Comparison of KBDI (Keetch-Byram Drought Index) and In-Situ Measured Soil Moisture as Predictors of Large Wildfires in Oklahoma

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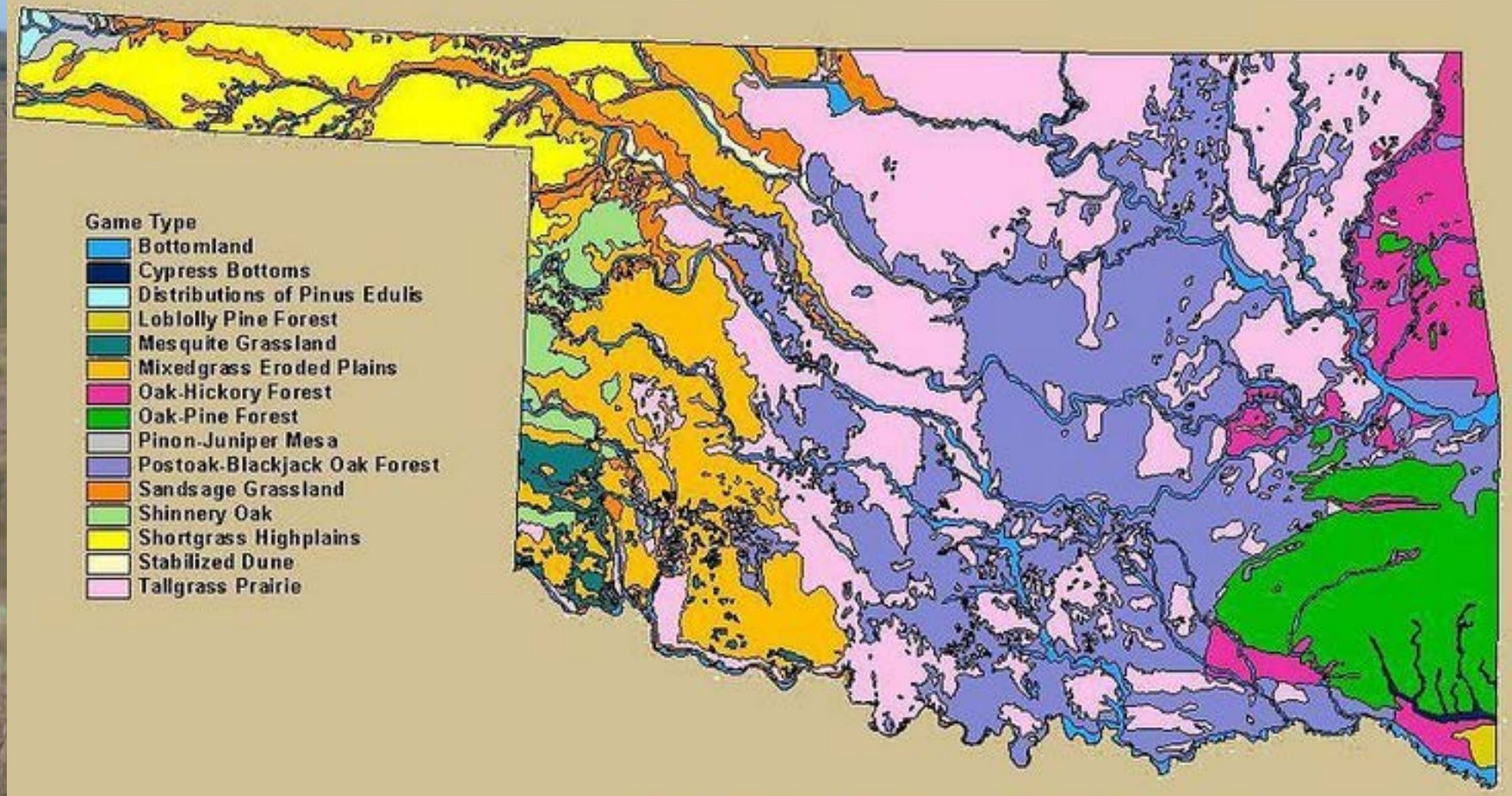
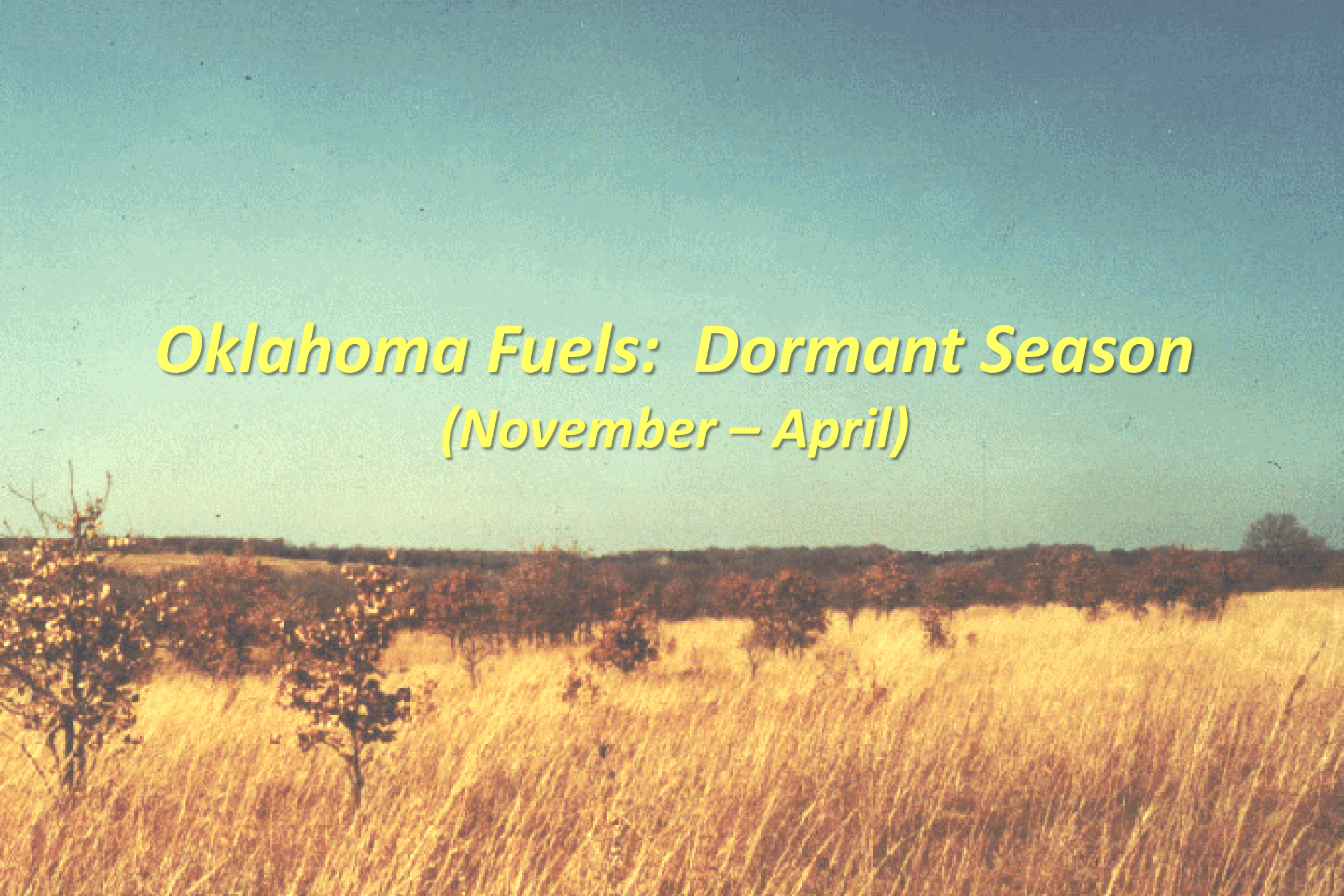
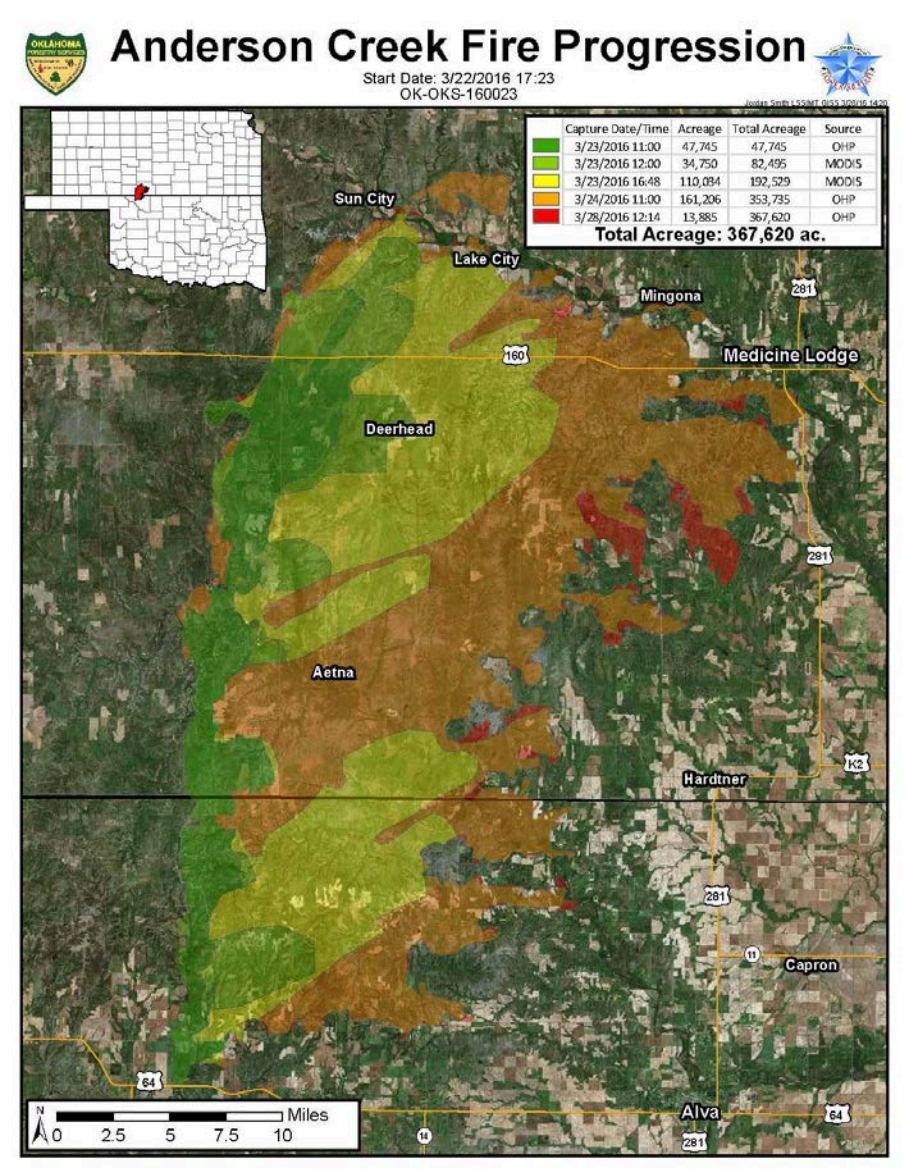


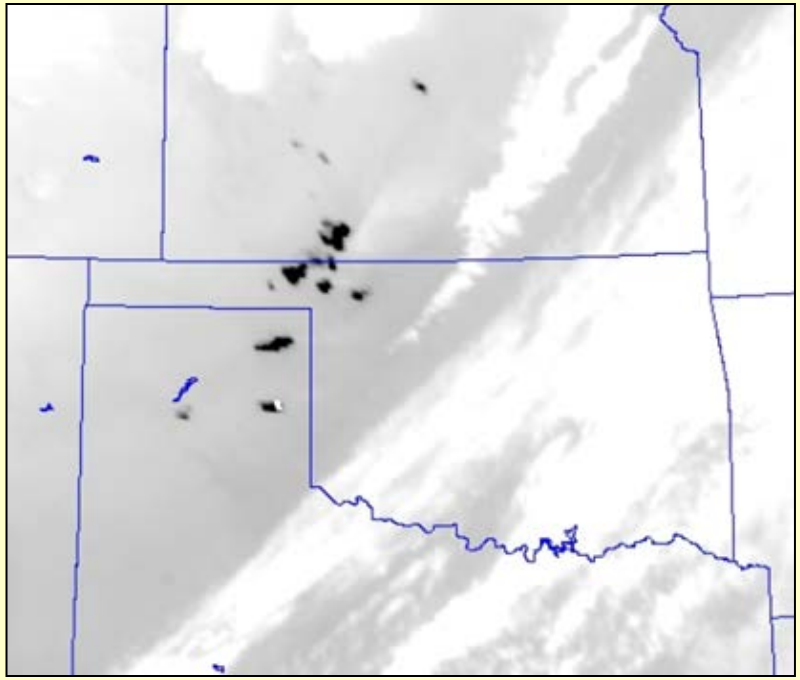
Map courtesy of Oklahoma Biological Survey


Oklahoma Fuels: Dormant Season
(November – April)

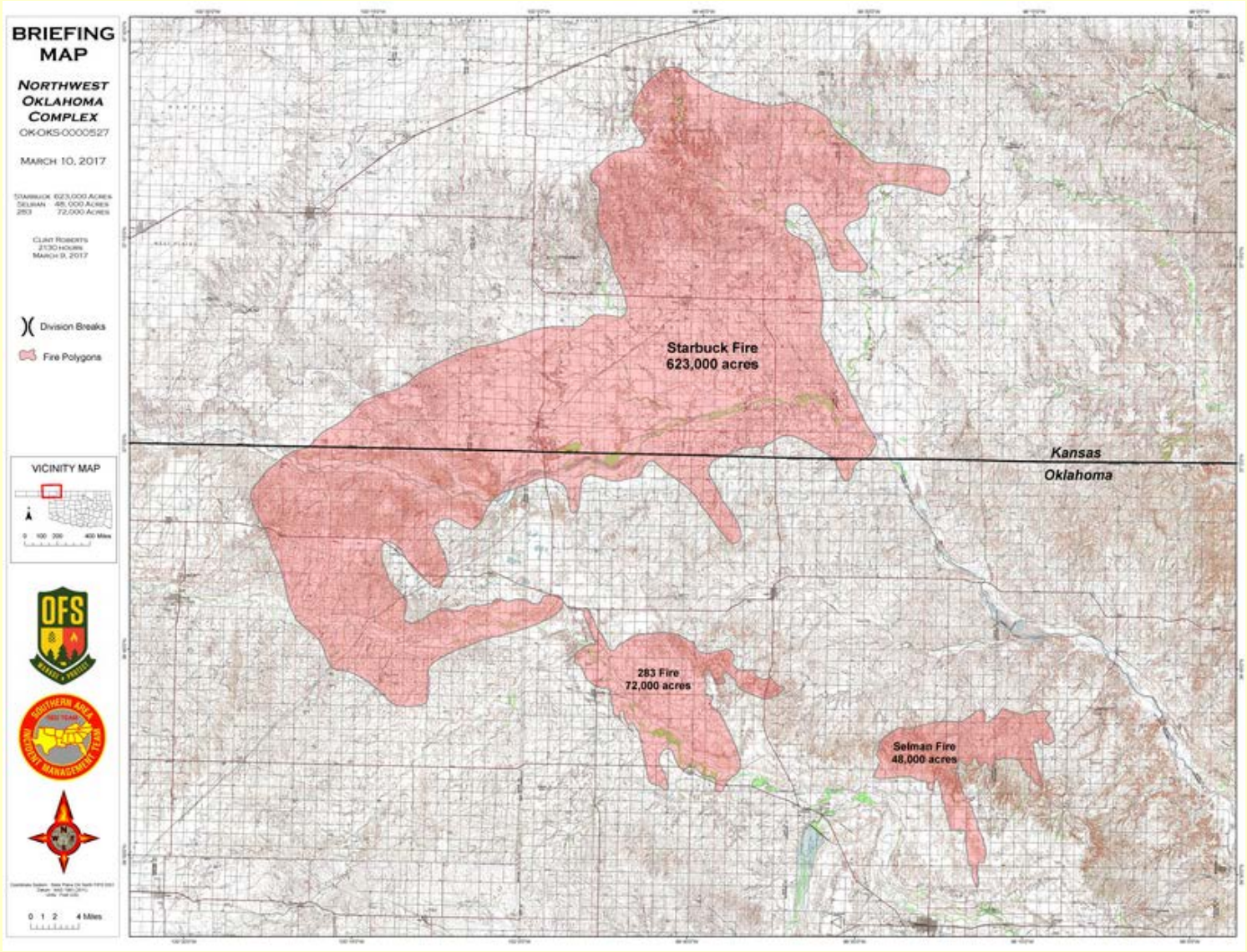
Anderson Creek Fire (March 22 – April 3, 2016)
367,620 acres (148,770 ha)



Northwest Oklahoma Complex (March 6 - 20, 2017)
> 1.25 million acres (505,857 ha)



Starbuck Fire (March 6 -20, 2017)
662,687 acres (268,180 ha)




Oklahoma Fuels: Growing Season
(May – October)


Growing Season Wildfires
August 4-5, 2012
“Glencoe” fire: 7,000 acres, 23 homes destroyed

Keystone/Terlton Complex

August 5-10, 2011

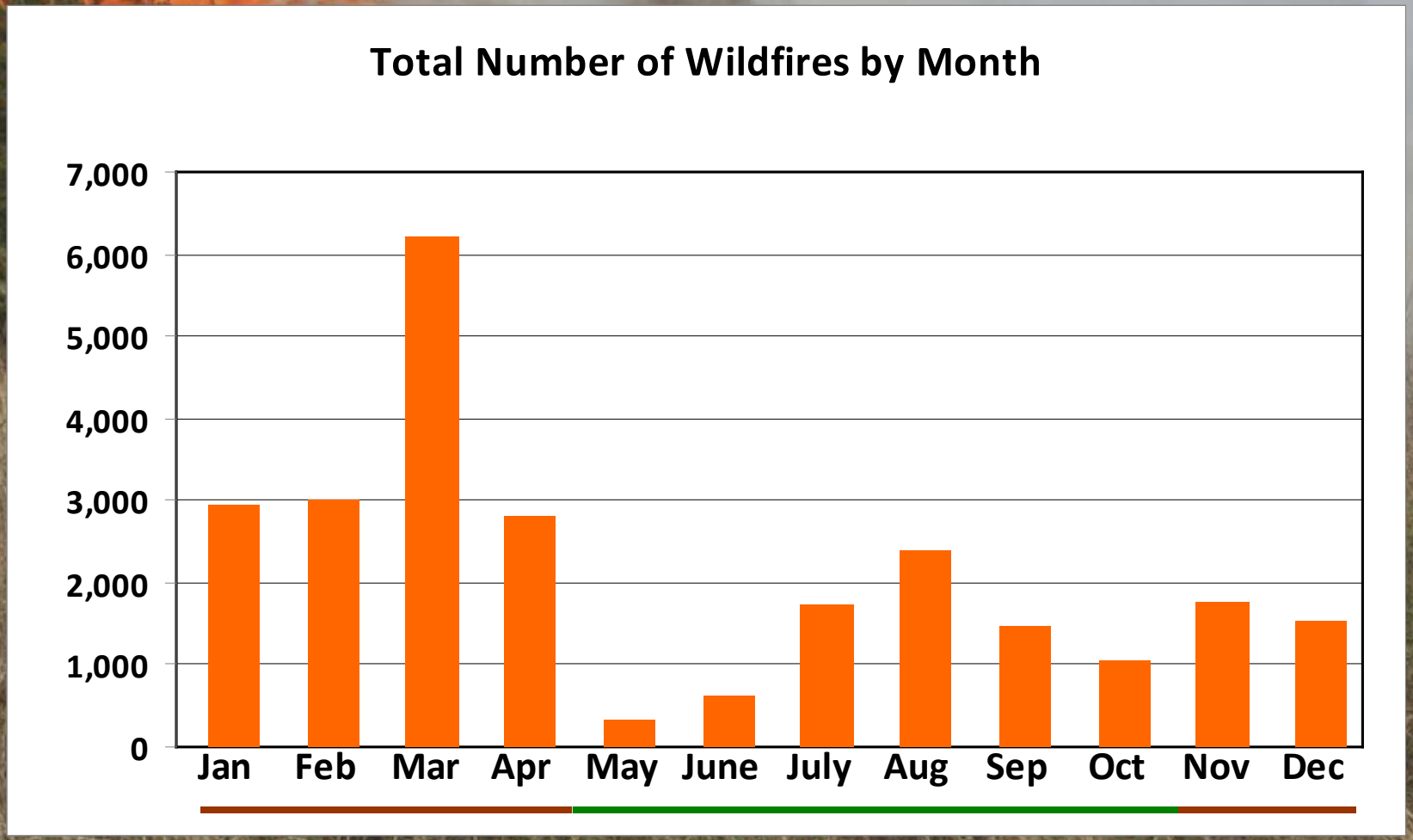
18,000 acres (7284 ha)

Ferguson Fire

September 1-10, 2011

39,907 acres (16,150 ha)

Oklahoma Wildfire Monthly Climatology
(25,829 wildfires from 2000-2012)



Oklahoma Wildfire Monthly Climatology
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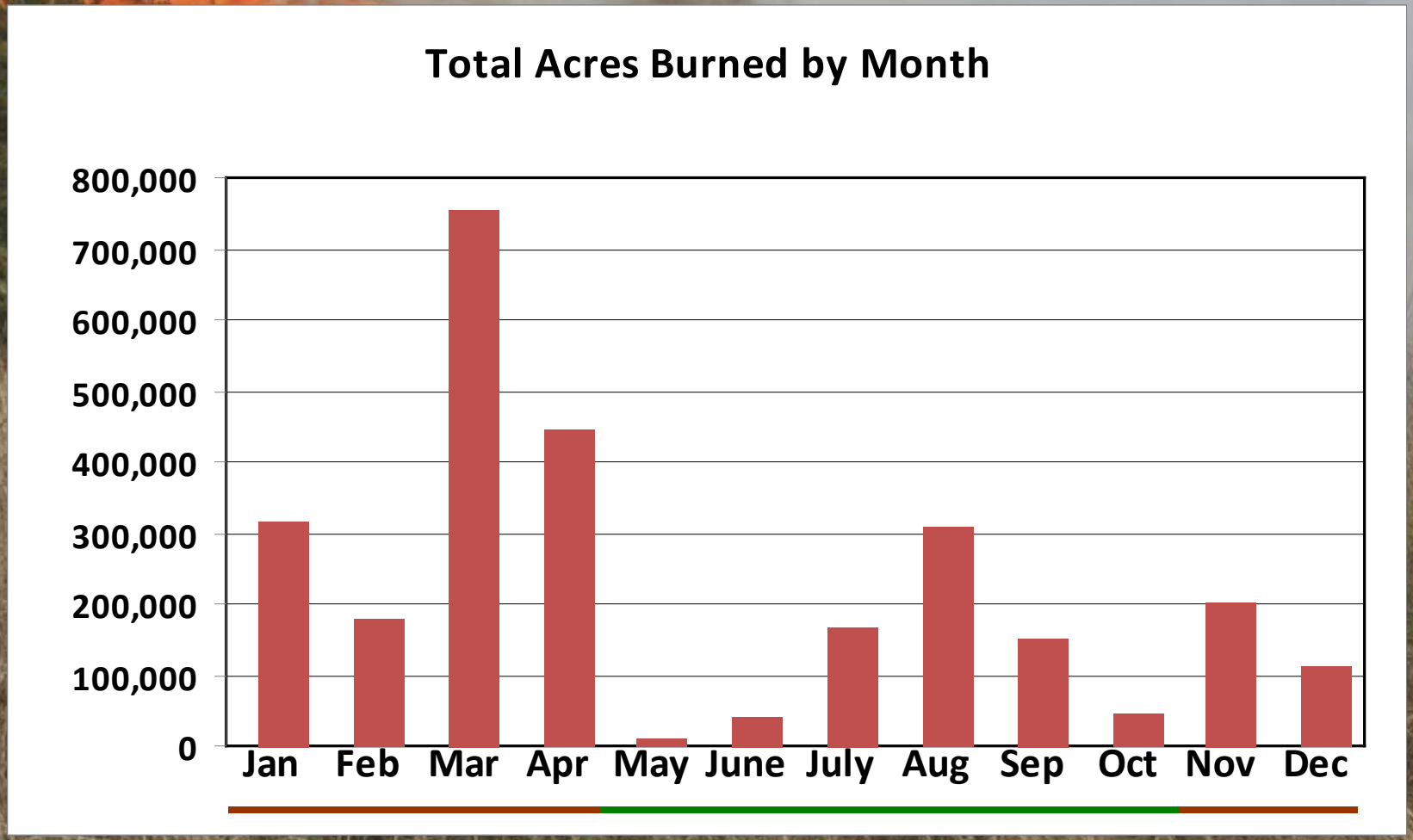
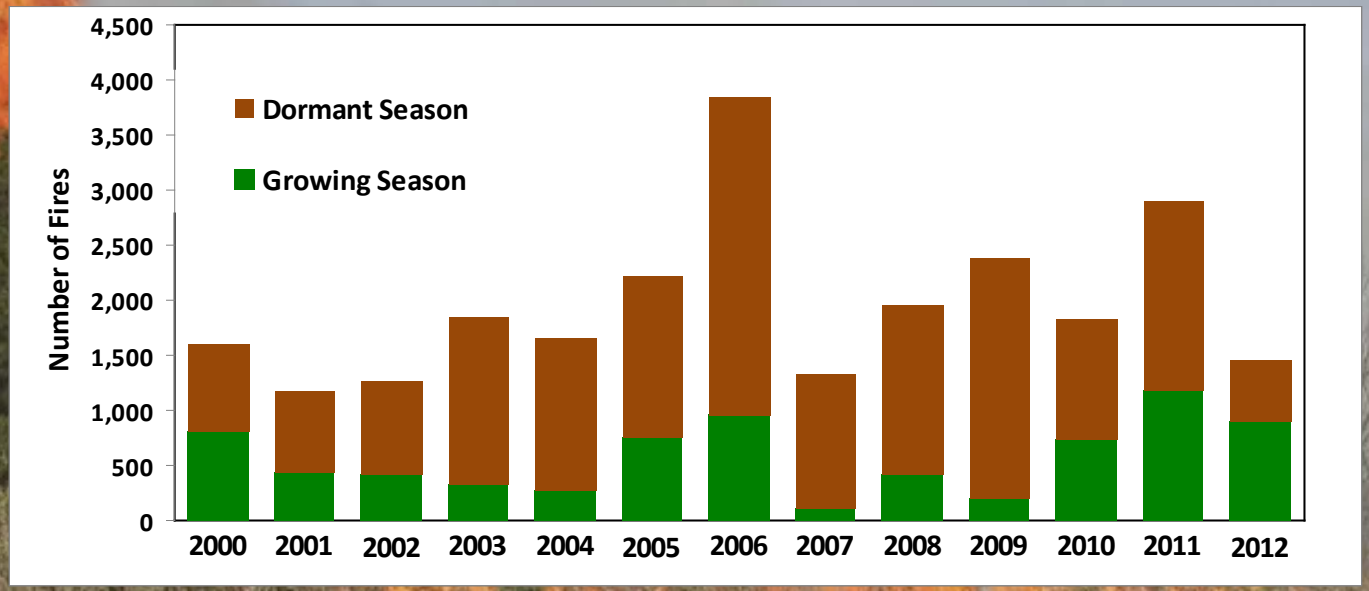
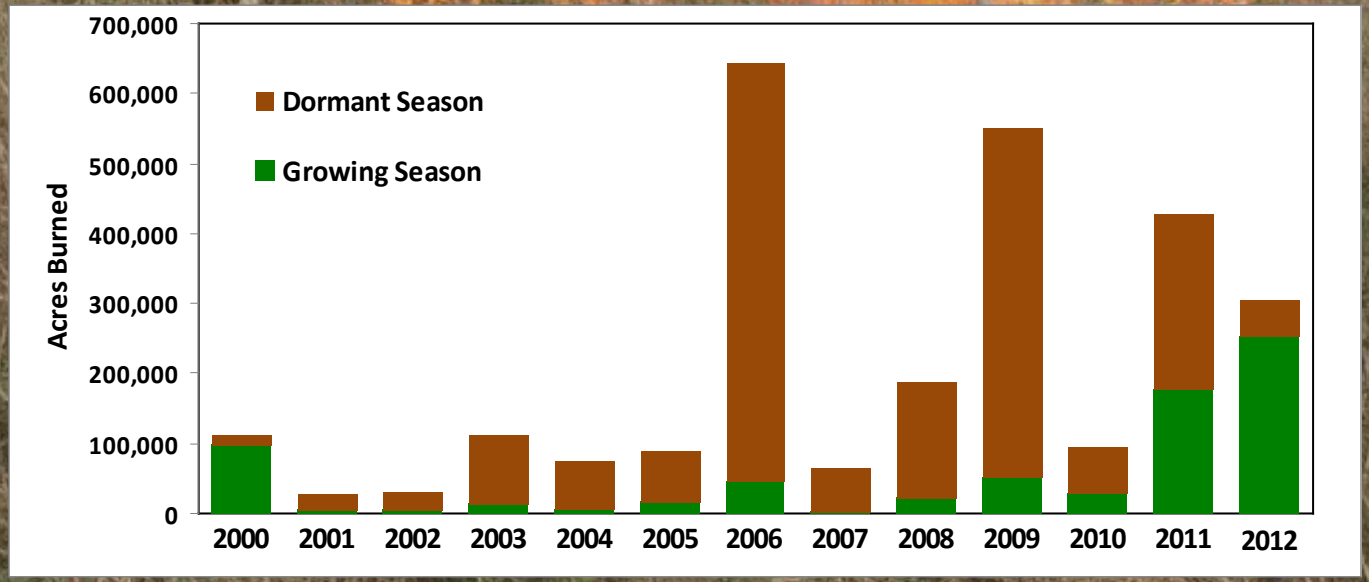


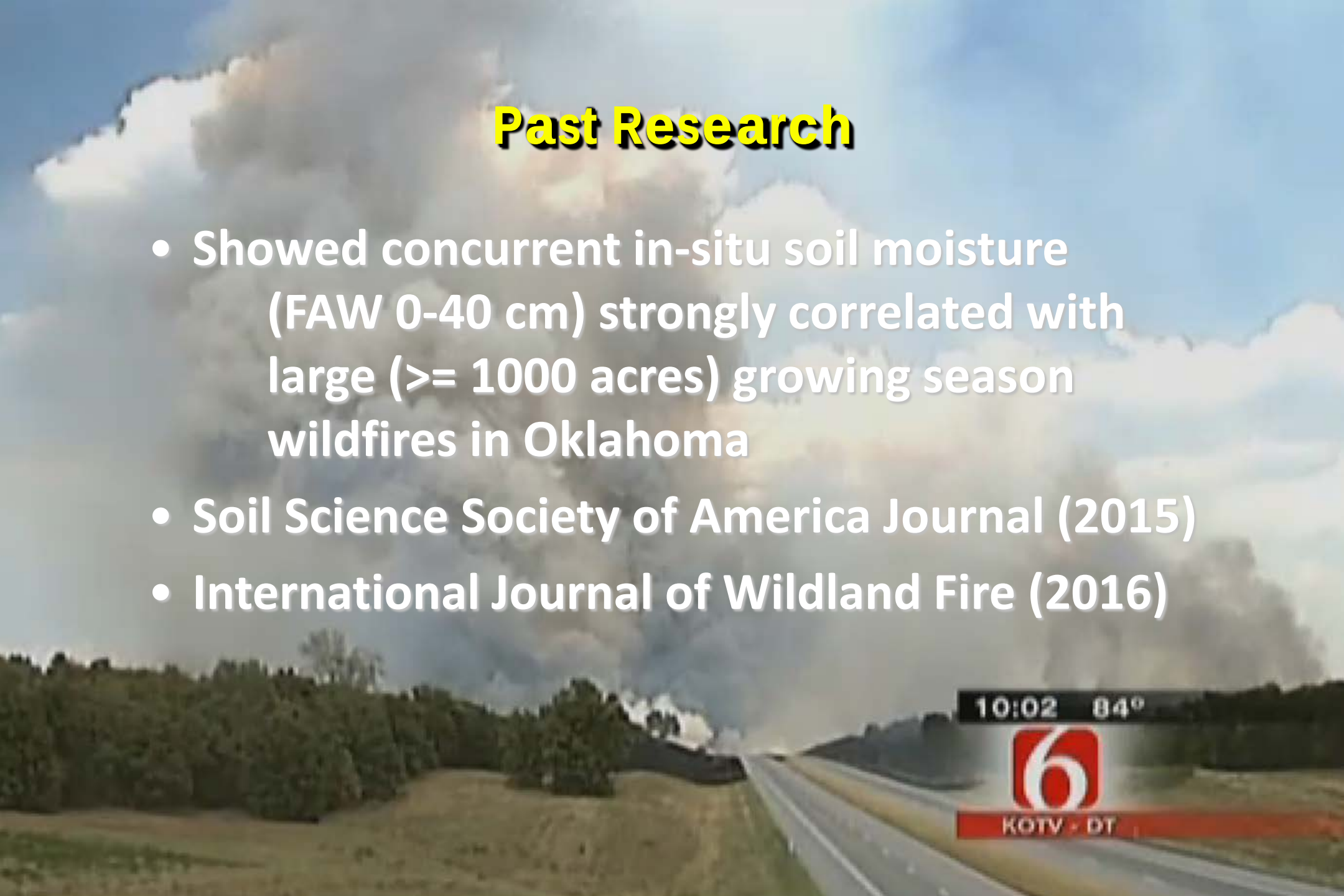
Oklahoma Wildfires by Year (2000-2012)





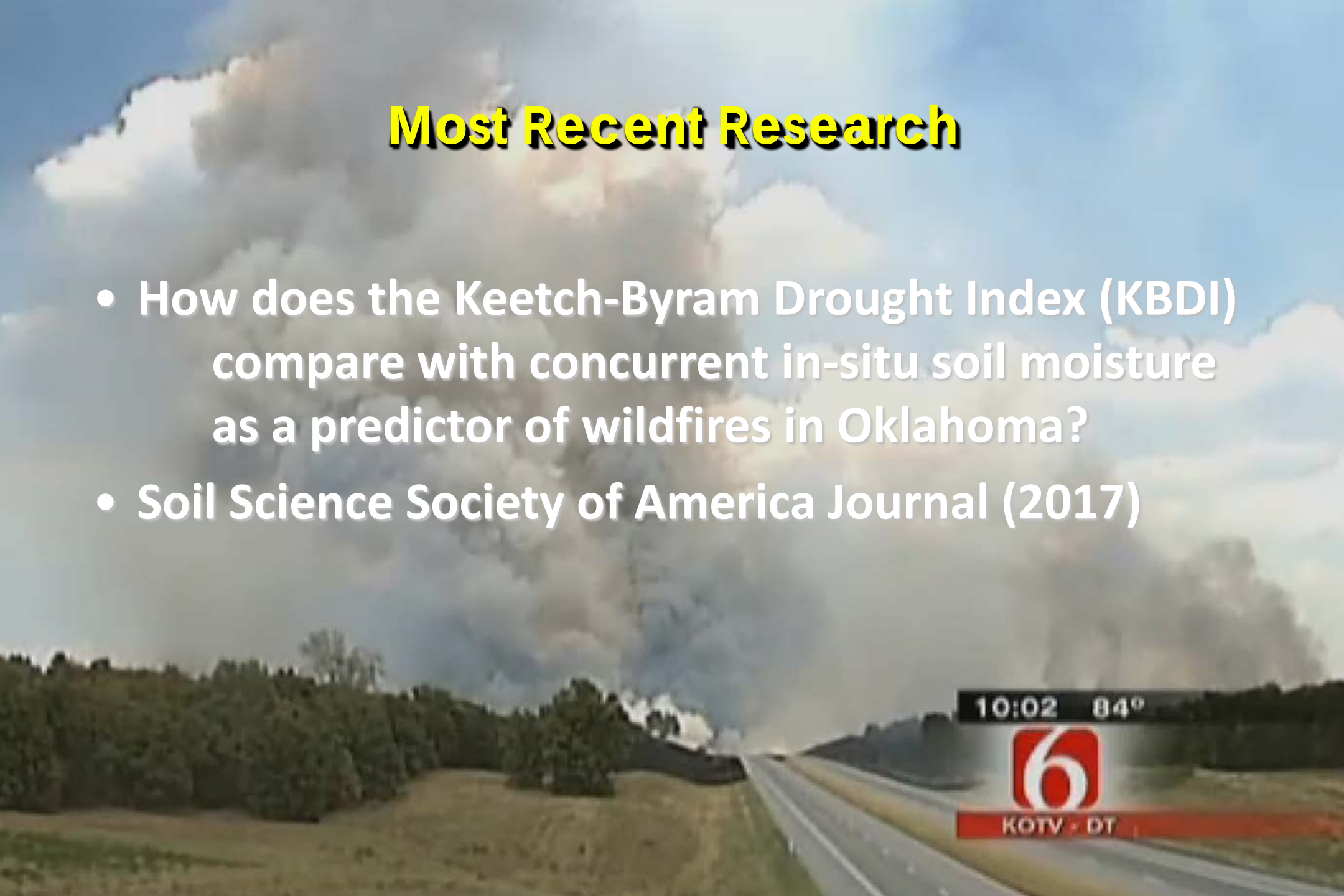
Past Research

- Showed concurrent in-situ soil moisture (FAW 0-40 cm) strongly correlated with large (>= 1000 acres) growing season wildfires in Oklahoma
- Soil Science Society of America Journal (2015)
- International Journal of Wildland Fire (2016)



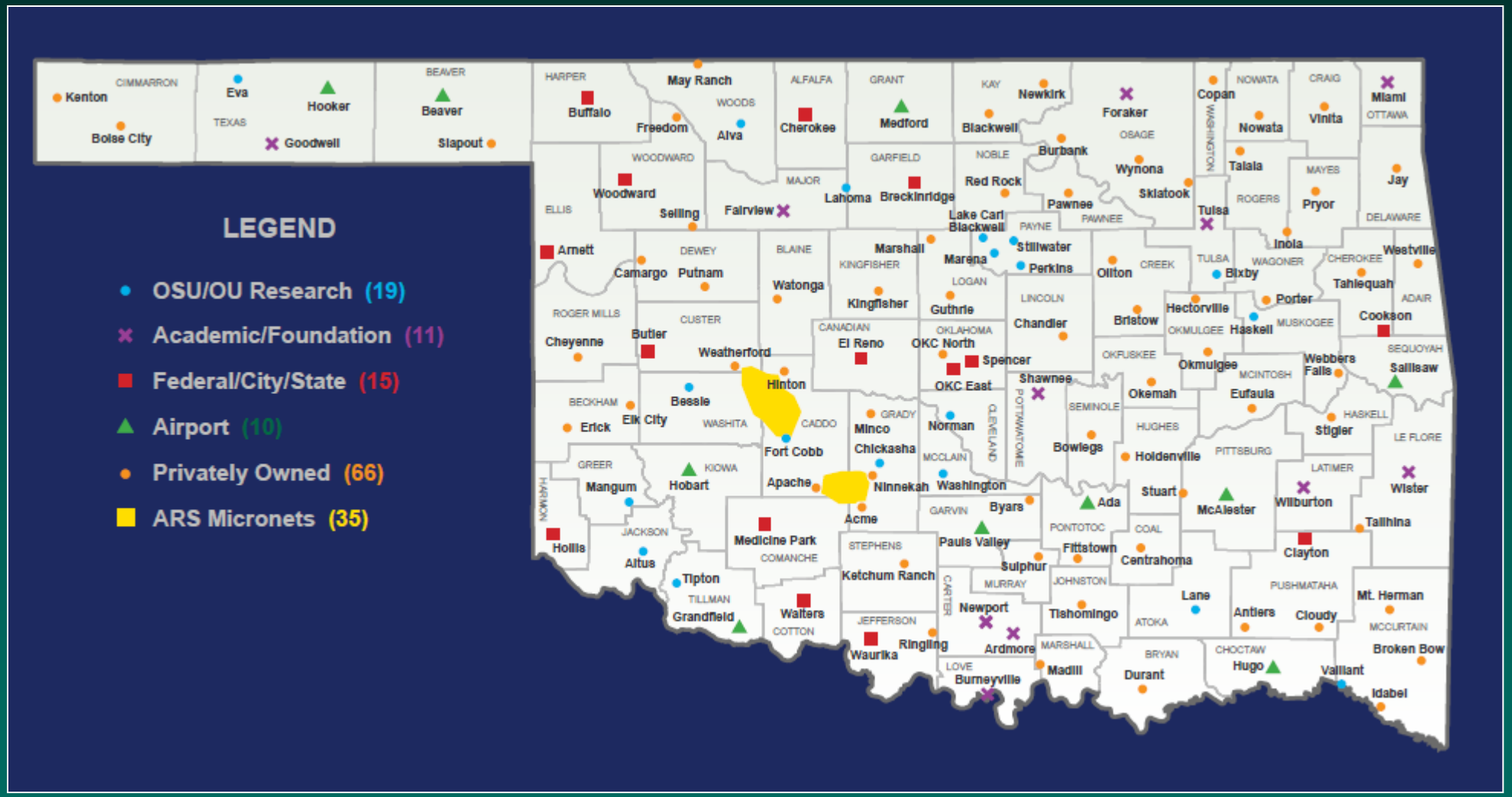
Most Recent Research

- How does the Keetch-Byram Drought Index (KBDI) compare with concurrent in-situ soil moisture as a predictor of wildfires in Oklahoma?
- Soil Science Society of America Journal (2017)



The Oklahoma Mesonet

Oklahoma Mesonet Tower Locations

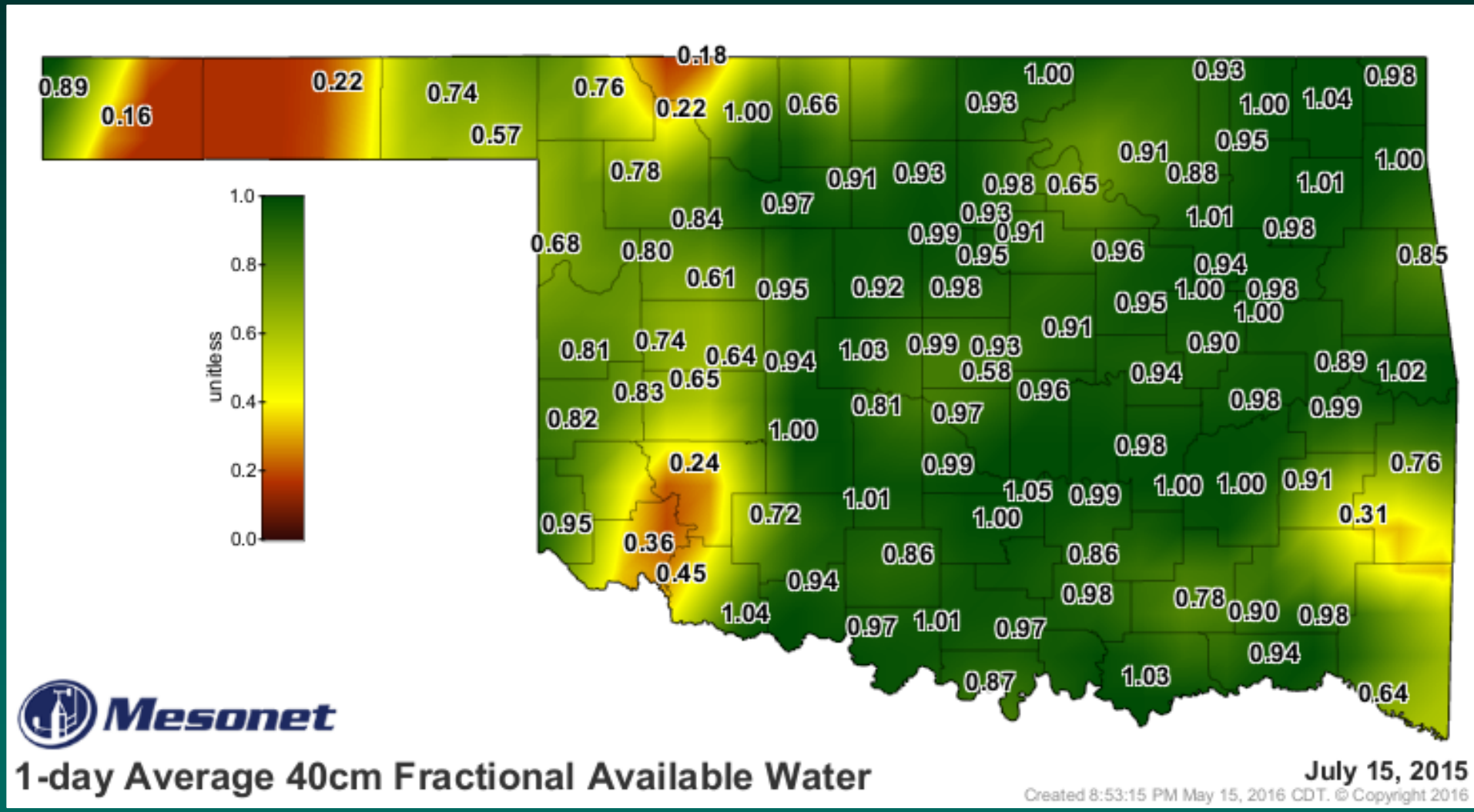


Soil Moisture
Fractional Available Water (FAW)

- Mesonet soil moisture sensors at 5, 25, 60 cm *(30 min)*
- Volumetric Water Content (VWC) at each depth
- Integrated Plant Available Water (PAW) in 0-10, 10-40, and 40-80 cm layers: PAW = $(VWC - VWC_{wp})*d$
- FAW = $[(VWC - VWC_{wp})*d] / [(VWC_{fc} - VWC_{wp})*d]$
- Daily average, depth-weighted FAW for 0-40, 40-80, and 0-80 cm

usually 0 <= FAW <= 1

Fractional Available Water 0-40 cm



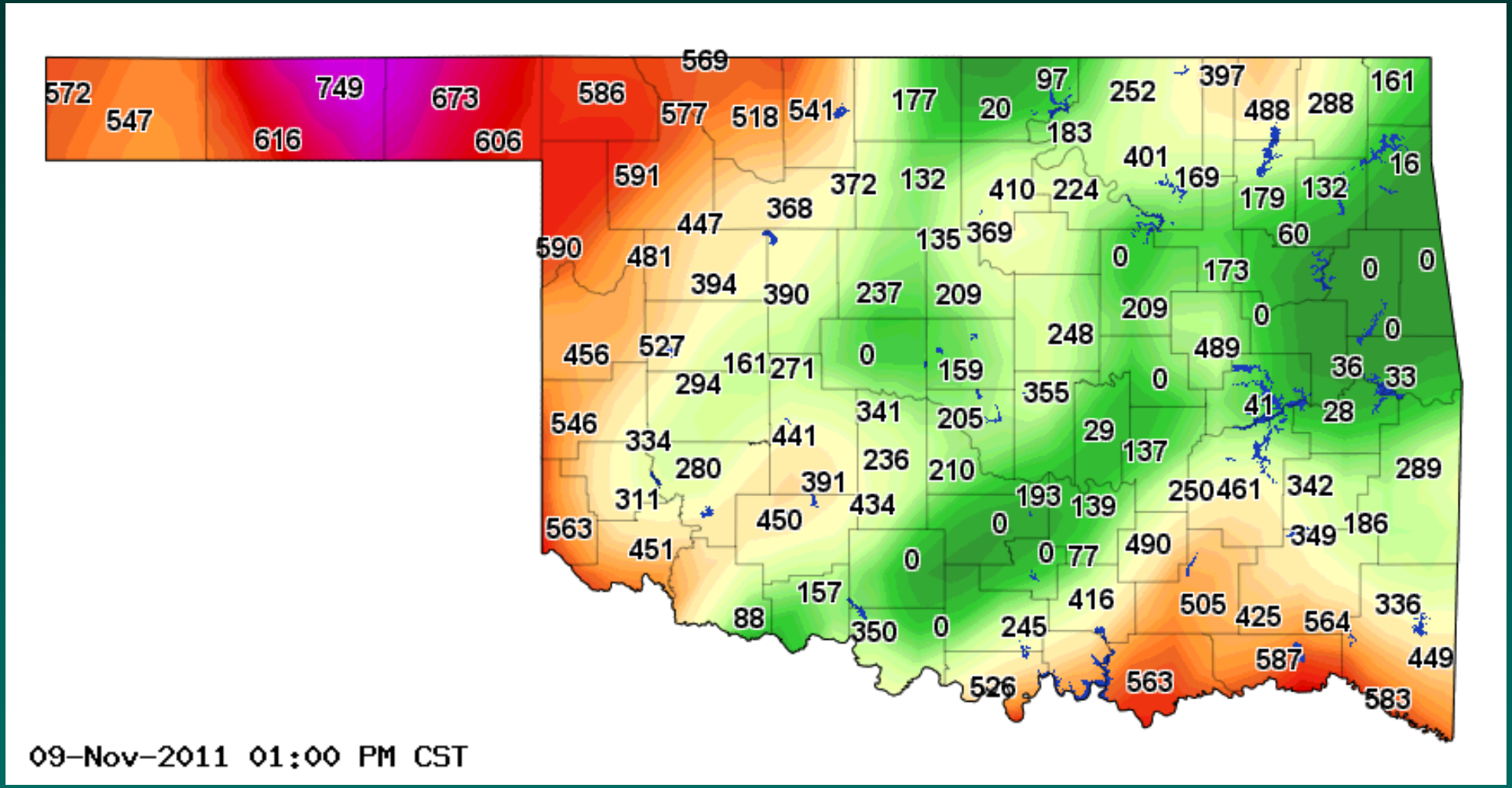
KBDI
(Keetch-Byram Drought Index)

- Uses only daily precipitation for recharge and daily max air temperature to estimate daily ET
- Subtracts off first 0.2” of a continuous rainfall event (assumes intercepted by tree canopy)
- Doesn’t take into account soil properties
- Assumes an 8” water holding capacity of the soil
- Designed to represent soil moisture to a depth of 76-89 cm (30-35”)

0 <= KDBI <= 800

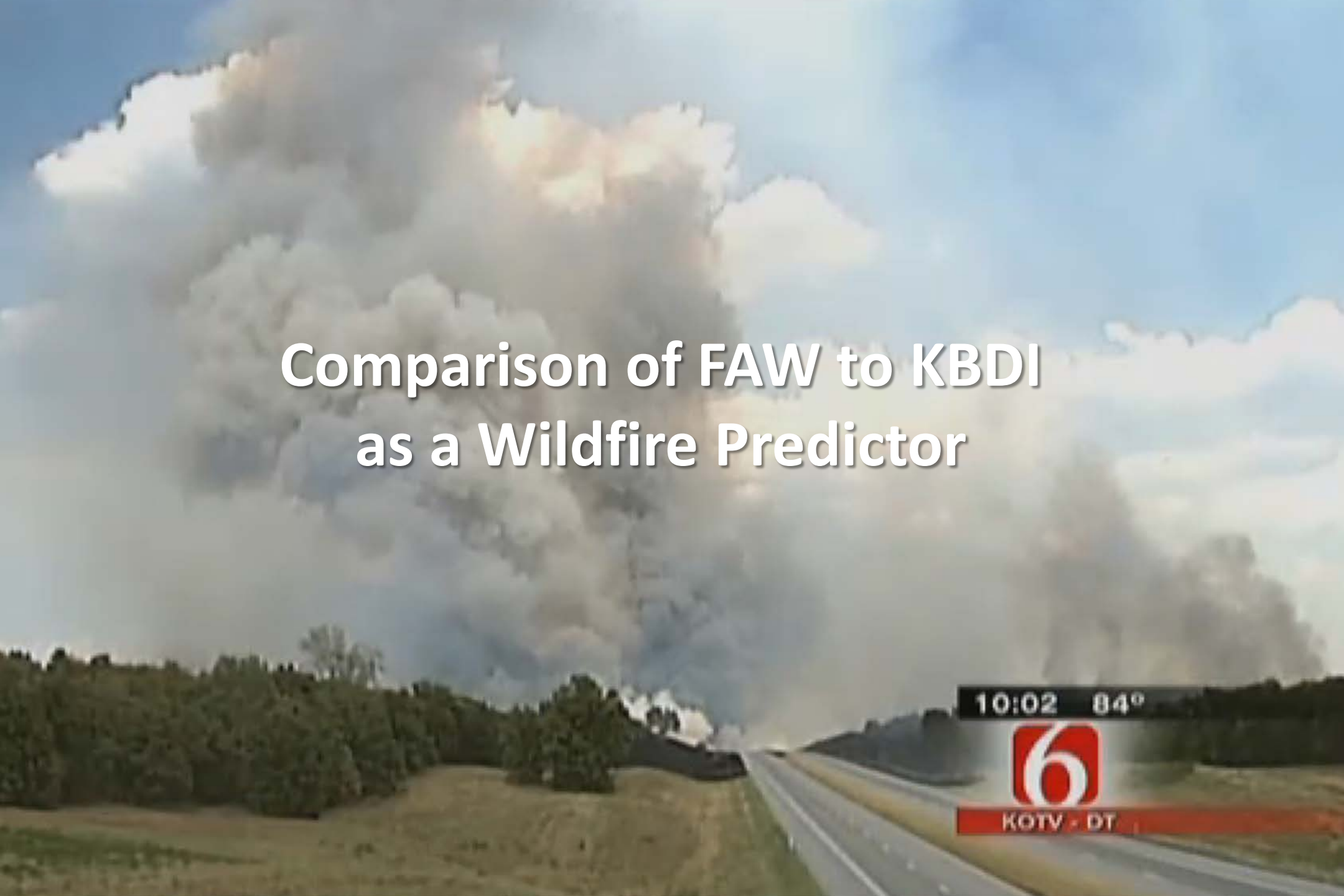
Keetch-Byram Drought Index (KBDI)

Function of daily max temp and precipitation



Correlations

	Growing Season			Dormant Season		
	FAW					
	0-40 cm	40-80 cm	0-80 cm	0-40 cm	40-80 cm	0-80 cm
Daily drought index values averaged across Mesonet stations						
FAW 40-80 cm	0.81			0.85		
FAW 0-80 cm	0.95	0.95		0.97	0.97	
KBDI	-0.868 a	-0.954 d	-0.956 d	-0.897 b	-0.938 c	-0.946 c
Daily drought index values at individual Mesonet stations						
FAW 40-80 cm	0.71			0.71		
FAW 0-80 cm	0.92	0.92		0.90	0.93	
KBDI	-0.713 c	-0.708 b	-0.765 e	-0.690 a	-0.752 d	-0.787 f



Comparison of FAW to KBDI as a Wildfire Predictor

Wildfire Database 1

(Oklahoma State Fire Marshal)

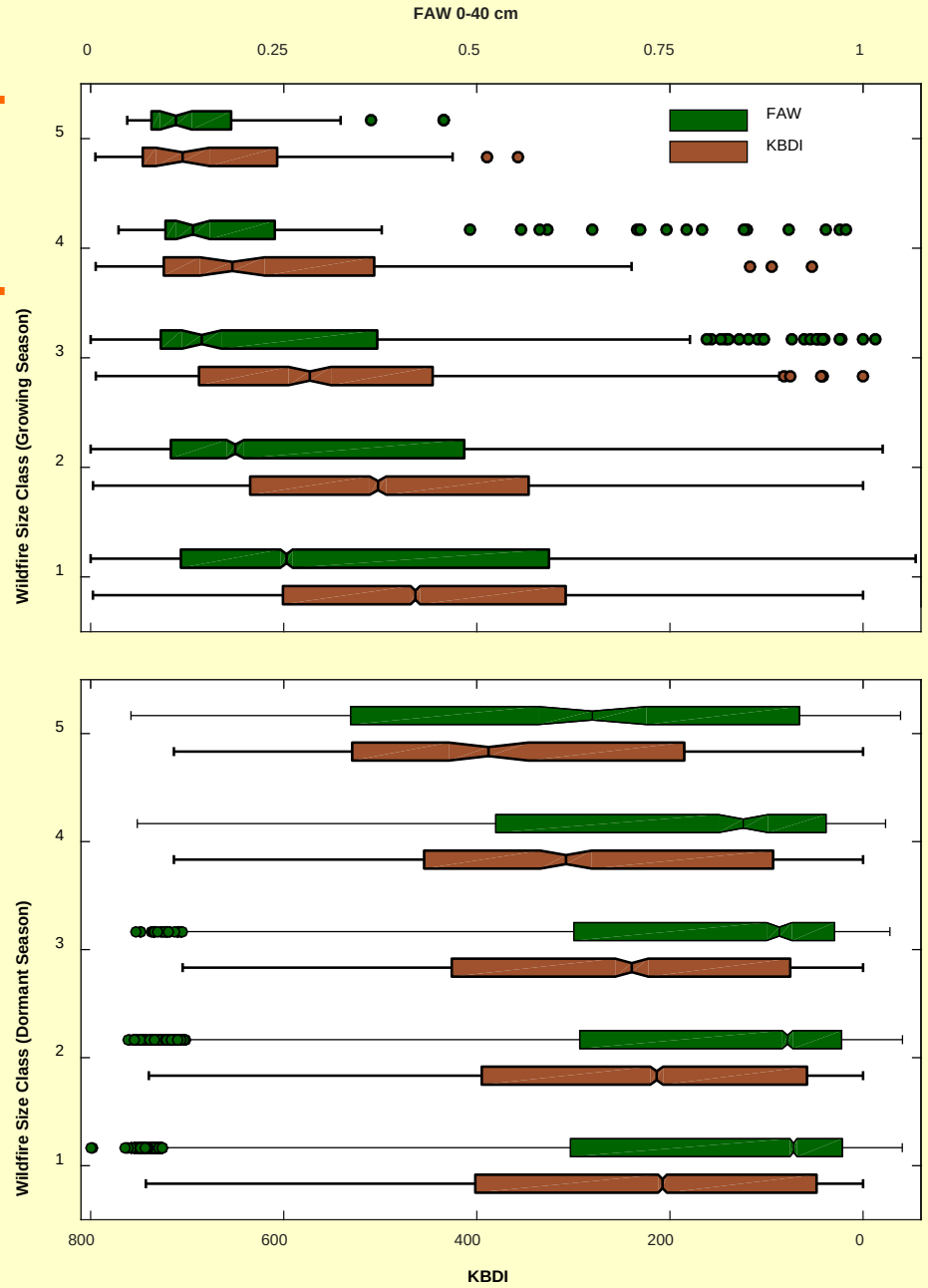
- 34,939 wildfires (2000-2012)
- Individual fires linked to nearest Mesonet station data on day of ignition
- Five fire size classes
- Dormant (Nov-Apr) and growing (May-Oct) seasons

Wildfire Size Classes

- Class 1 < 10 acres (4.05 ha)
- Class 2 10-111 acres
- Class 3 111-300 acres
- Class 4 300-1,000 acres
- Class 5 >= 1,000 acres (405 ha)

25th – 75th percentiles

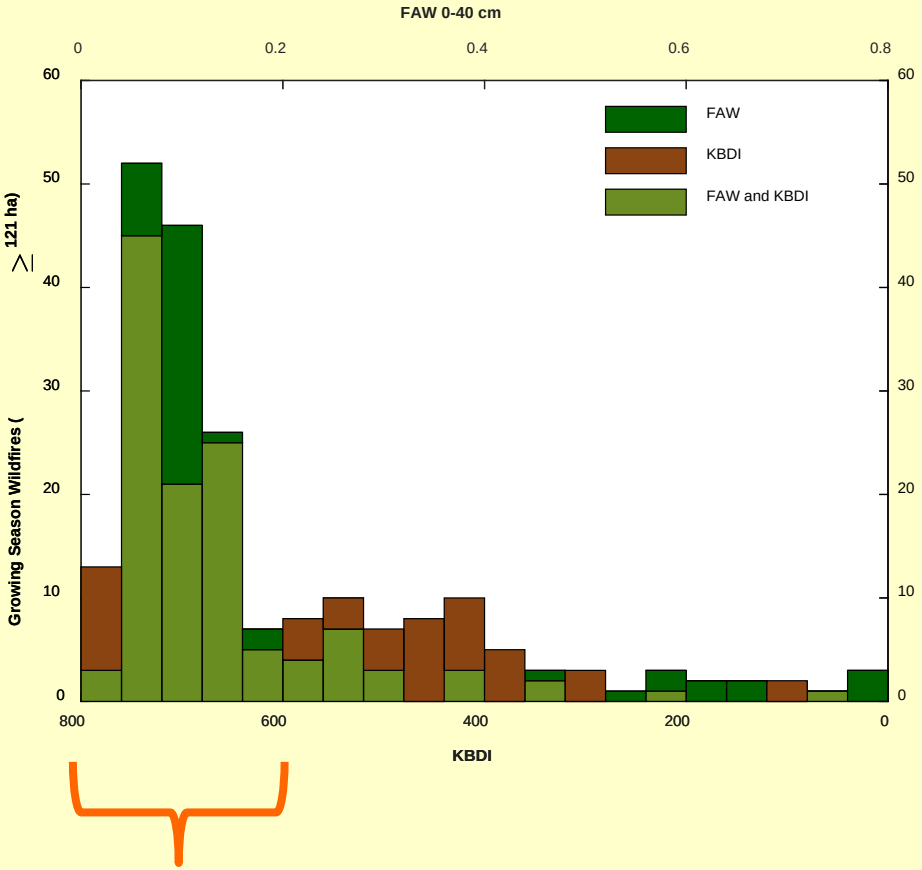
FAW: 0.08-0.24 (16% of range)
KBDI: 506-746 (30% of range)

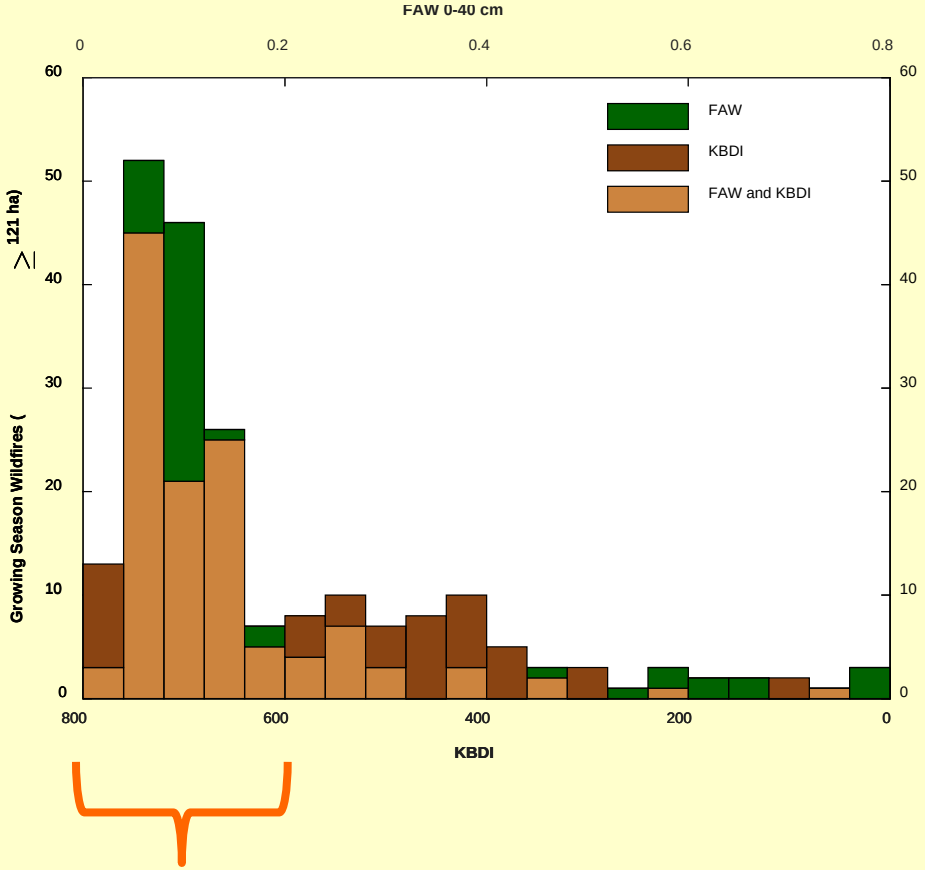


Medians

FAW: < 0.2
KBDI: 502-702

Large Growing Season Wildfires (> 300 acres)





FAW: 81% of Large Fires in 0.0 to 0.25 range
(77% < 0.2)

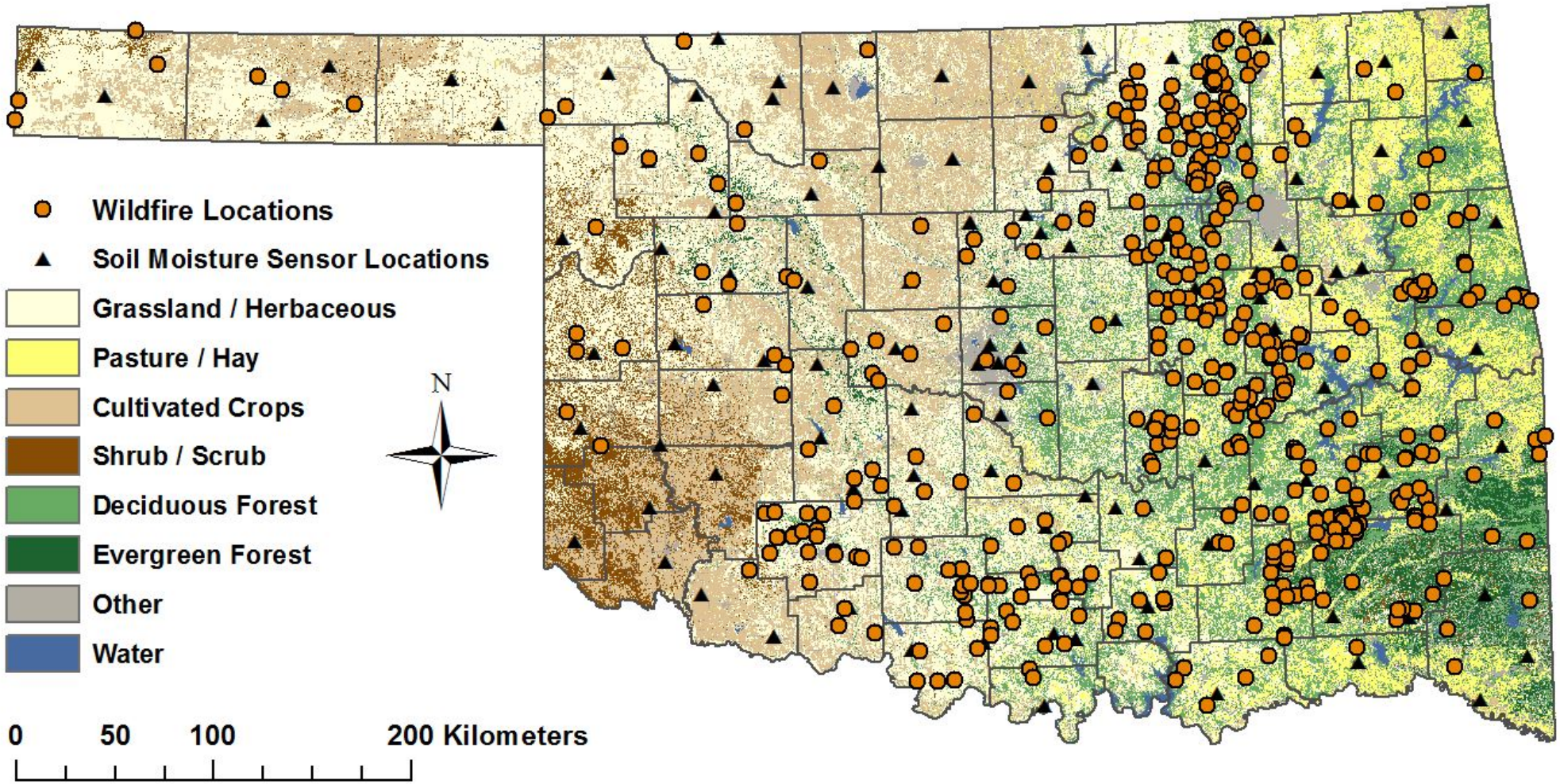
KBDI: 66% of Large Fires in 600-800 range

Wildfire Database 2 (Large Wildfires)

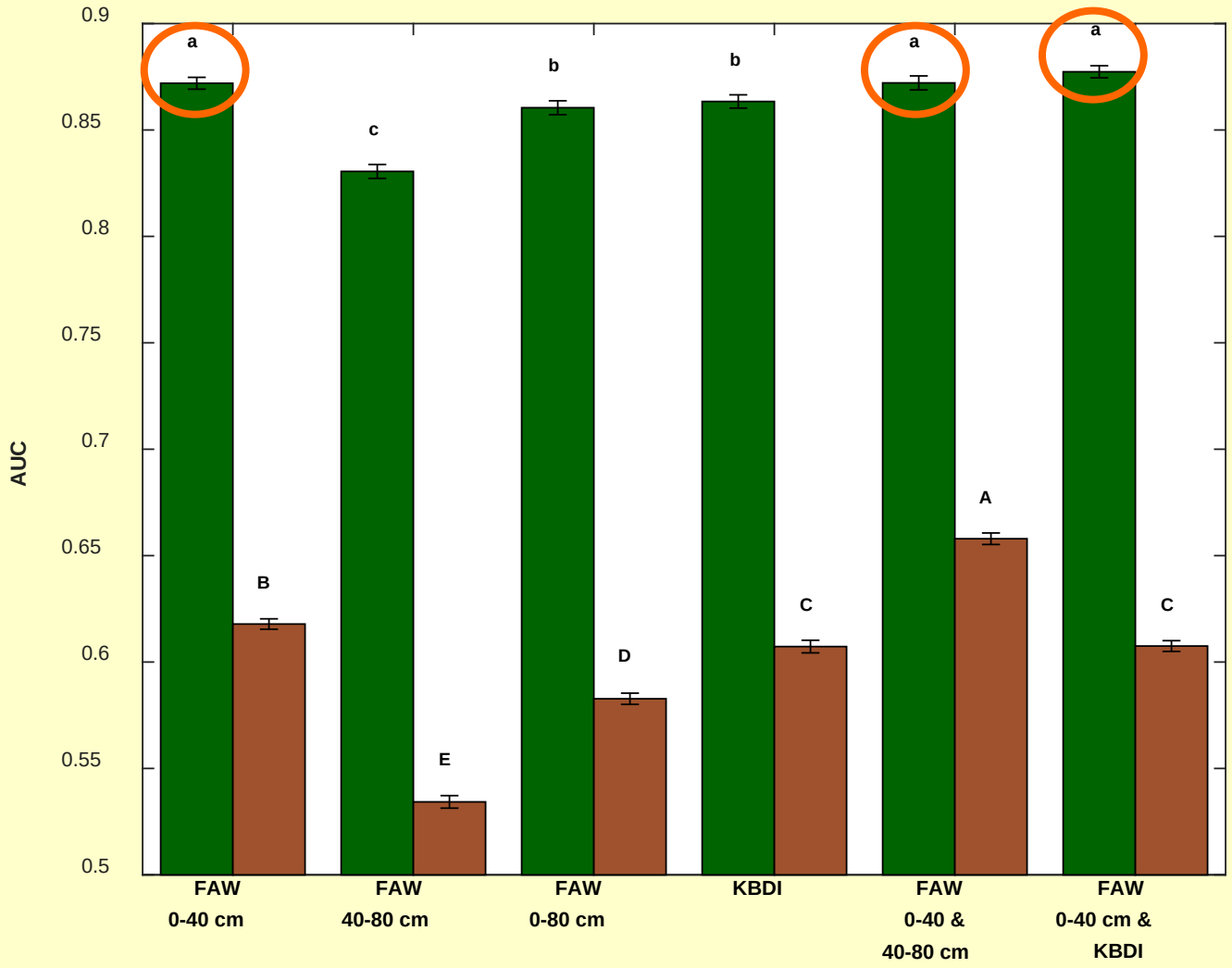
(US Forest Service – Karen Short)

- 501 wildfires >= 1000 acres (2000-2012)
- Dormant (Nov-Apr) and growing (May-Oct) seasons
- Statewide average soil moisture (KBDI, FAW) during each DS or GS day
- Logistic regression modeling: daily probability of a fire >= 1000 acres somewhere in the state during each season

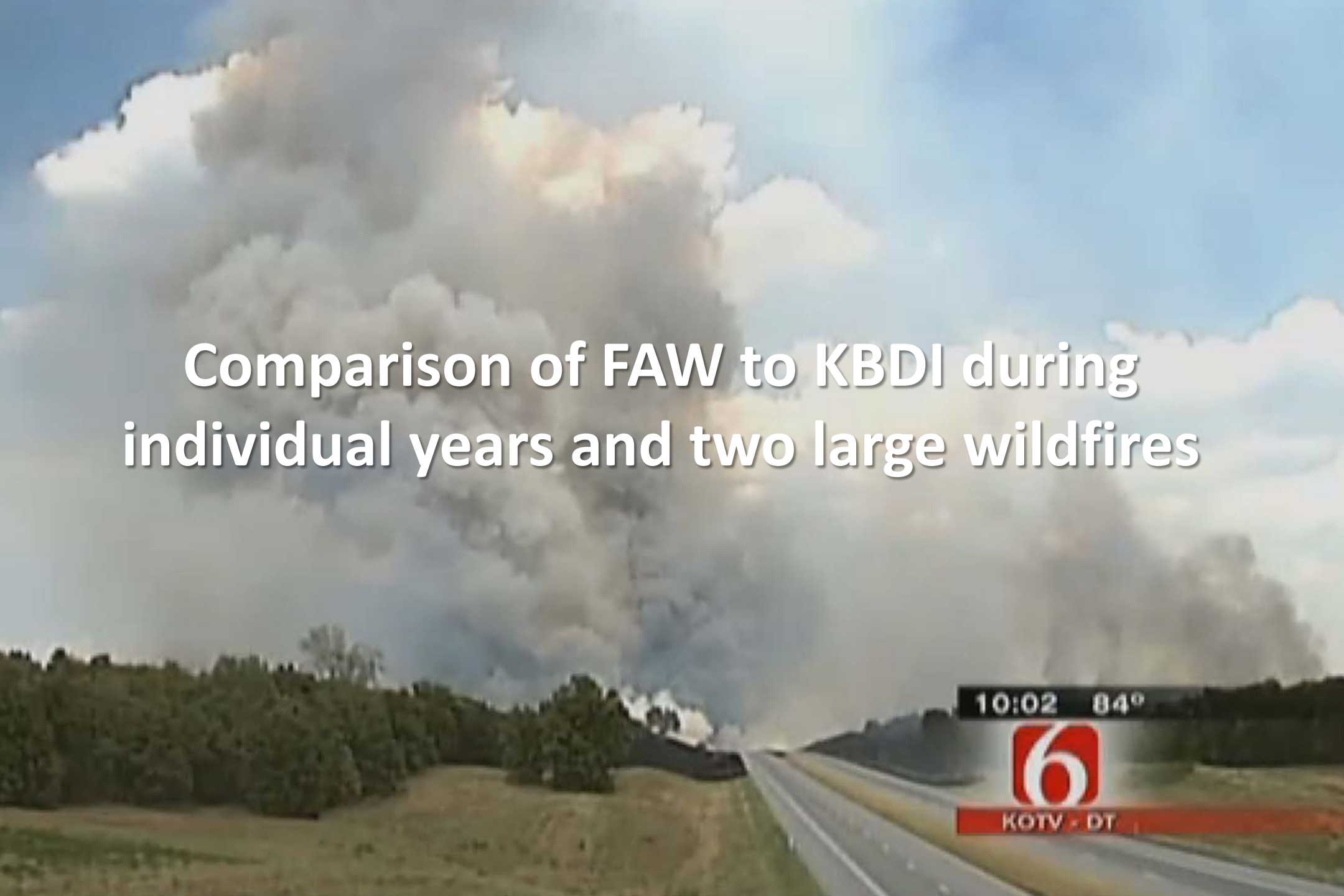
Location of 501 Wildfires and Soil Moisture Sensors



Logistic Regression Models (>= 1000 acres)

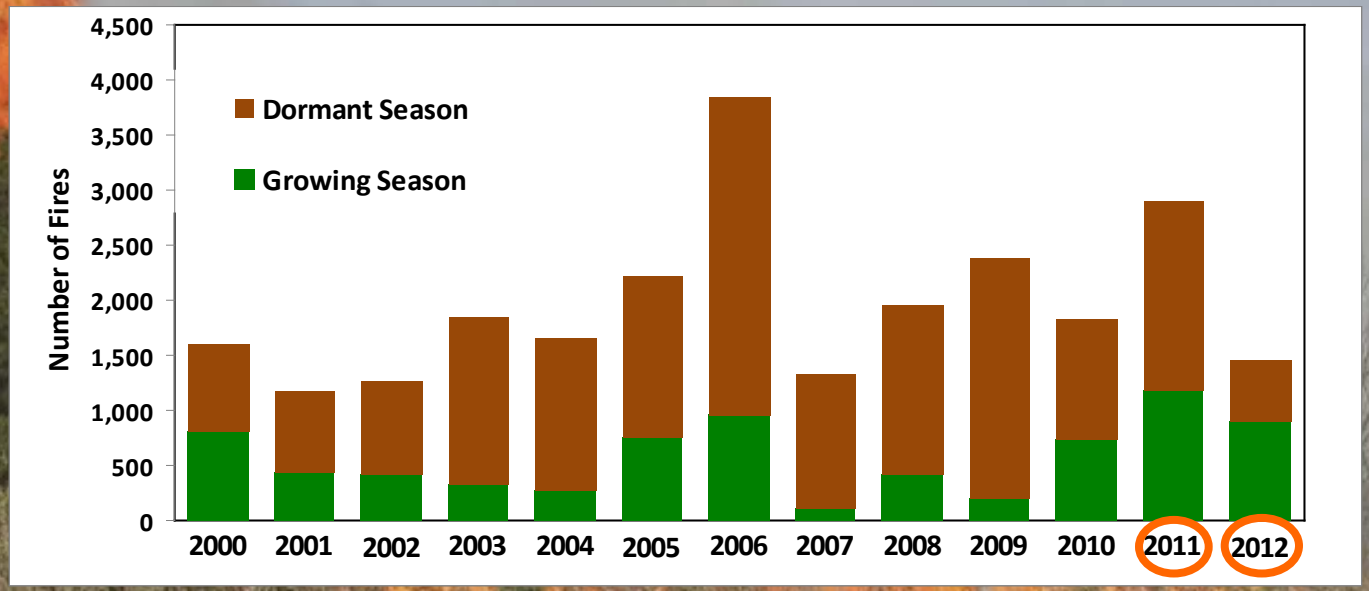


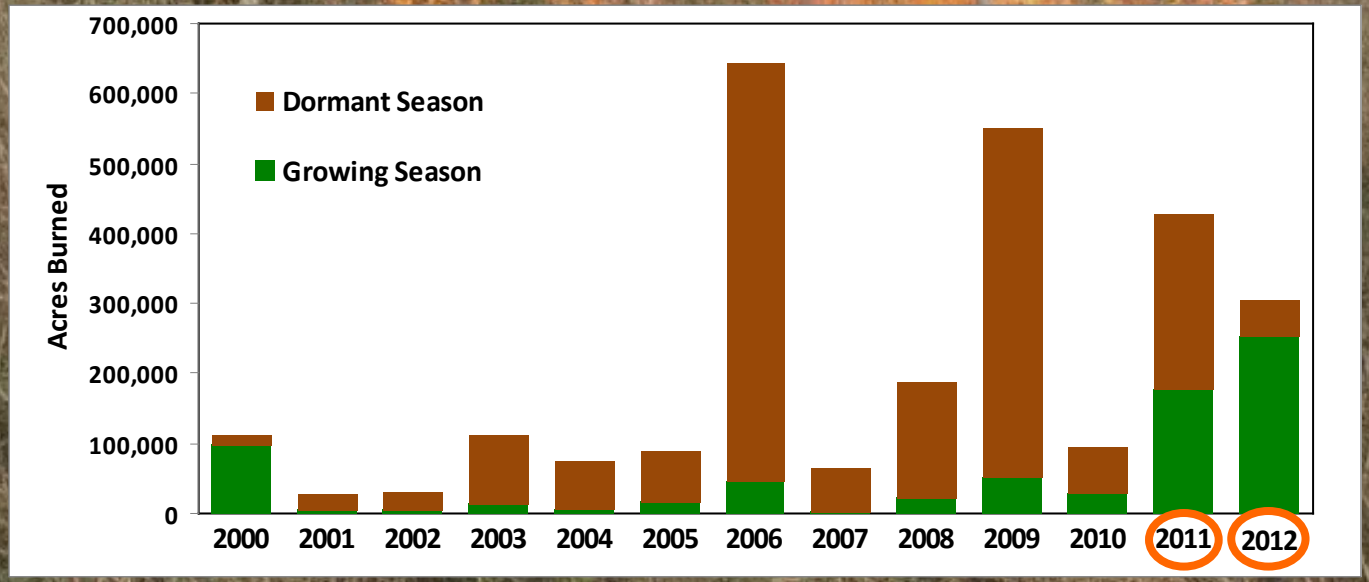
GREEN = GROWING season models; BROWN = DORMANT season models



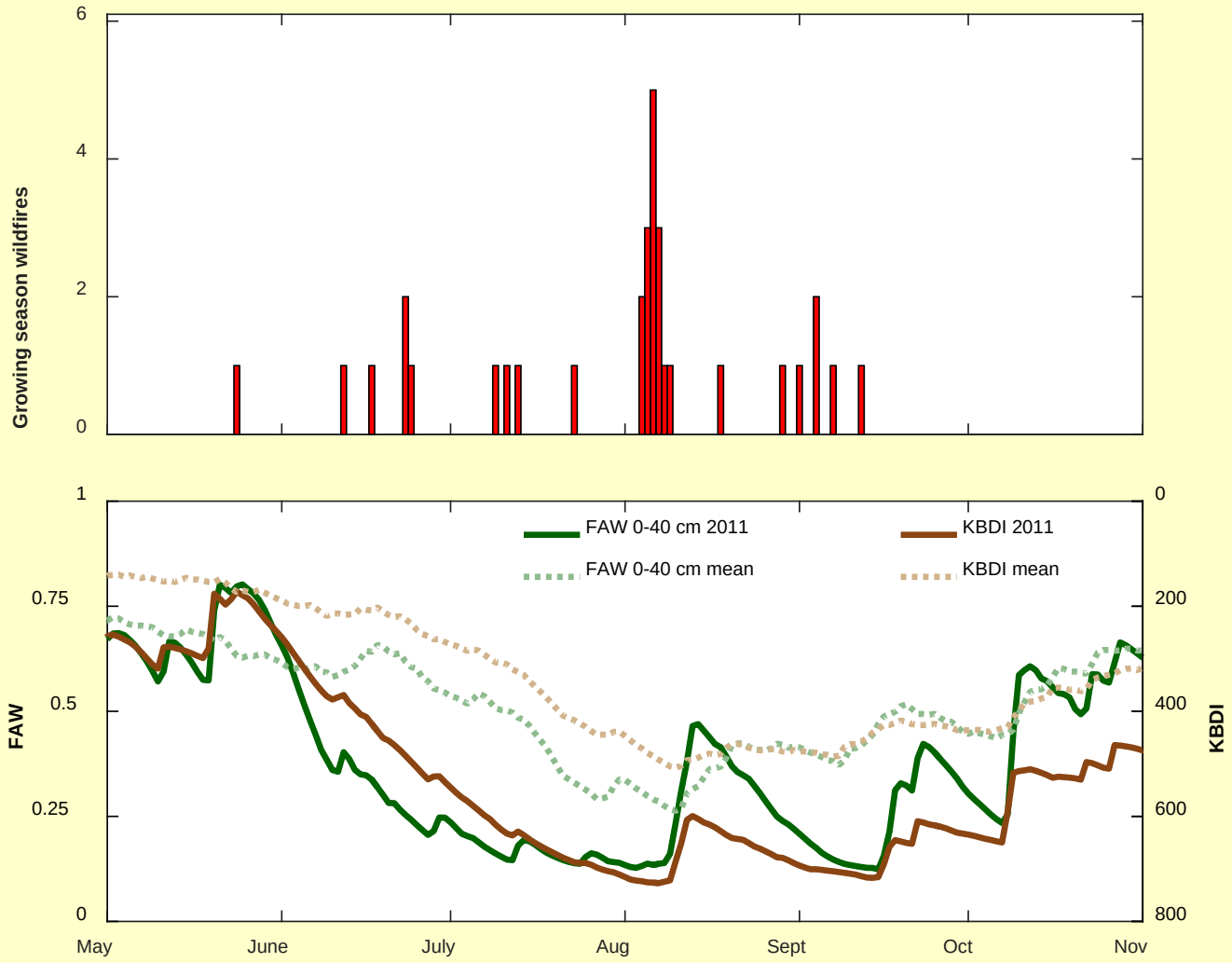
Comparison of FAW to KBDI during individual years and two large wildfires

Oklahoma Wildfires by Year (2000-2012)

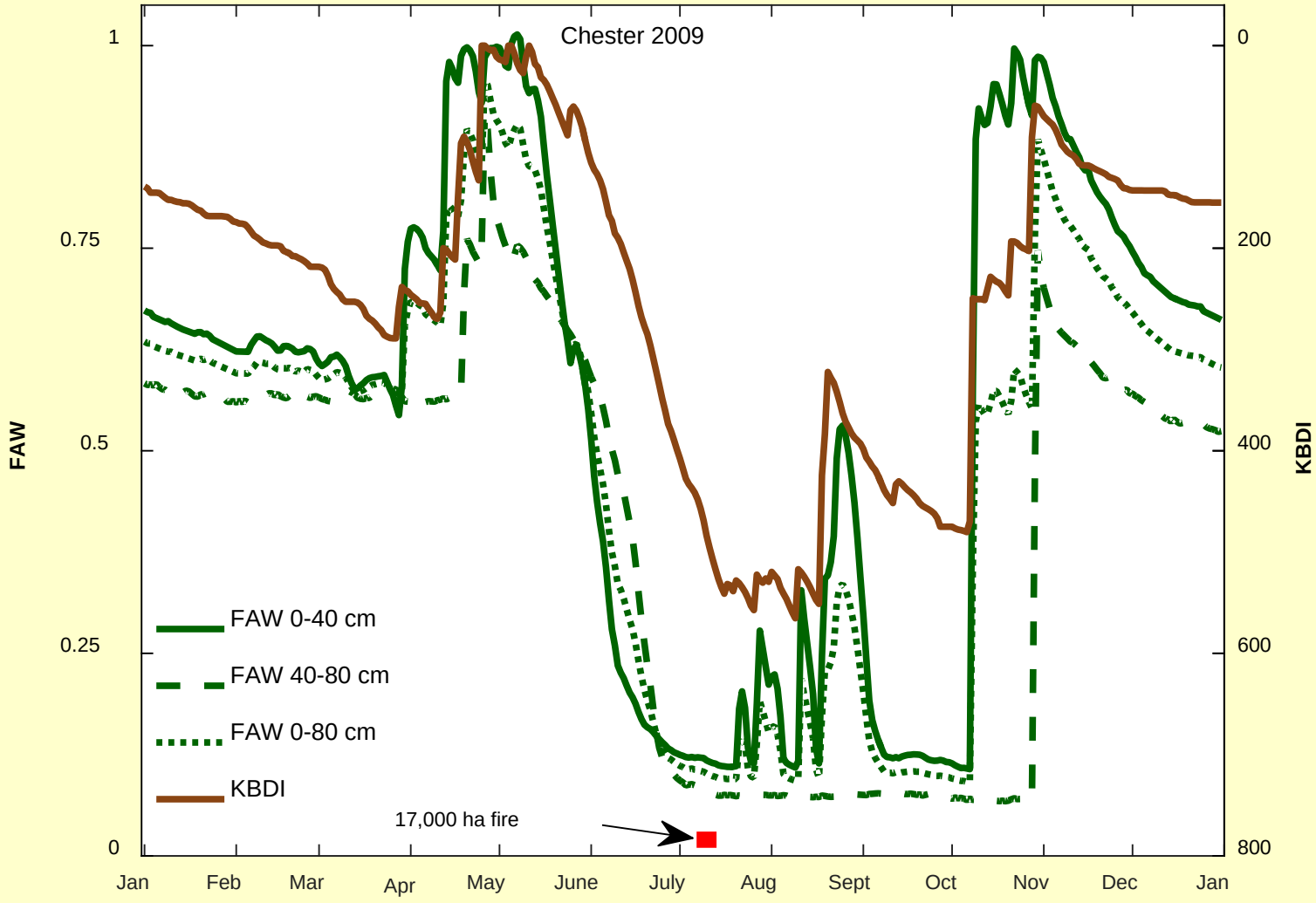


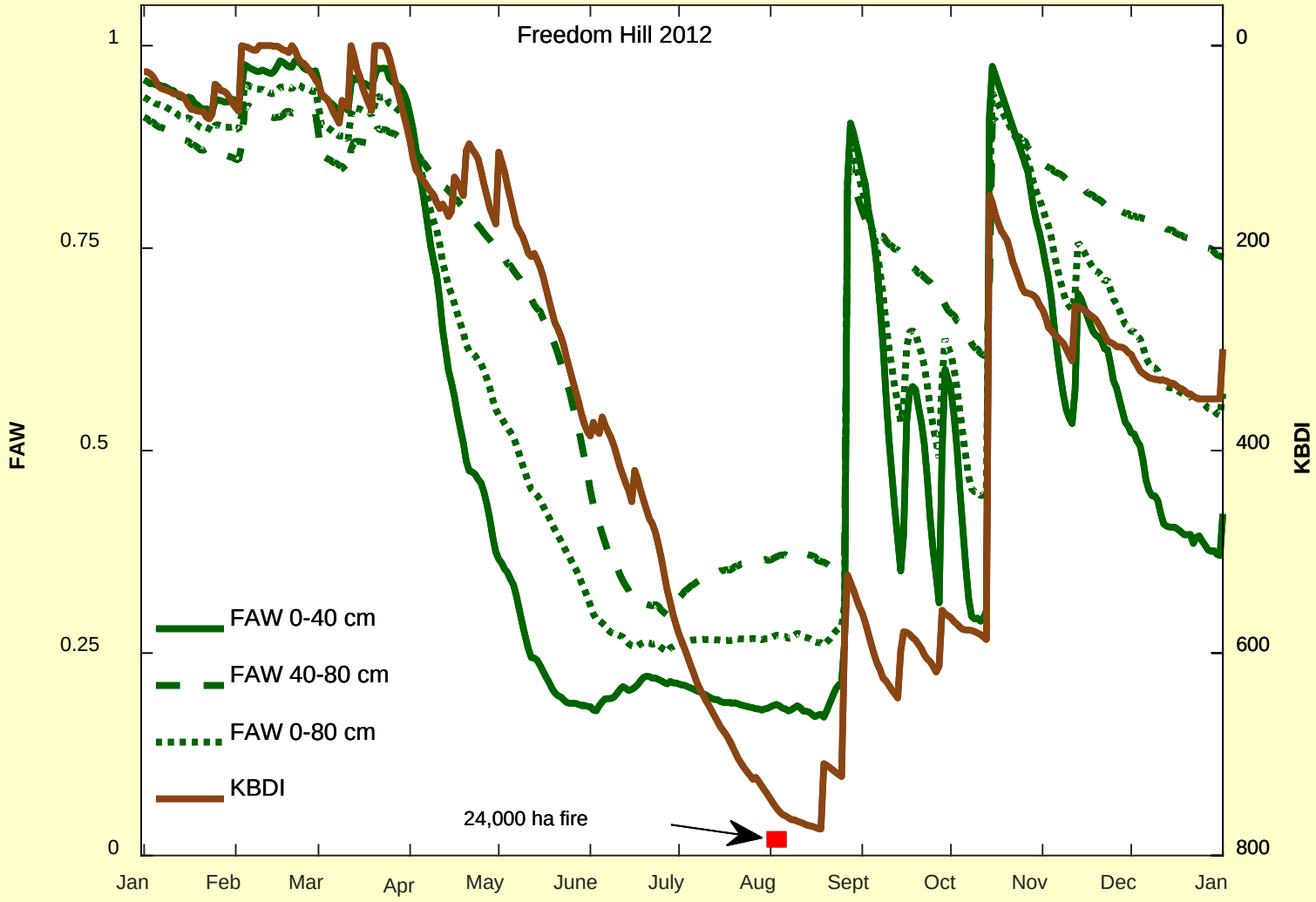


Daily Statewide Values (2011)



Daily Statewide Values (2012)


Chester 2009
FAW
KBDI
1
0.75
0.5
0.25
0
0
200
400
600
800
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Jan
FAW 0-40 cm
FAW 40-80 cm
FAW 0-80 cm
KBDI
17,000 ha fire


Freedom Hill 2012
FAW
KBDI
1
0.75
0.5
0.25
0
0
200
400
600
800
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Jan
FAW 0-40 cm
FAW 40-80 cm
FAW 0-80 cm
KBDI
24,000 ha fire

Growing Season: KBDI or 40-cm FAW ?

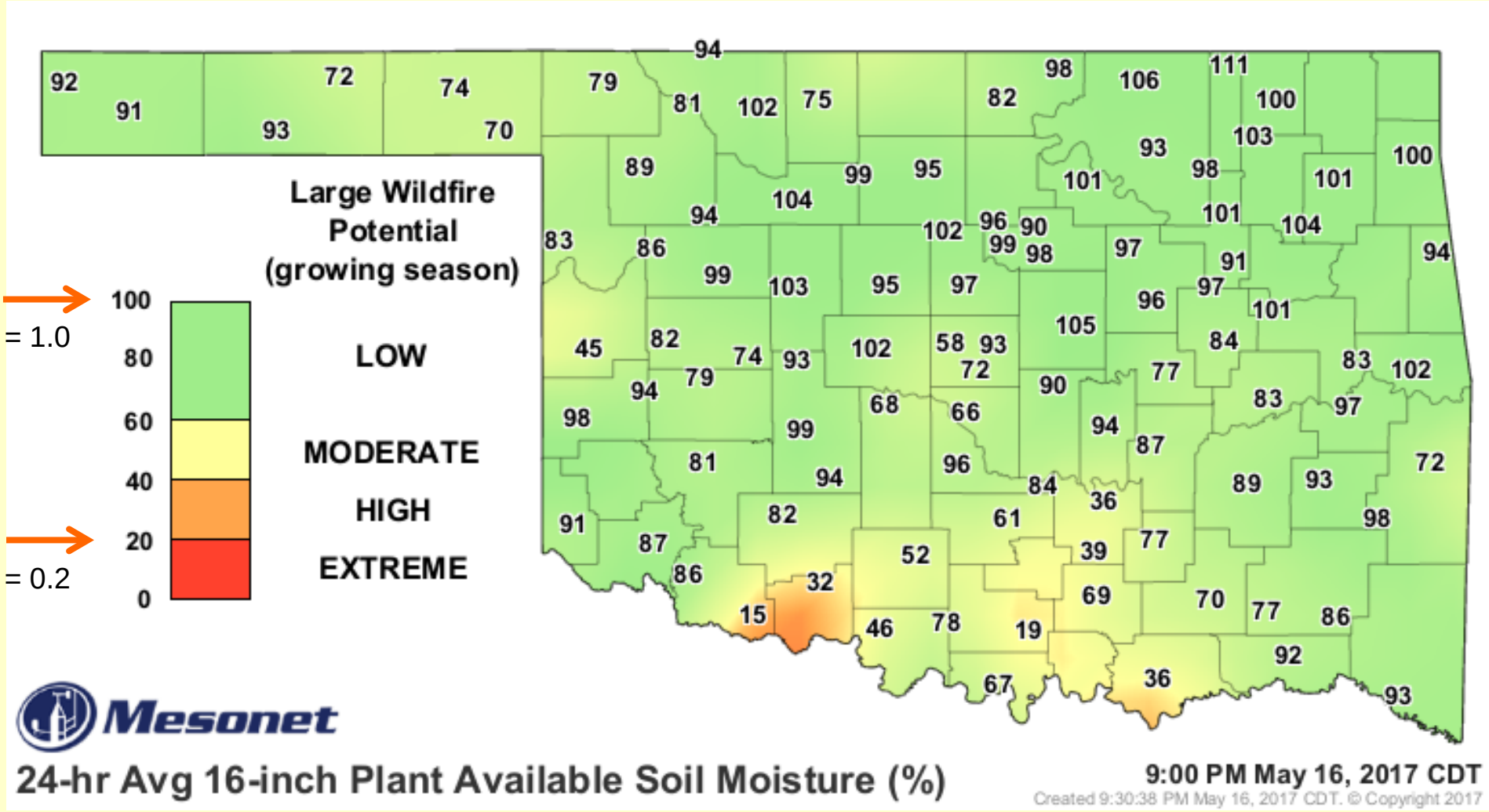
For the 10 largest growing season fires, FAW 0-40 cm indicated elevated wildfire conditions **an average of 10 days before KBDI**, with FAW 0-40 cm reaching critical levels (≤ 0.2) an average of 29 days before the fire occurred and KBDI reaching critical levels (≥ 600) an average of 19 days before the fire occurred. These results corroborate previous studies highlighting the potential to identify flash droughts using in situ soil moisture data in Oklahoma (Ford et al., 2015) and those reporting that the long memory of KBDI resulted in peak values of KBDI lagging behind the peak of the wildfire season (Liu et al., 2014).

Some Salient Conclusions

- Large wildfires during the GROWING season are strongly associated with concurrent LOW soil moisture (low FAW and high KBDI)
- Large wildfires during the DORMANT season are only weakly associated with soil moisture (FAW, KBDI) as weather is the primary driver
- FAW 0-40 cm outperforms KBDI and deeper depths of FAW during the growing season and has a faster response to soil drying and moisture recharge
- In areas of similar climate and vegetation and where soil moisture data exists, FAW 0-40 cm should replace KBDI as a wildfire predictor during the growing season

A New Operational Product for Oklahoma *(OK-FIRE)*

(FAW 0-40 cm)*100



- Current Station Conditions
- Current Maps
- Past & Forecast Animated Maps
- Past & Forecast Charts/Tables
- Fire Prescription Planner
- NWS Forecast Chart (Stillwater)
- NWS Forecast Table (Stillwater)
- Relative Greenness Zoom Map
- Default Fuel Model Zoom Map
- Fire Advisories and Outlooks
- 3.9 µ Infrared Satellite Map
- Oklahoma Burn Bans
- Additional Resources
- Contact and Product Information
- News

Current Fuel Model for Stillwater

N-Sawgrass

Default is T

Using Alternative Fuel Model!

Station Fuel Model Options

OK-FIRE

Past & Forecast Charts/Tables

Forecast based on 1 pm CDT 05/22/17 NAM; NEXT forecast update expected 11 pm CDT 05/22/17

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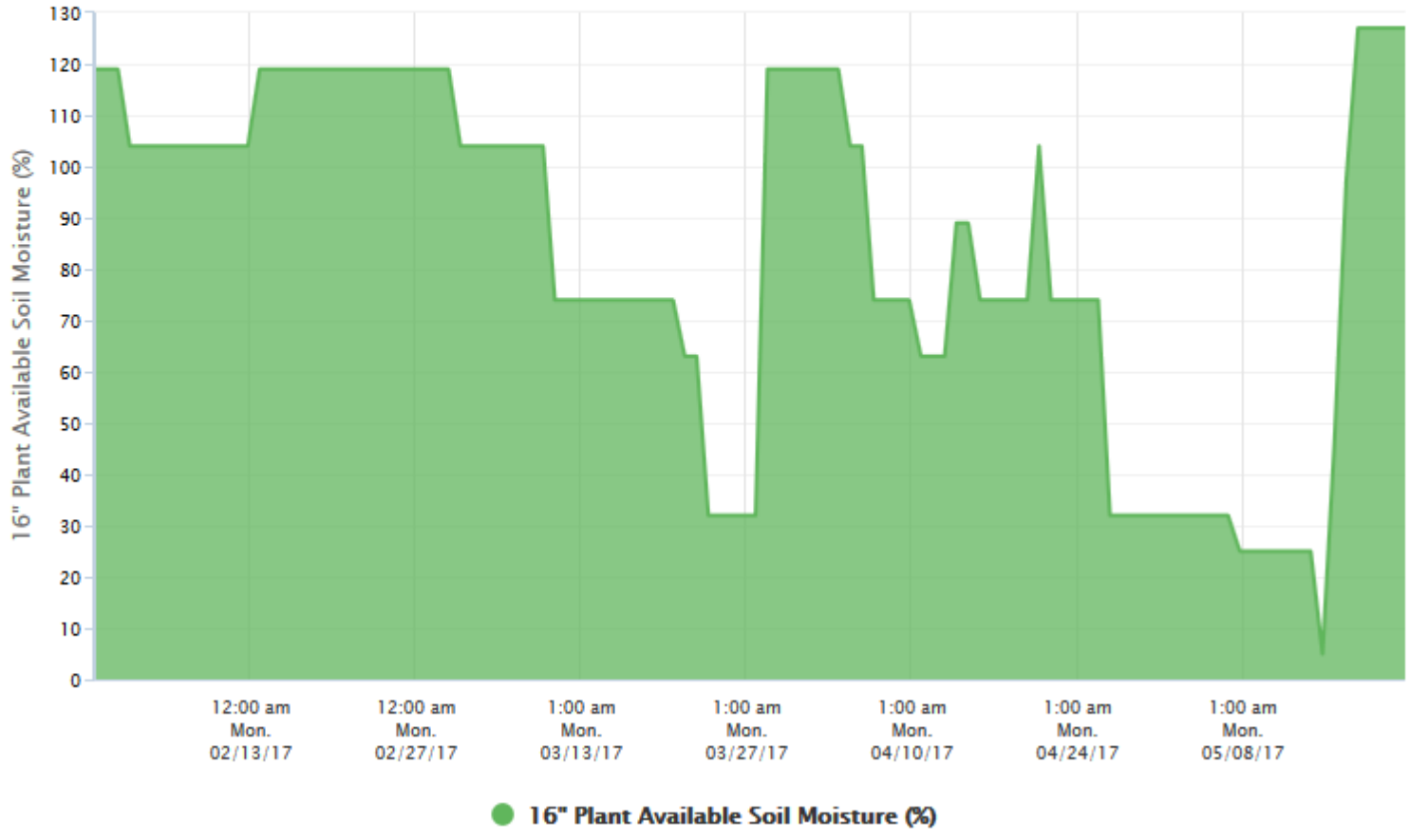
Past Firegram Chart for Grandfield



Funding Acknowledgements

Joint Fire Science Program

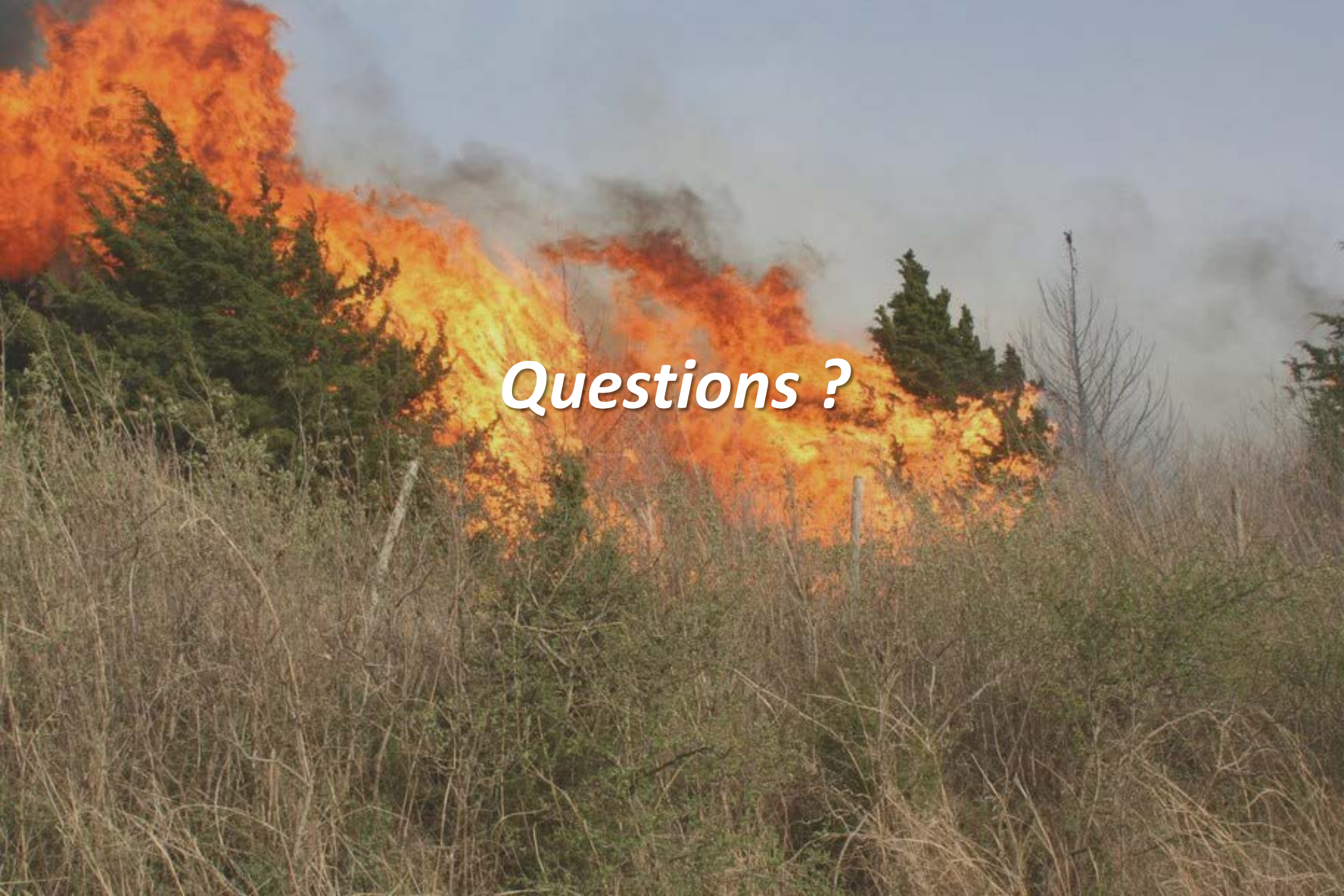
JFSP 11-1-2-19 (2011-2015)

South Central Climate Center

G15AP00151 ( )

Oklahoma Cooperative Extension Service

Oklahoma Agricultural Experiment Station


Questions ?