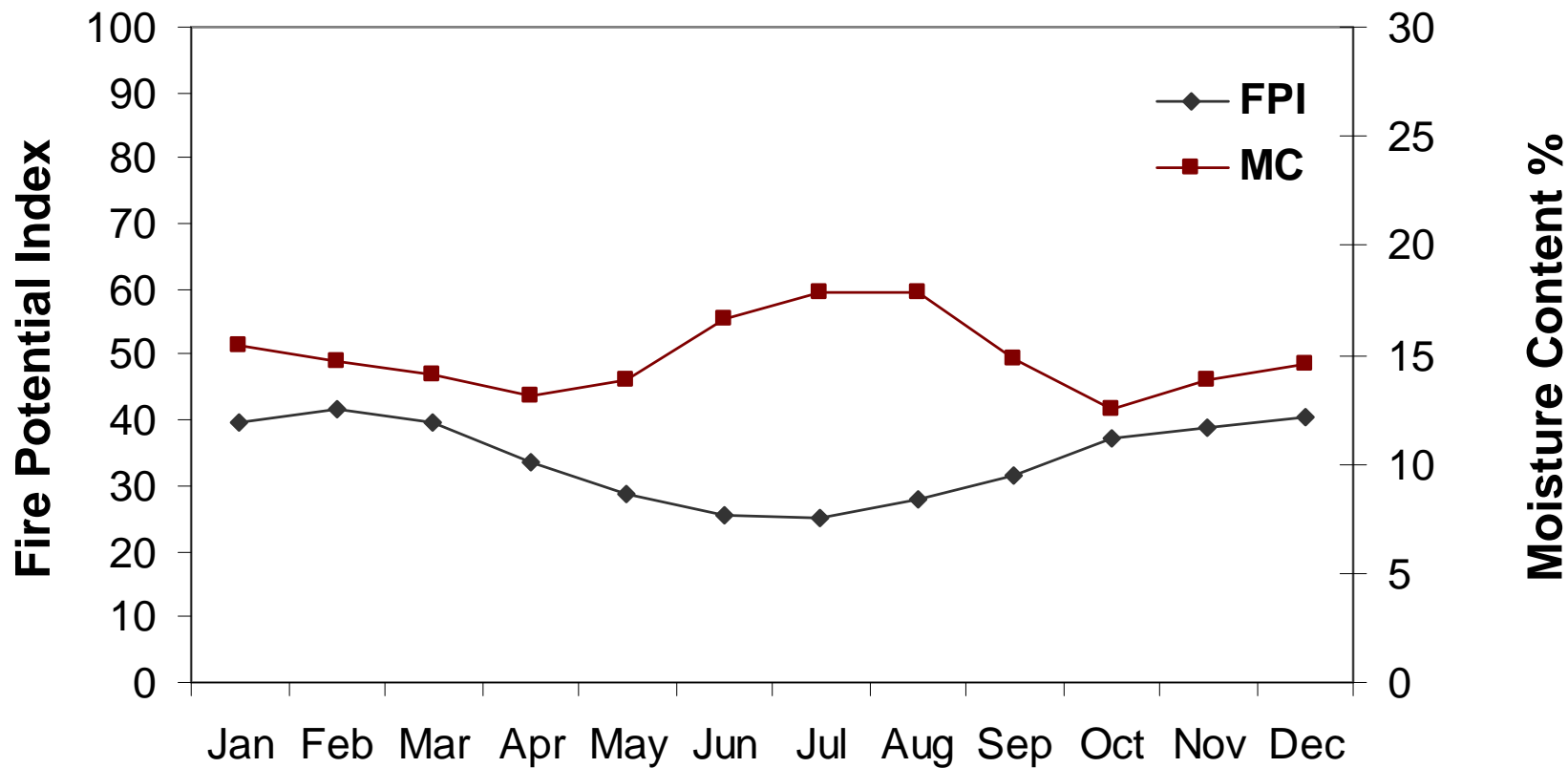
# Characterizing Fire Potential by Ecoregion

## Gulf Coast - Southern Tertiary Plains



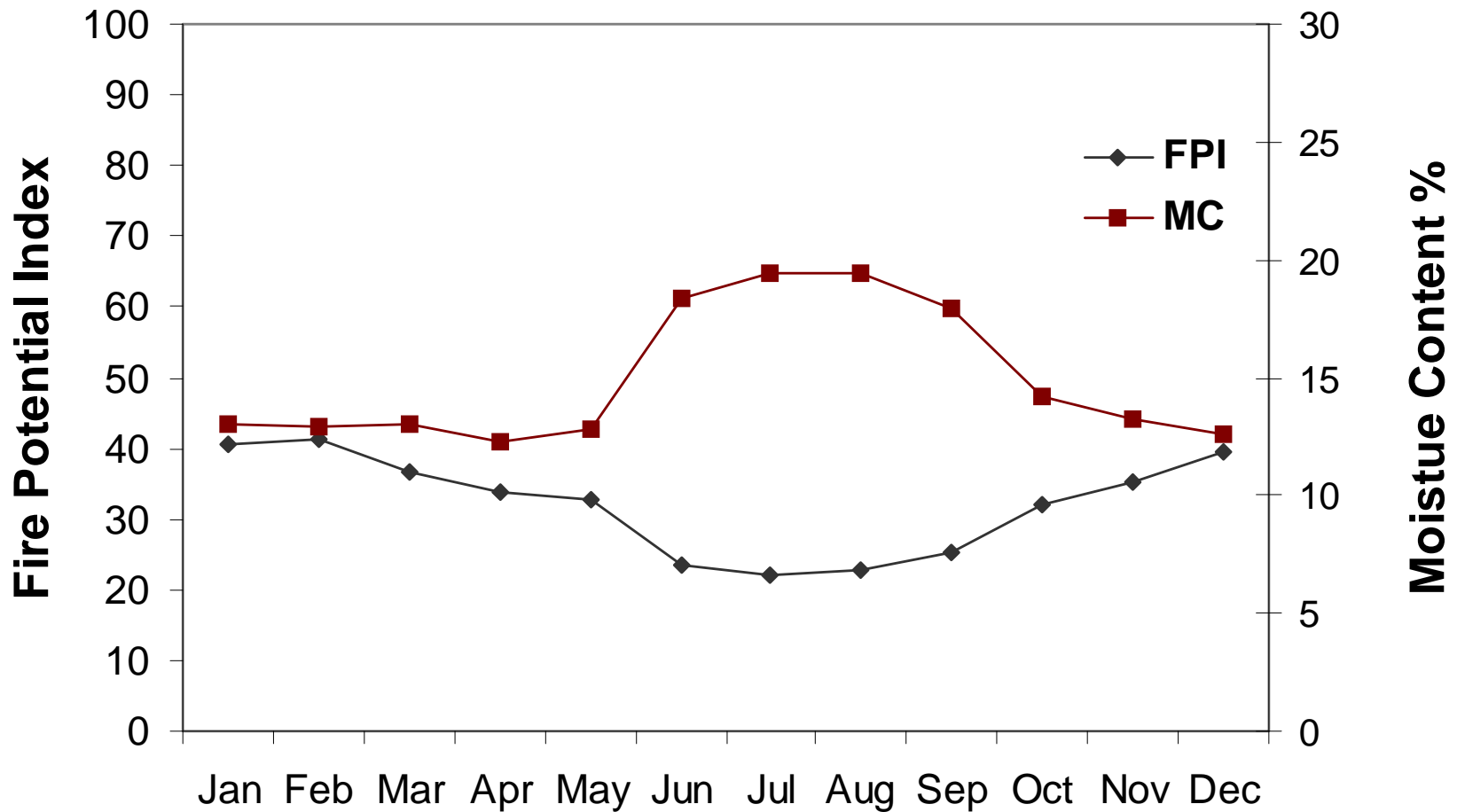
# Characterizing Fire Potential by Ecoregion

## Upper Gulf Coast - Southern Pine Plains



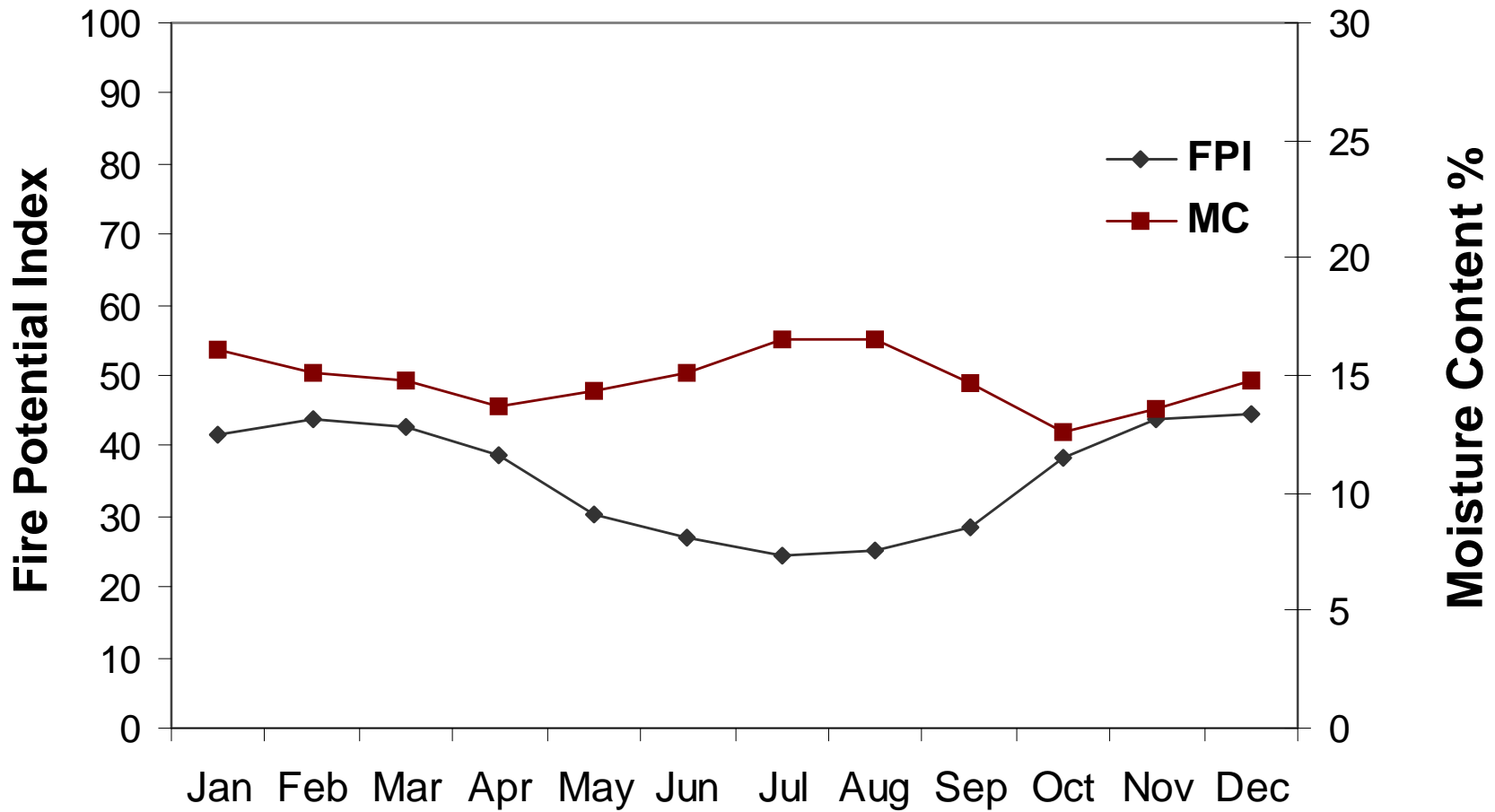
# Characterizing Fire Potential by Ecoregion

## Southwest Florida Flatwoods



# Characterizing Fire Potential by Ecoregion

## Mid-Atlantic Coastal Plain

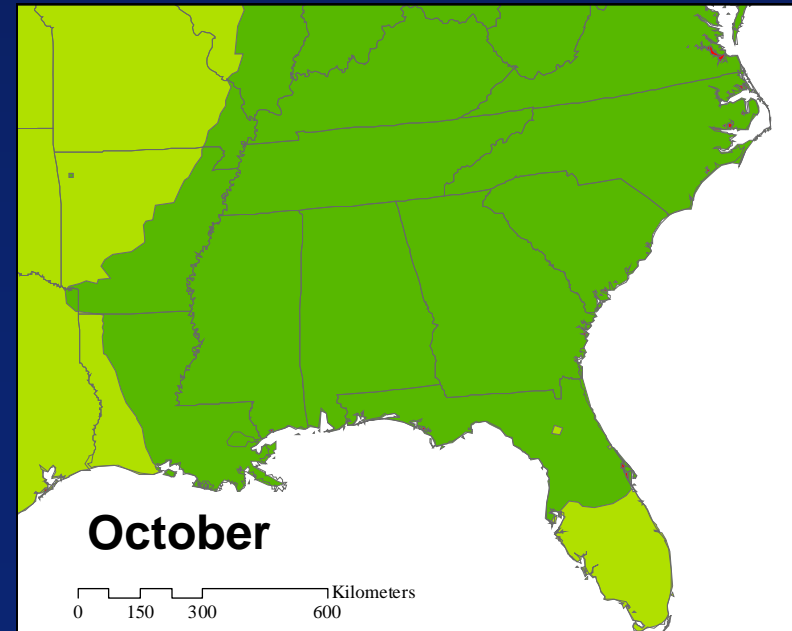
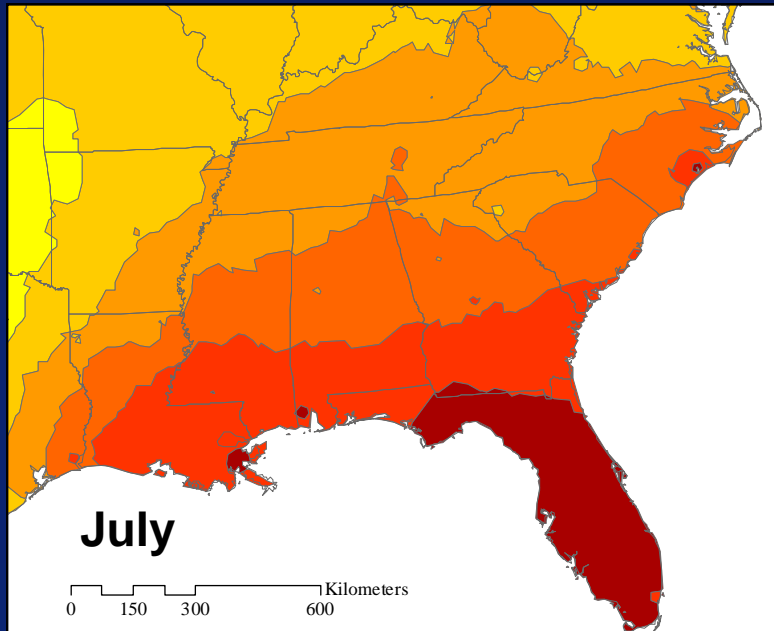
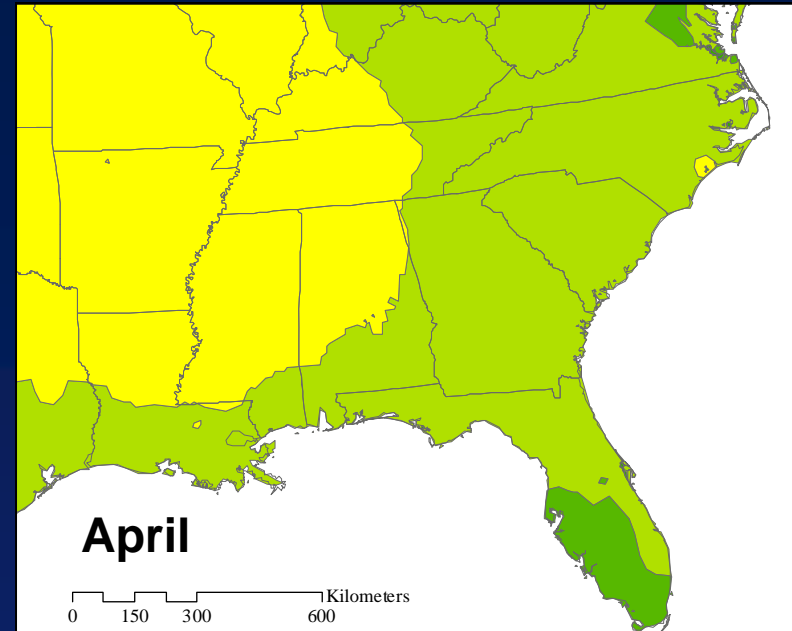
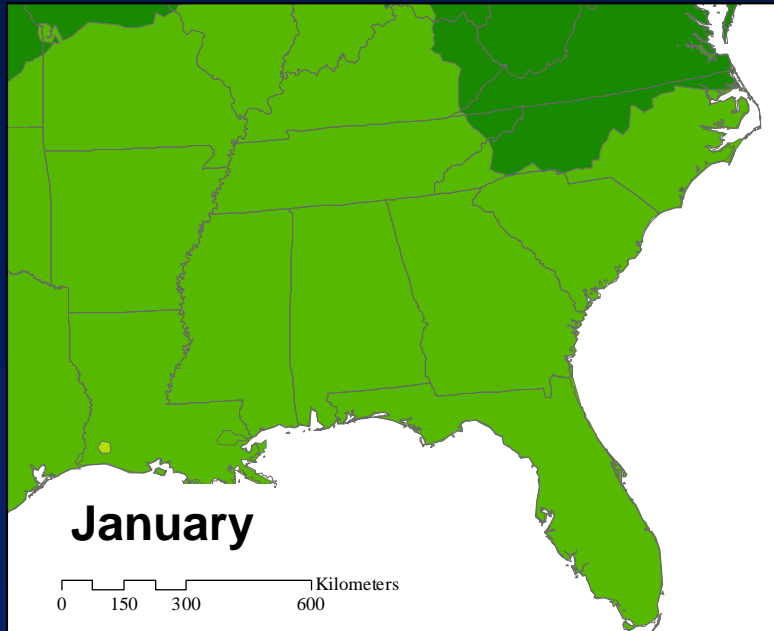
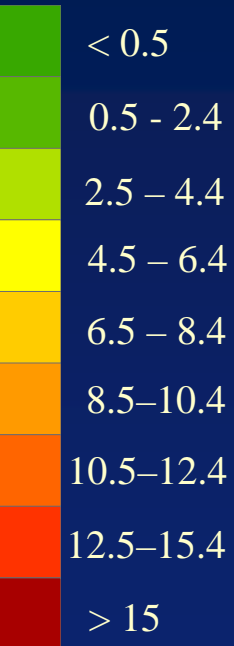


# Ignitions

- Monthly thunderstorm frequency from National Climatic Data Center, NCDC (anthropogenic sources considered in future)
- Threshold of at least 3 storms per month
- Locations with months below threshold drop out of analysis

# Thunderstorm Seasonality

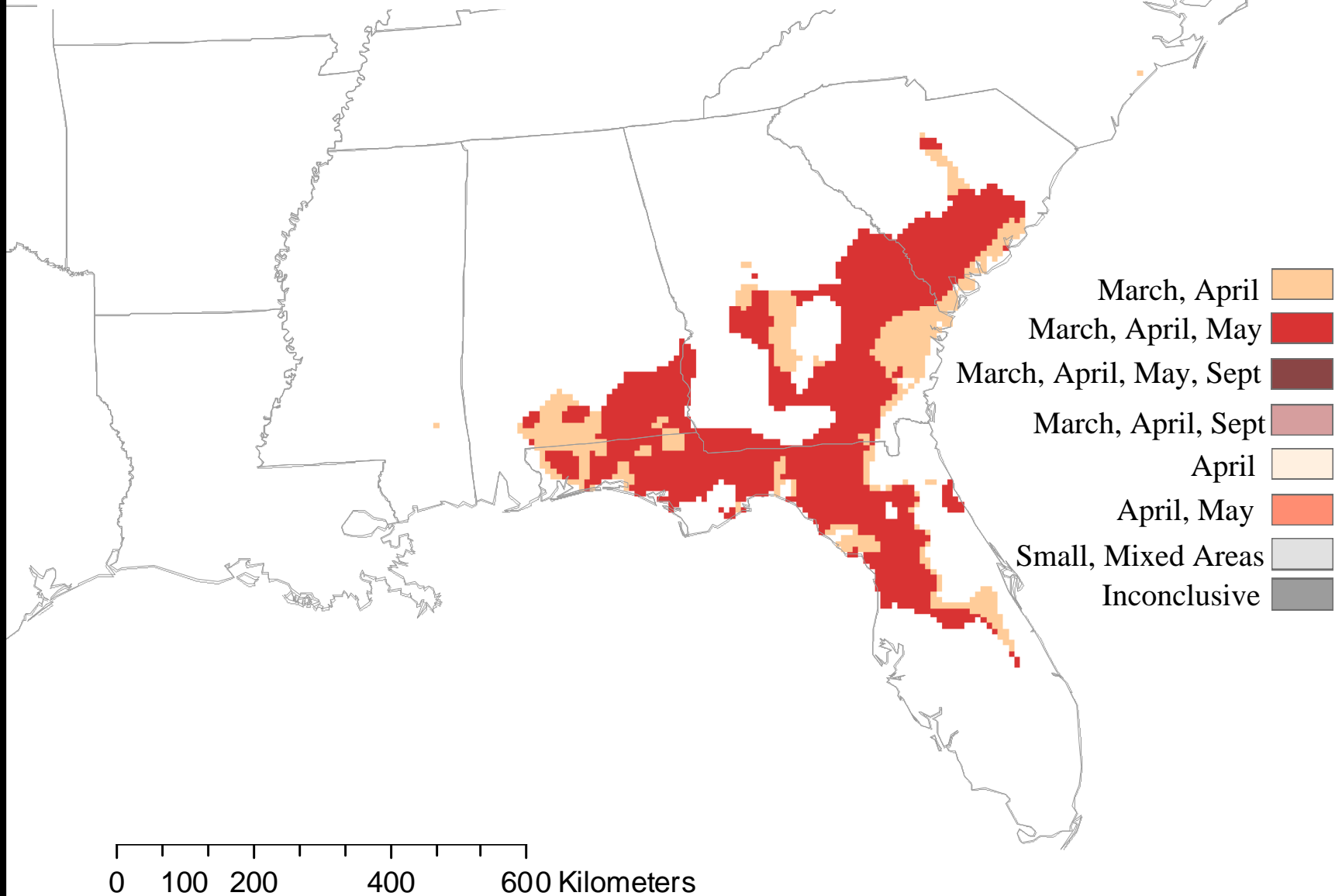
Days per Month



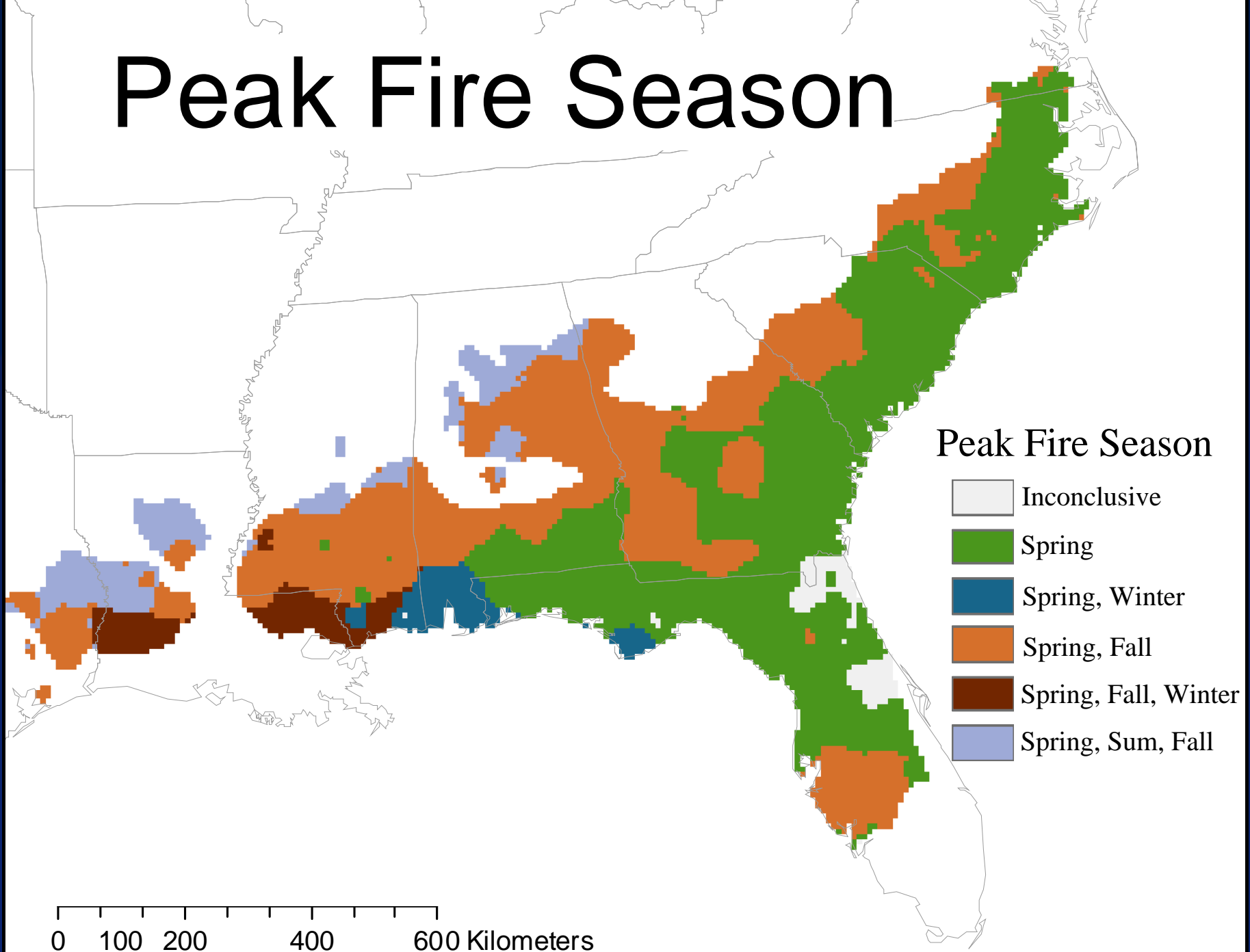
# Final Fire Season Model

- Ignitions: More than 3 thunderstorms per month
- Dryness and Fuel: Mean monthly FPI 30 or higher
- Localized Dryness: Mean monthly MC below yearly mean MC

# Peak Fire Season



# Peak Fire Season



# Next Steps

- Expert review of the peak fire season.
- Use drought indices that incorporate local soil information.
- Integrate results with soils, landform, and fire blocks to identify the pre-settlement longleaf distribution.
- Use Southeast Gap Analysis land cover data to identify potential restoration areas within the pre-settlement distribution.
- Off fire season modeling to test the sensitivity of the predicted distribution to anthropogenic burning.

# Questions?

<http://www.basic.ncsu.edu/segap>

Southeast Gap Analysis Project

- Home
- Mission
- Land Cover
- Mapping
- Vertebrate
- Modeling
- Stewardship
- Analysis
- Contact
- Links

## SOUTHEAST GAP ANALYSIS PROJECT



The Southeast Gap Analysis Project (SEGAP) is a regional representative of the National Gap Analysis Program sponsored by the Biological Resources Division of the United States Geological Survey (USGS-BRD).

"The intent of the Gap Analysis is to provide focus and direction for proactive rather than reactive land management activities at the community and landscape levels" (J. Michael Scott, 1995).

A cooperative project by:

- USGS Biological Resources GAP National Gap Analysis Program
- AL-GAP
- NC GAP
- GEORGIA GAP

For questions or comments related to this website, please contact: [Steve.Villiers@ncsu.edu](mailto:Steve.Villiers@ncsu.edu)  
Updated 04-12-2004 by Andrew Bailey

*Special Thanks to Cecil Frost and Curtis Belyea*