Mapping When and Where Invasive Buffelgrass is Green

Southwest Association for Fire Ecology

November 29, 2016

Tucson, Arizona

Cynthia SA Wallace (USGS)

Co-researchers: Jessica J. Walker (USGS), Jake Weltzin (USA-NPN), Caroline Patrick-Birdwell (TEP), Susan Skirvin (ARS-USDA), Helen Raichle (Contractor)

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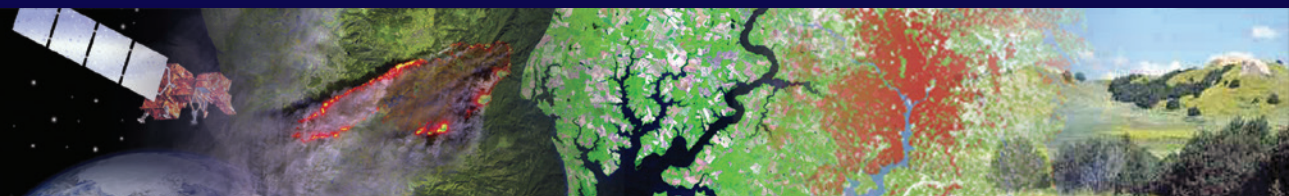
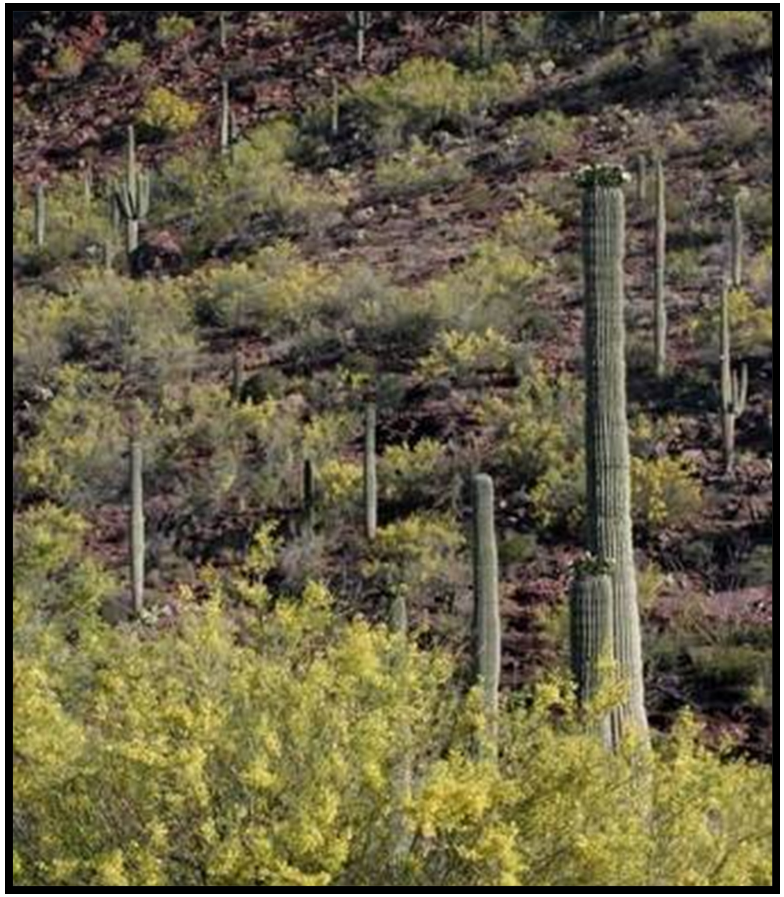


The Sonoran Desert Ecosystem and Buffelgrass



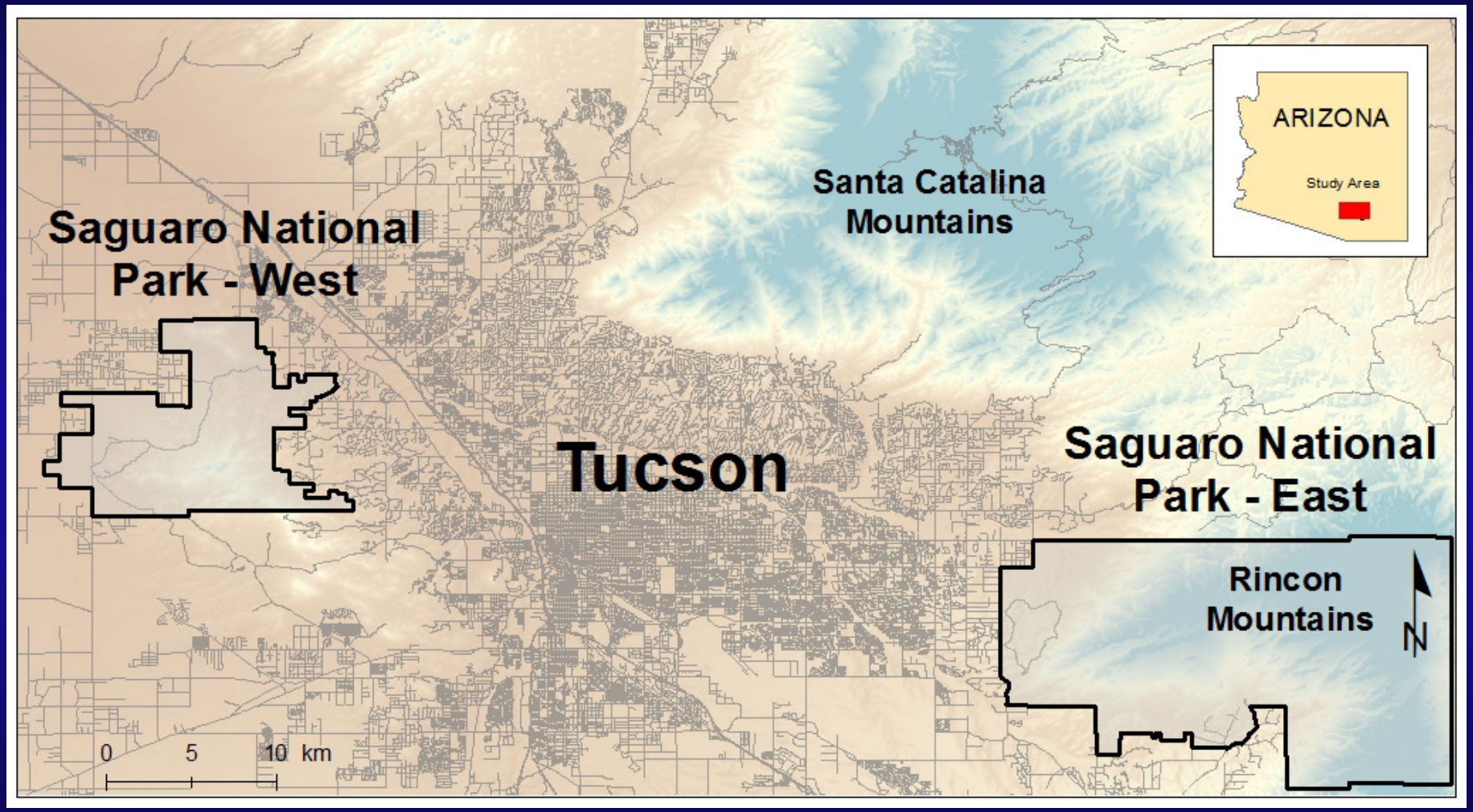
Examples of (left) a Sonoran Desert landscape showing the characteristic arrangement of clumps of native vegetation separated by bare ground; and (right) a Sonoran Desert landscape that has been invaded by buffelgrass, which fill in the open spaces to form a continuous mat of plant material that carries fire readily across the landscape.

For effective treatment, managers need to know where plants are and when they're green

Individual plants

Regional spraying

Location map



The study area is focused on the Saguaro National Parks East and West, but data are collected across the Tucson region in southeastern Arizona, USA.

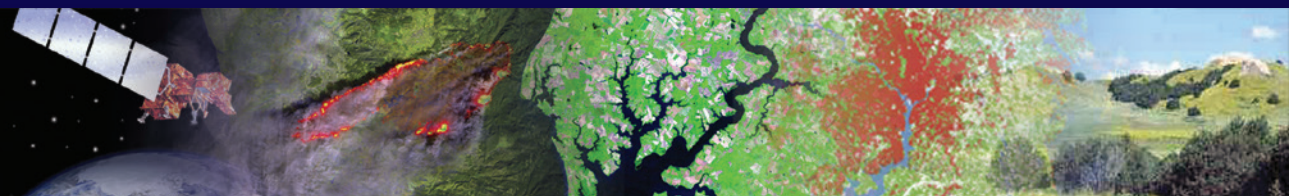
Data

- MODIS Satellite Data
- SNP Mapping of Buffelgrass
- Climate Data
- Buffelgrass Phenology Observations

Results

- Where?
- When?

Next Steps



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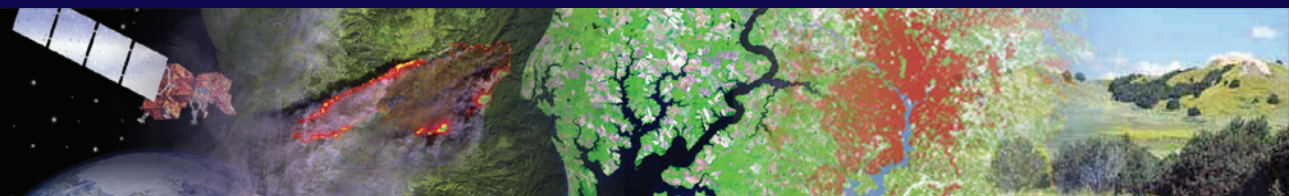
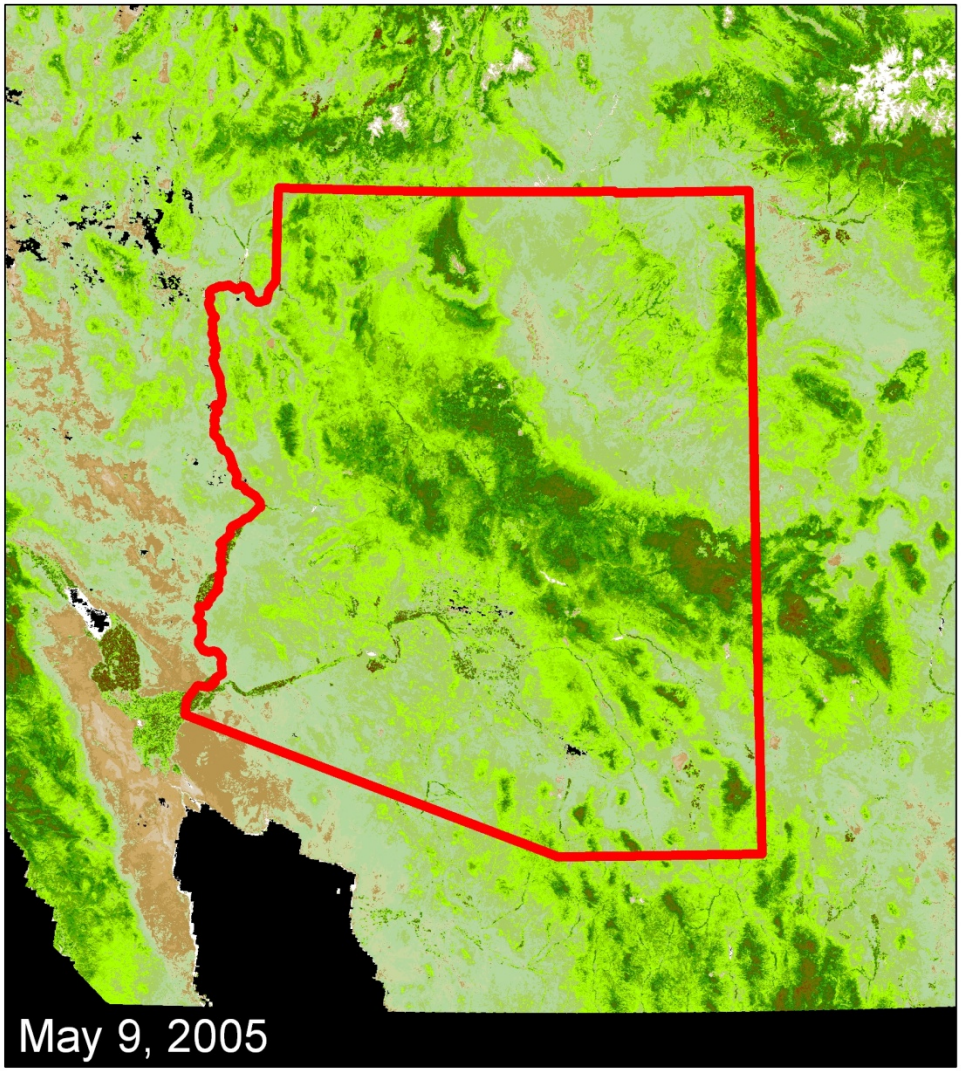
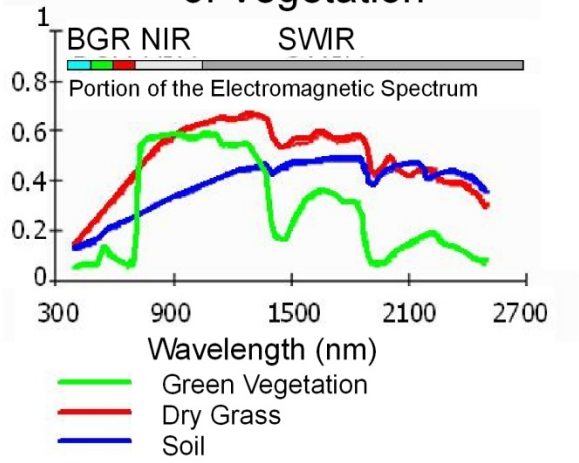




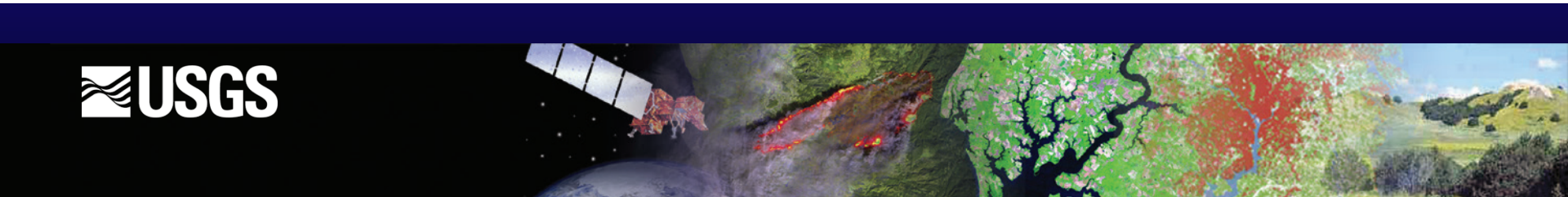
Distinctive Spectral Reflectance of Vegetation



Normalized Difference Vegetation Index (NDVI):

$$NDVI = \frac{(NIR - Red)}{(NIR + Red)}$$

The highest daily NDVI value observed for each pixel is composited over a 8 to 16 day period to produce a "cloud-free" image



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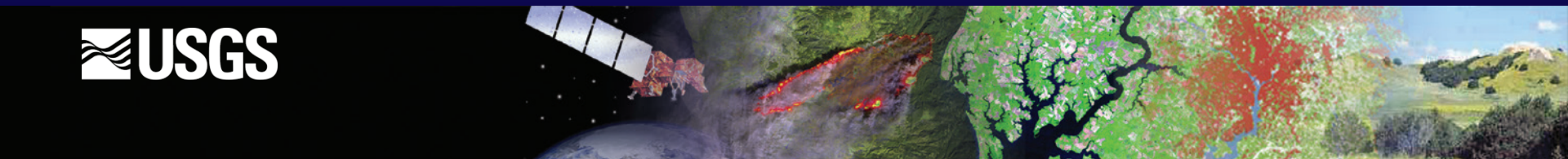
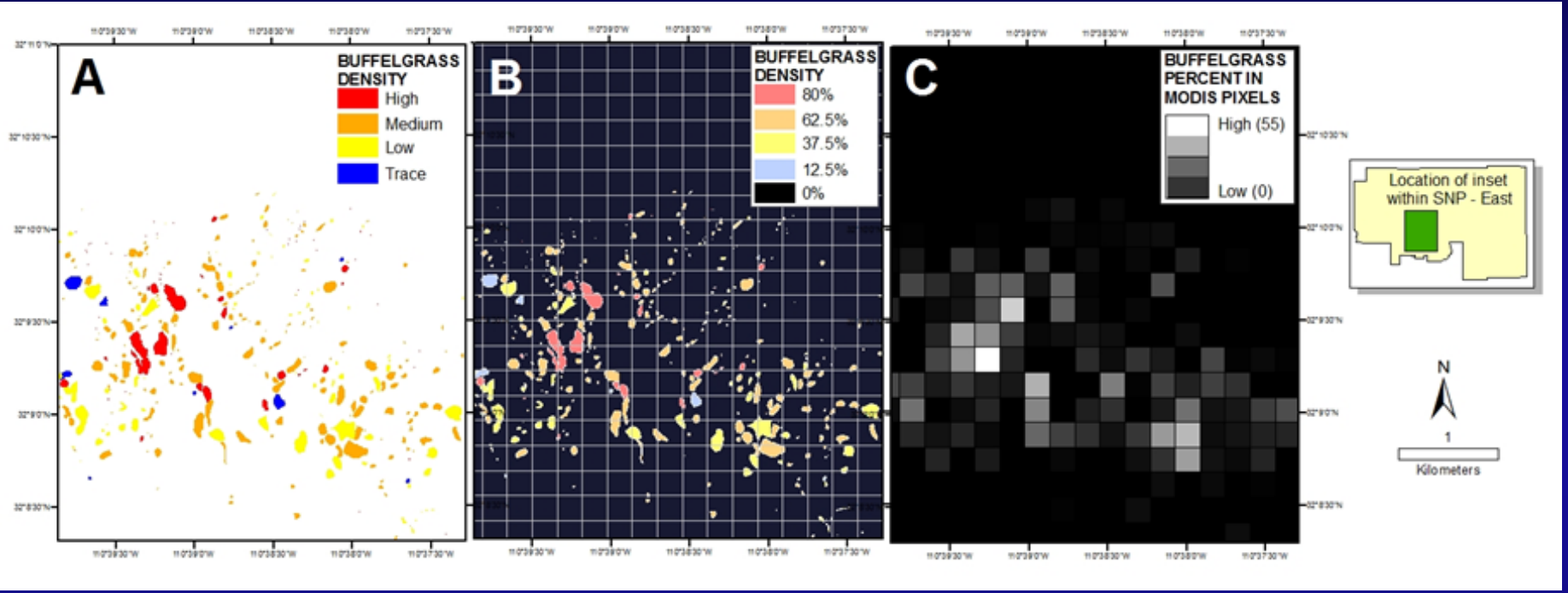


Saguaro National Park - East



Visual explanation of the percent buffelgrass raster creation. The polygon coverage of categorical buffelgrass density (A) supplied by Saguaro National Park personnel was converted to a 5-m raster with midpoint densities assigned to each category (B). The average density of buffelgrass within each 250-m MODIS pixel cell (white grid in B) was then calculated (C).

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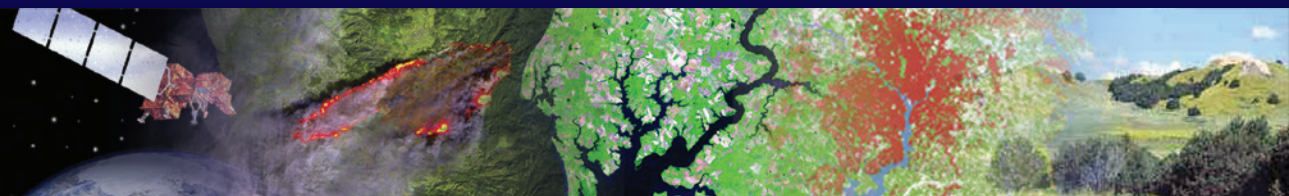

The spatial pattern of rainfall is highly variable in the Sonoran Desert

1. Station Data (MesoWest)
2. Gridded PRISM Data (4km)

Photo Credit: Zack Guido, CLIMAS, The University of Arizona

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Buffelgrass Phenology Observations

Buffelgrass percent greenness and phenology observations were collected by both professional and citizen scientist observers at various locations.

These data were recorded on the USA National Phenology Network (NPN) Nature's Notebook website (*www.usanpn.org/natures_notebook*).

Volunteers in photo are entering data on their smart phone app.

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Watching Grass Grow

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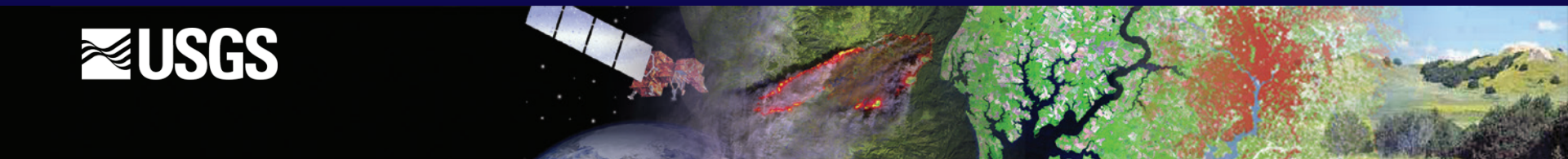

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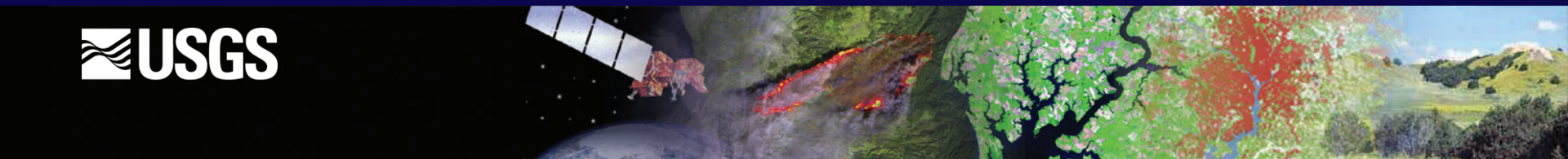

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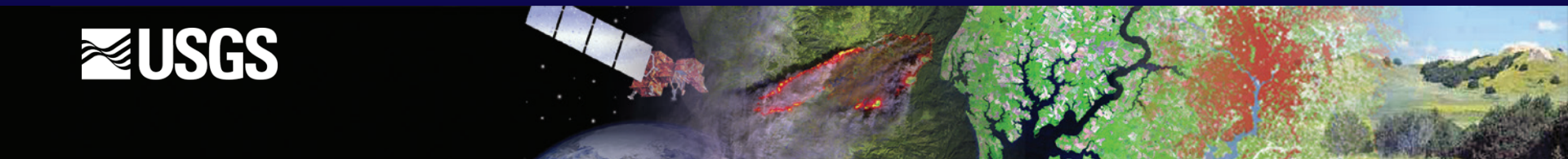

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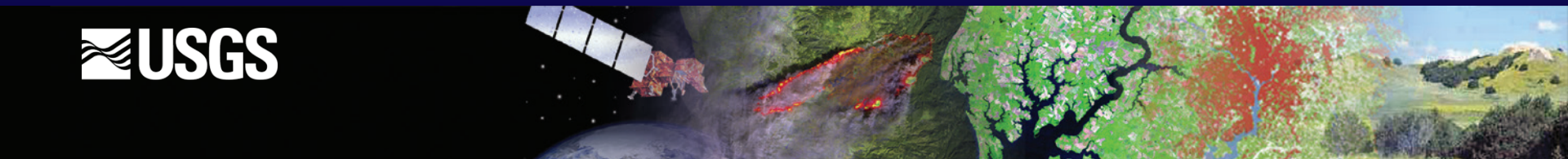

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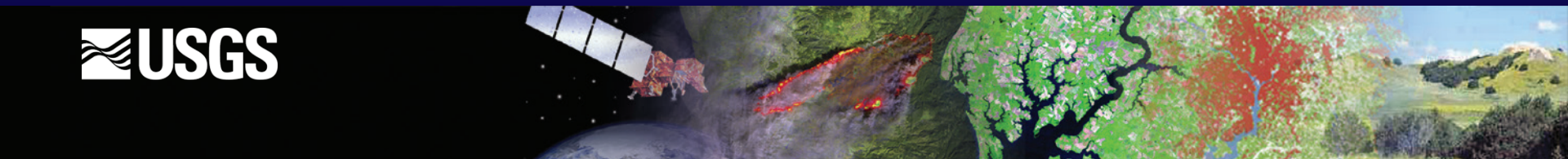
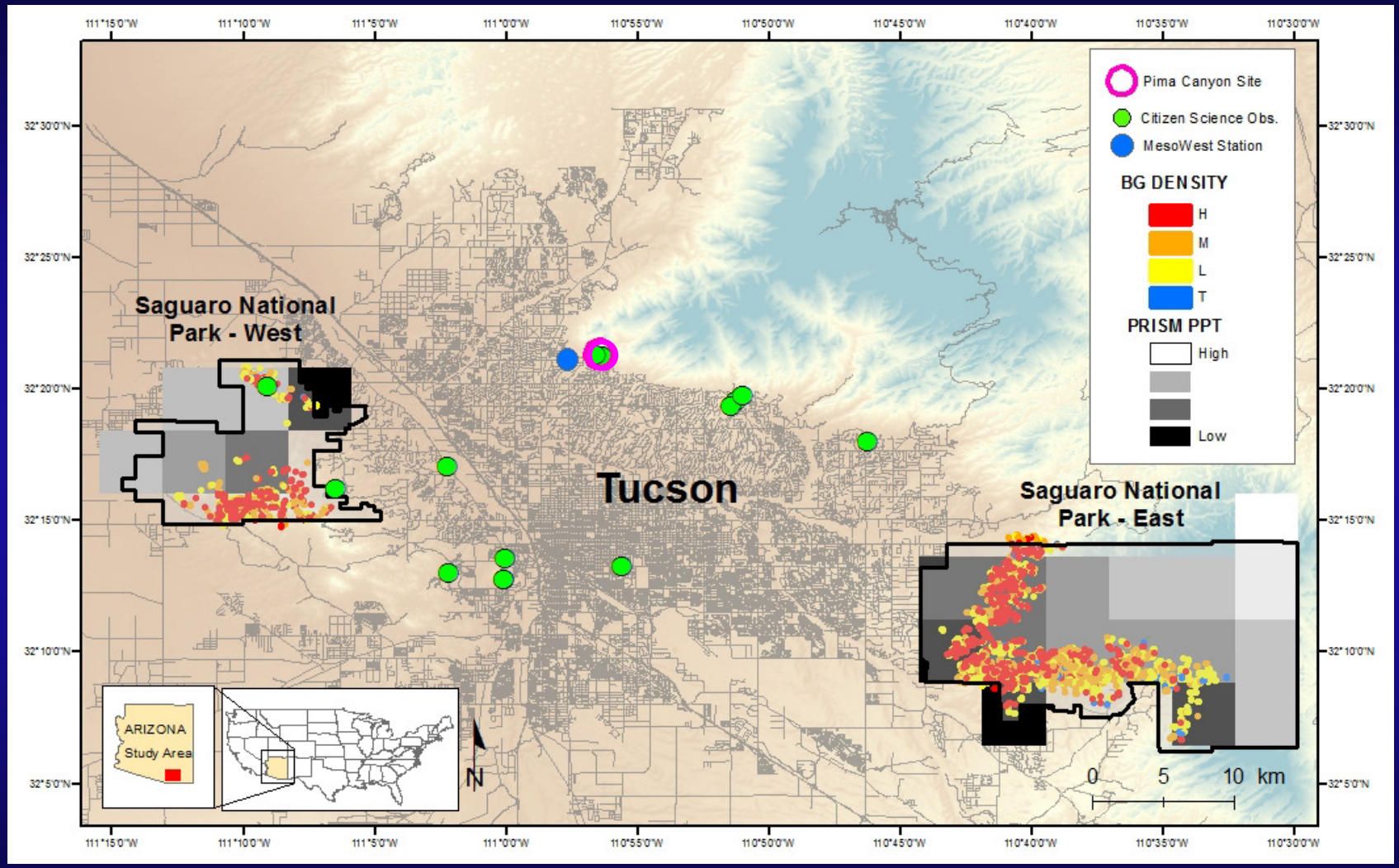


Summary of Data Used



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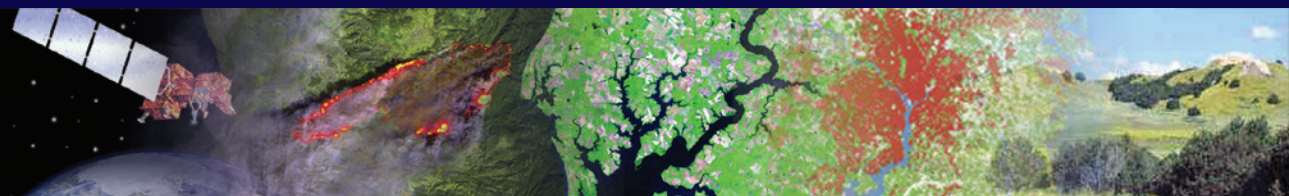
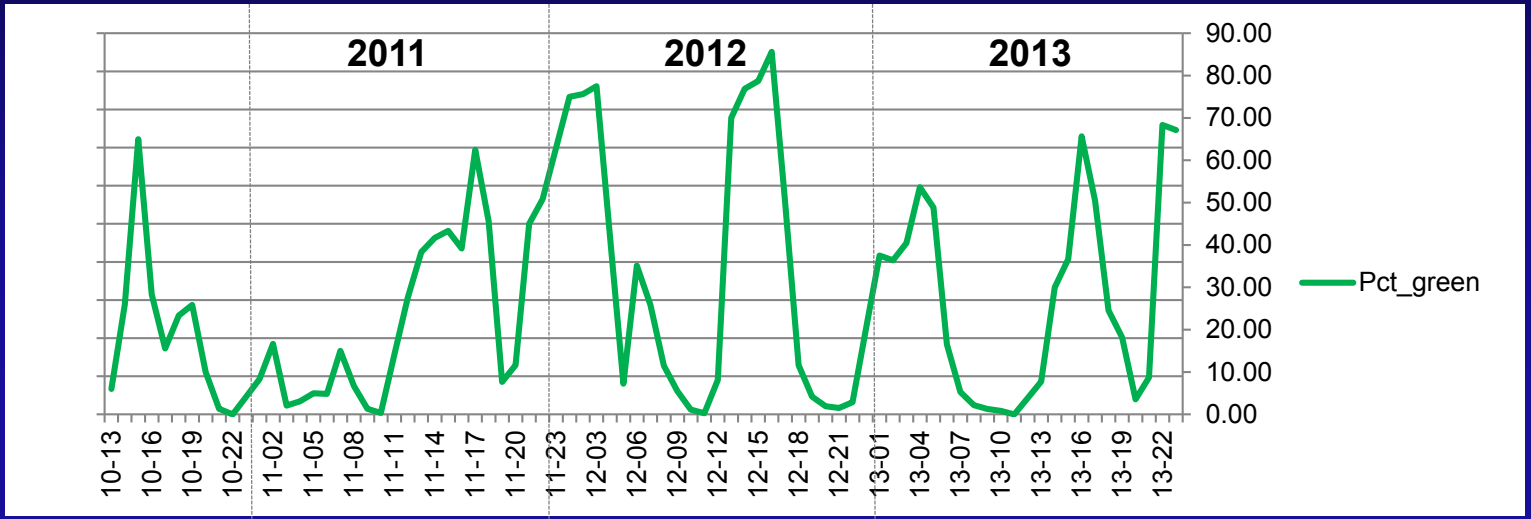


Buffelgrass Green-up: Where?

Pima Canyon Site with long-term observations



Observed buffelgrass greenness (Pct_green)

Buffelgrass Green-up: Where?

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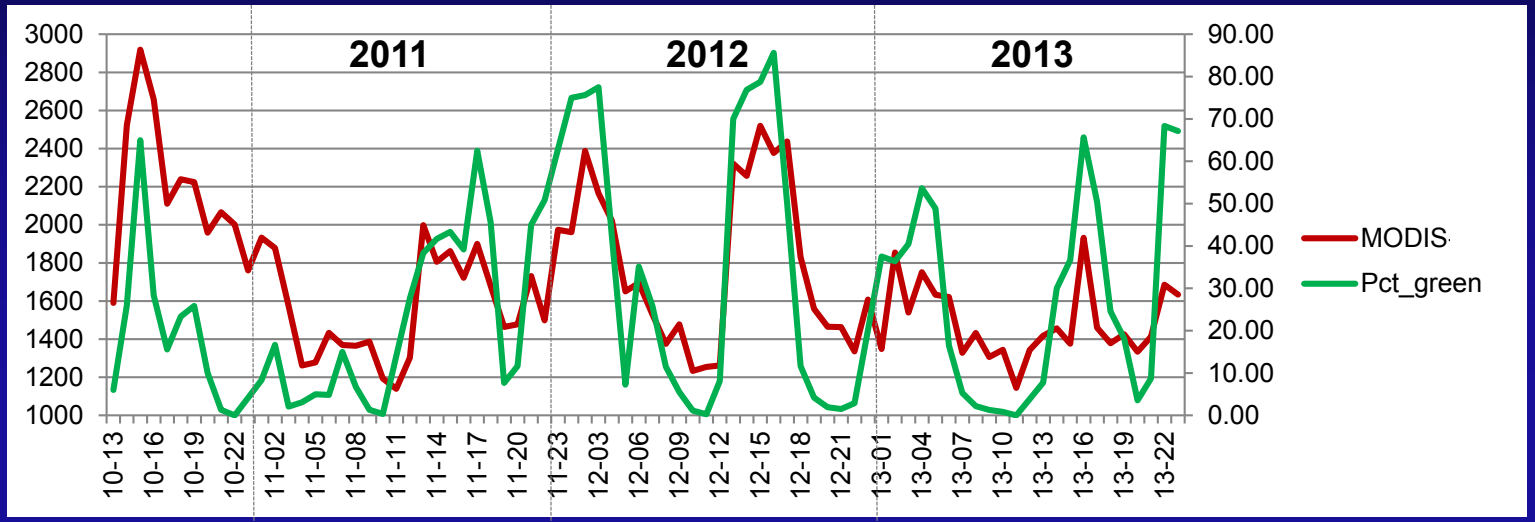

Observed buffelgrass greenness (Pct_green) and MODIS Satellite greenness

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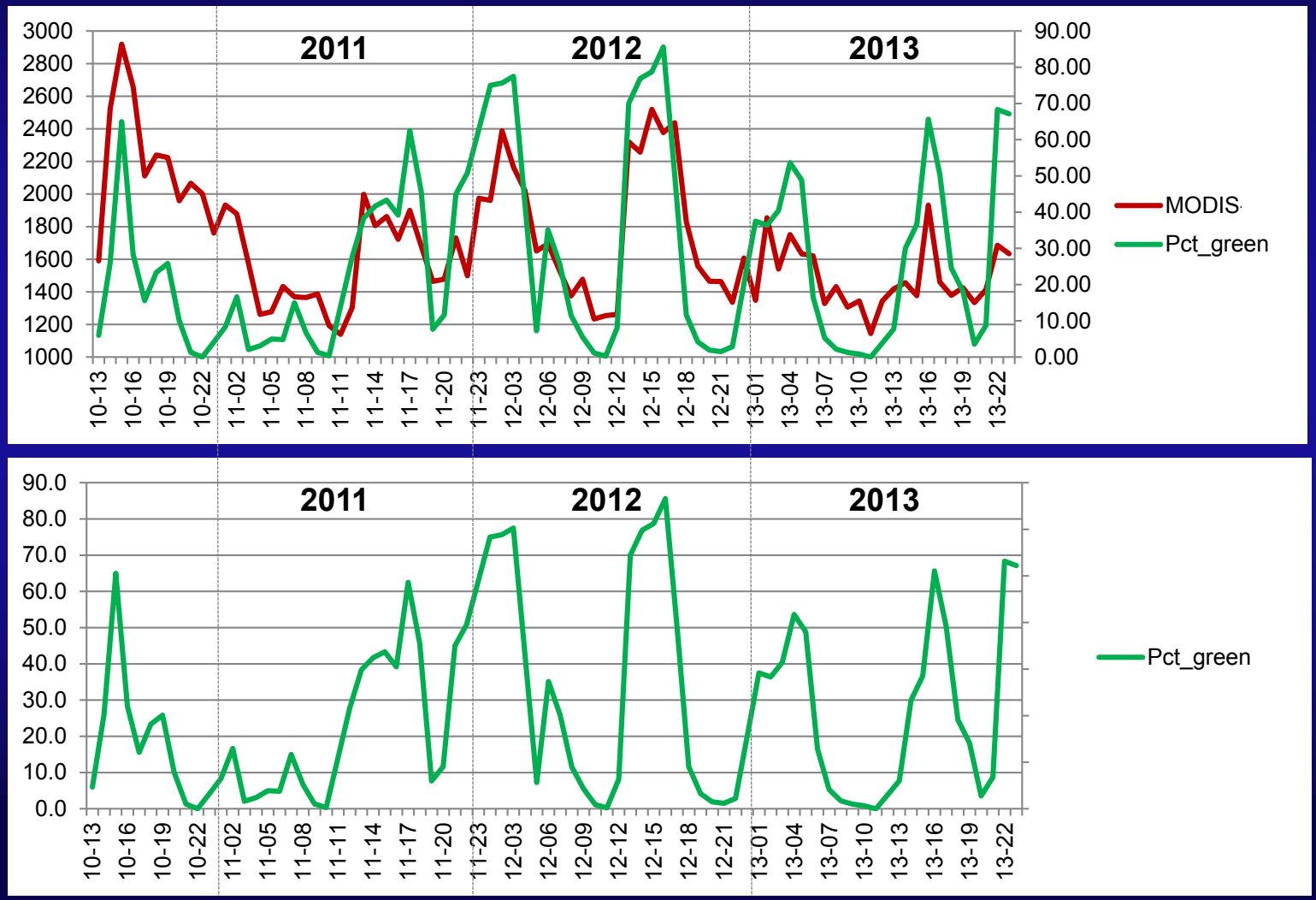

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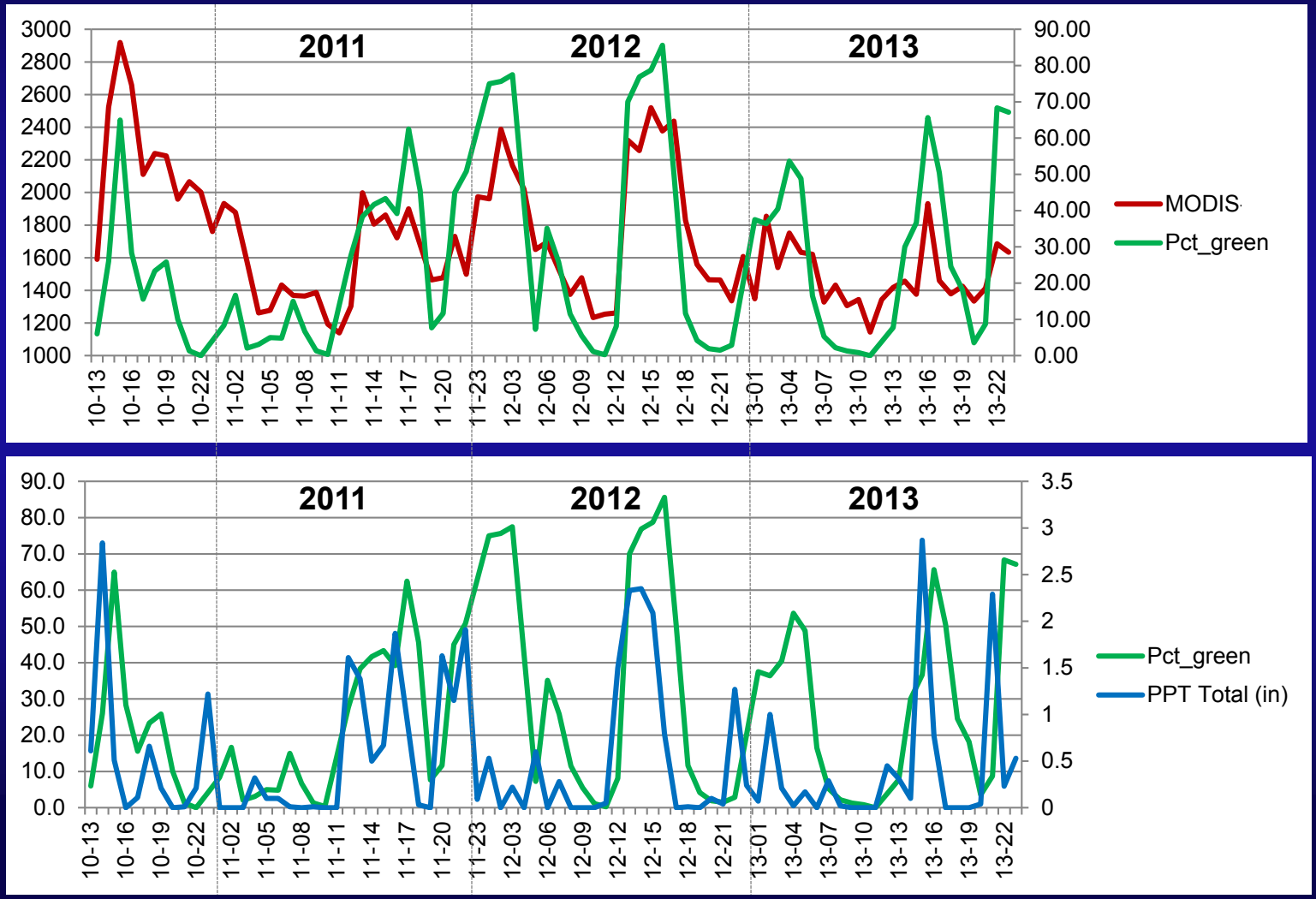

Observed buffelgrass greenness (Pct_green) and Precipitation data (PPT Total)

Buffelgrass Green-up: Where?

	Field Obs	MODIS	ppt	ppt1	ppt2	ppt3	ppt12	ppt123
Field Obs	1	0.63	0.24	0.44	0.55	0.55	0.62	0.71
MODIS	0.63	1	0.33	0.4	0.45	0.38	0.54	0.58

Statistical Correlation Analysis

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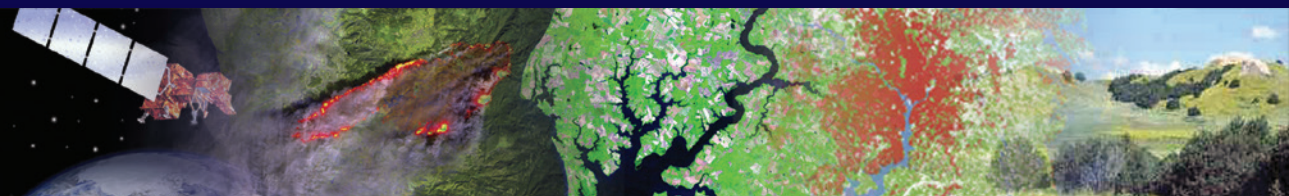

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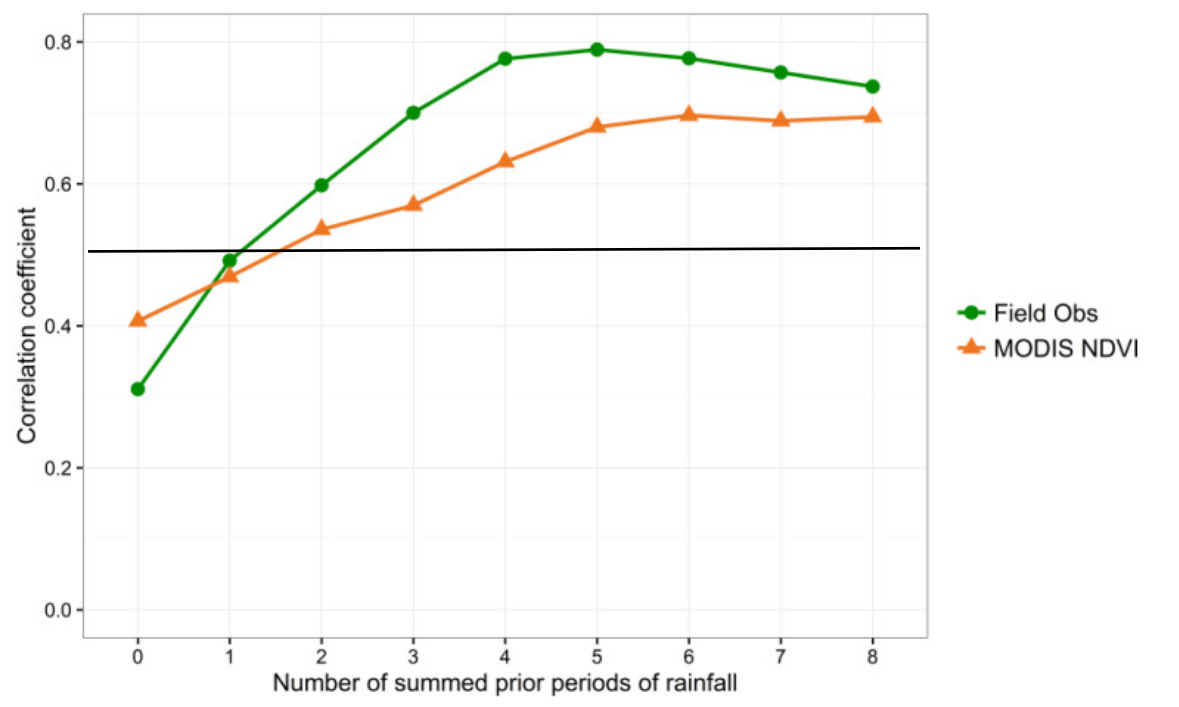

0 = PPT current
1 = PPT lag1
2 = PPT lag1+2
3 = PPT lag1+2+3
4 = PPT lag1+2+3+4
5 = PPT lag1+2+3+4+5
6 = PPT lag1+2+3+4+5+6
7 = PPT lag1+2+3+4+5+6+7
8 = PPT lag1+2+3+4+5+6+7+8

Correlation Coefficients between MODIS-NDVI (orange) or Field-Observed percent greenness (green) and PRISM precipitation totals summed for various lags (pooled 2011, 2012 and 2013 data)

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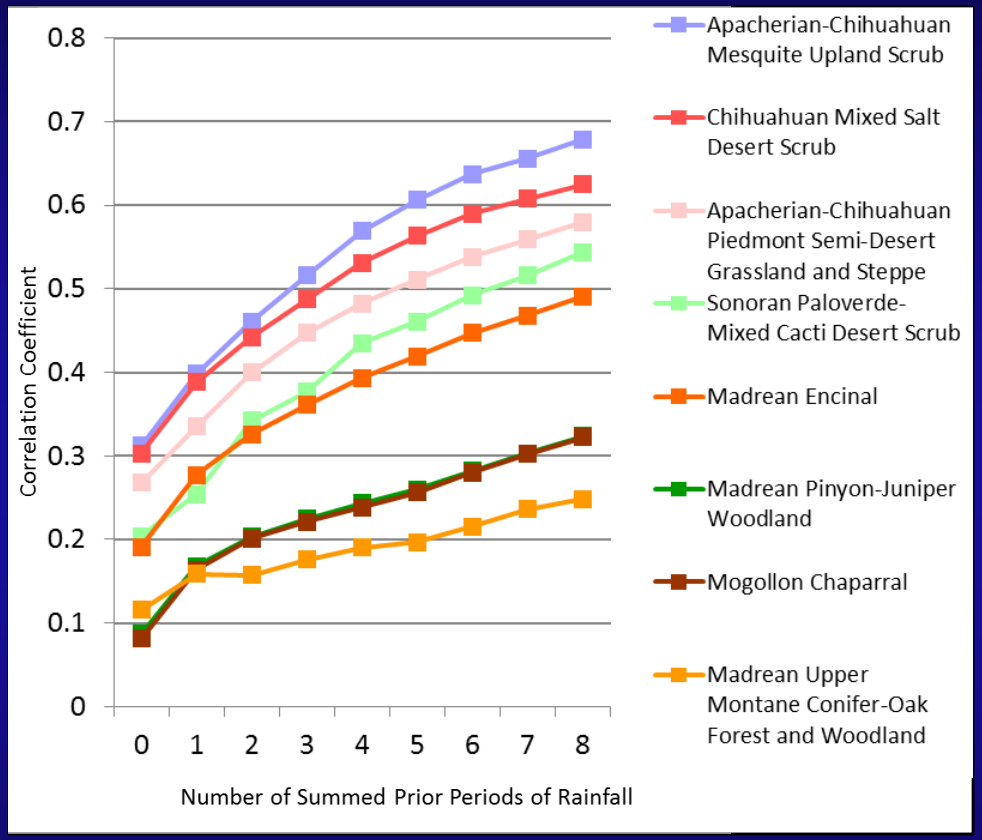
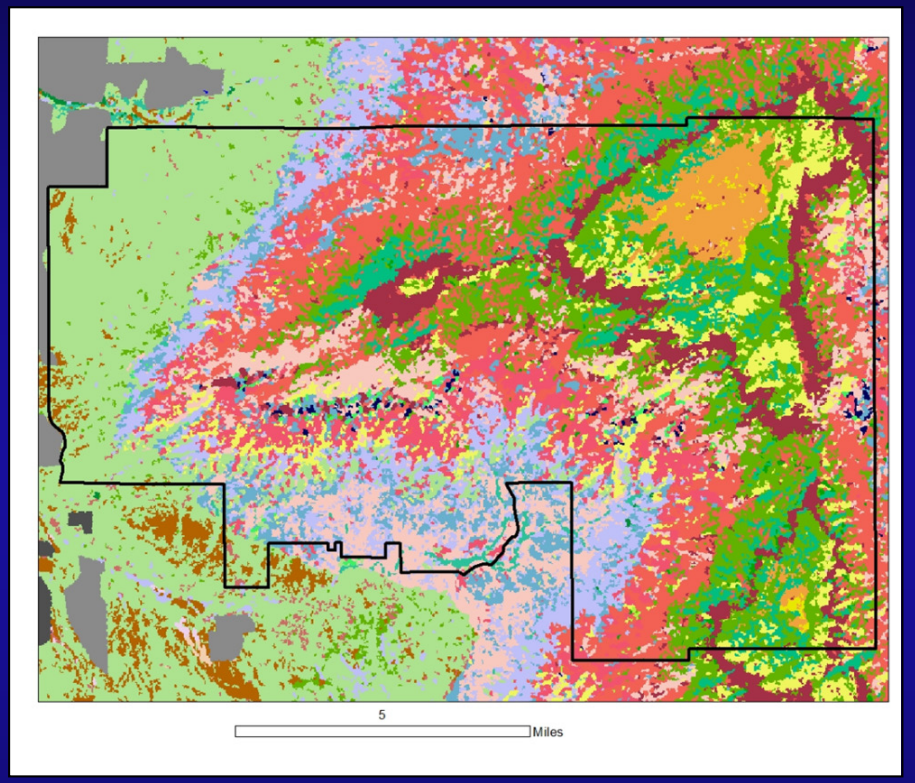
Saguaro National Park East: Where?

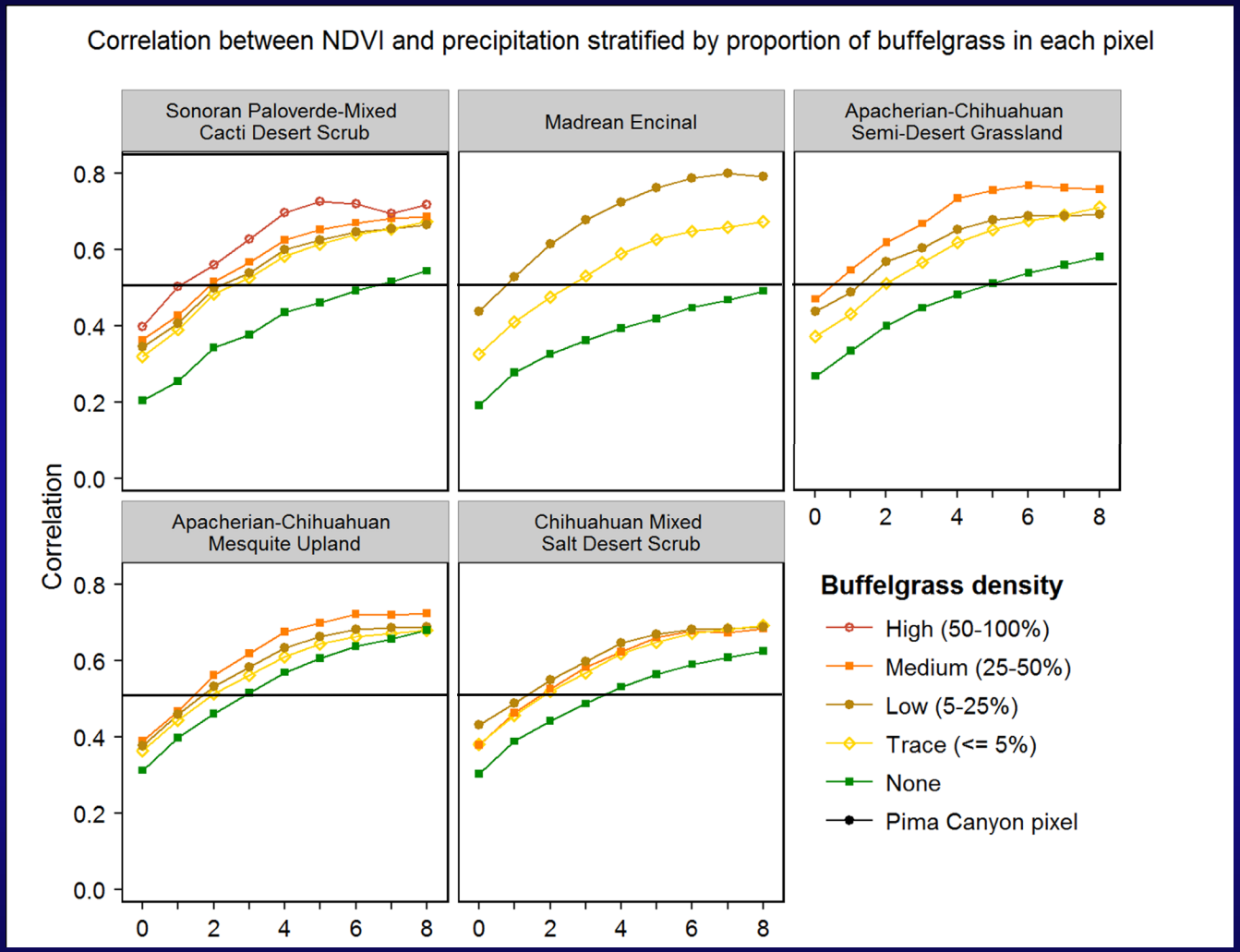




SWreGAP Vegetation Map

Average correlation values across a suite of phenometrics for native vegetation in major vegetation types of Saguaro National Park - East

Saguaro National Park East: Where?



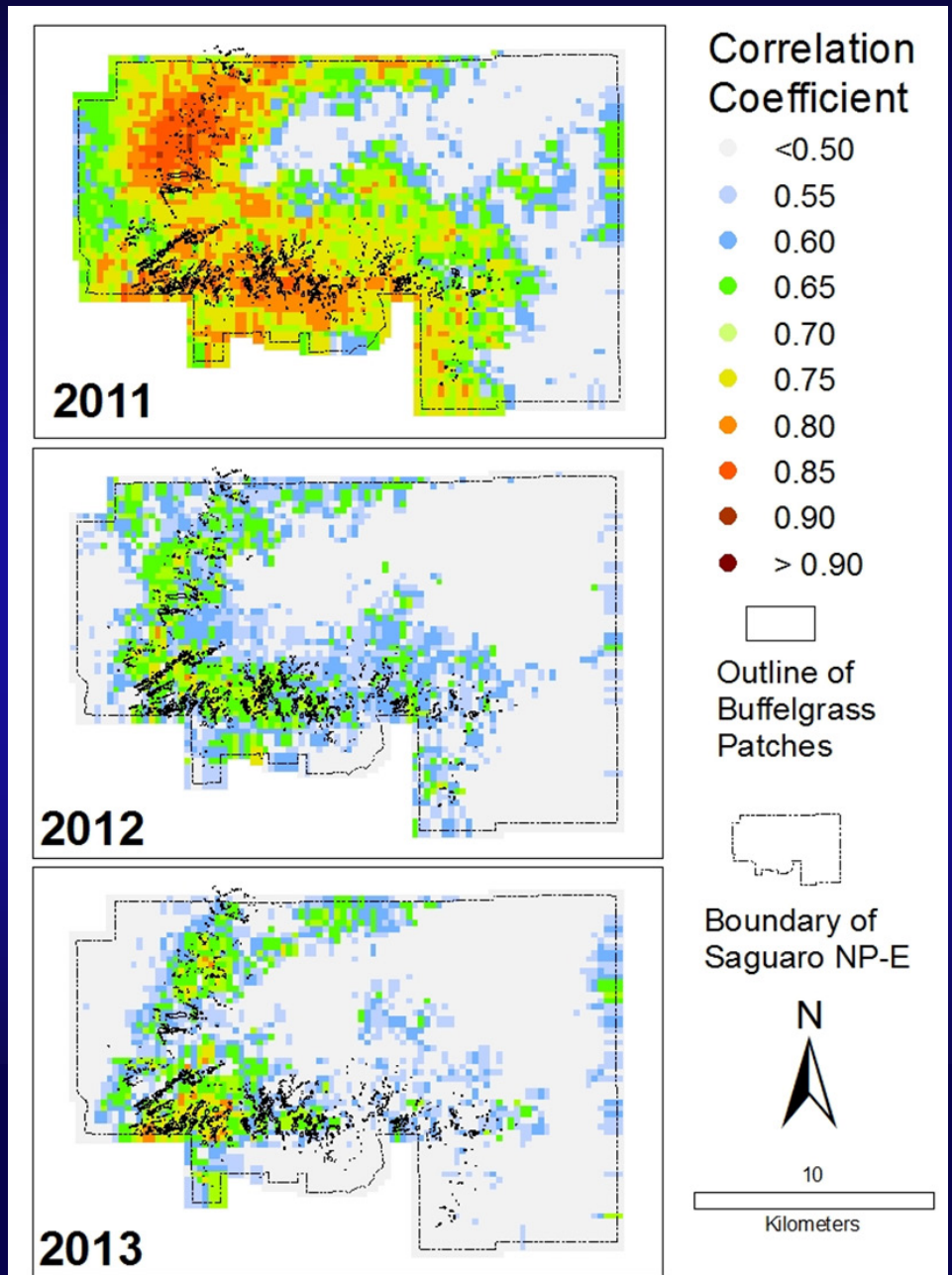
Average correlation values across a suite of phenometrics for native vegetation compared to averages for various densities of buffelgrass. Note that small amounts of buffelgrass can dramatically increase the correlation values.

Buffelgrass Green-up: Where?

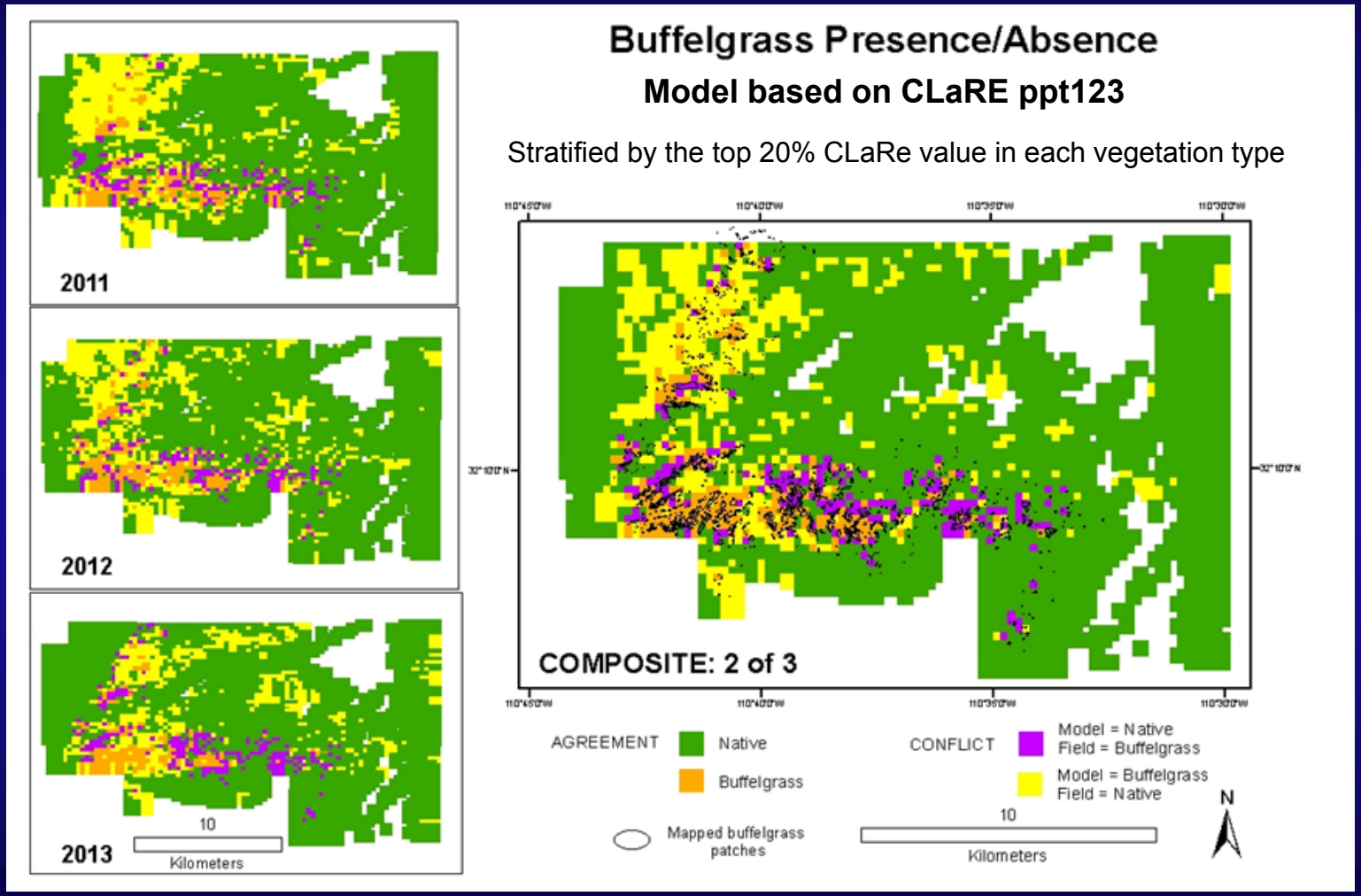
Create: Climate Landscape Response (CLaRe) phenometrics.

Example: The CLaRe Phenometric displayed (CLaRe-ppt123) is the correlation between MODIS NDVI and the cumulative precipitation for the three prior 8-day time periods.

Note: Monsoon rainfall totals
Average: 6.08 in
2011: 8.62 in
2012: 6.02 in
2013: 3.74 in



Saguaro National Park East: Where?



Modeled buffelgrass presence-absence based on Top 1/5th CLaRe Phenometrics.
Validation: 2011-2012-2013-composite = 79-80-79-83% overall; =45-49-42-72% known

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Buffelgrass Green-up: When?

Santa Catalinas~Rincon Mountains

50% Green

will occur 8 to 16 days after a ~3 week (24 day) period that totaled over 1.80 inches of rain

70% Green

will occur 8 to 16 days after a ~3 week (24 day) period that totaled over 2.78 inches of rain

90% Green

will occur 8 to 16 days after a ~3 week (24 day) period that totaled over 3.77 inches of rain

50%	Composite	
	ppt (in)	R^2
lag12	1.46	0.38
lag123	1.80	0.56
lag23	1.42	0.41
lag234	1.80	0.53

70%	Composite	
	ppt (in)	R^2
lag12	2.38	0.38
lag123	2.77	0.56
lag23	2.31	0.41
lag234	2.78	0.53

90%	Composite	
	ppt (in)	R^2
lag12	3.31	0.38
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lag23	3.19	0.41
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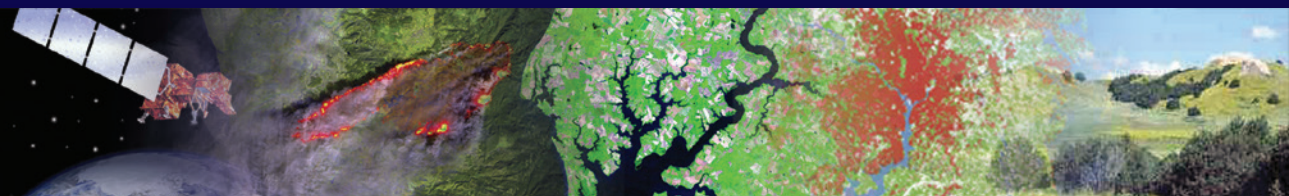

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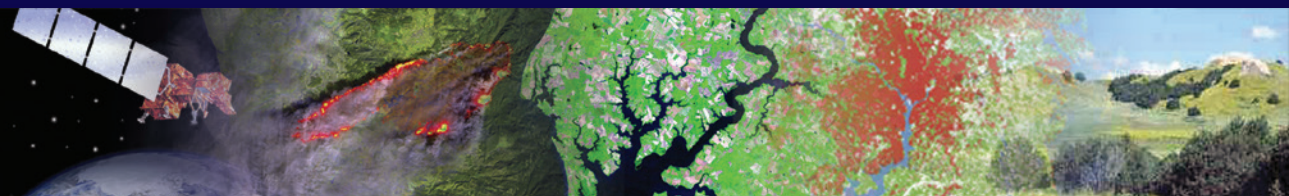
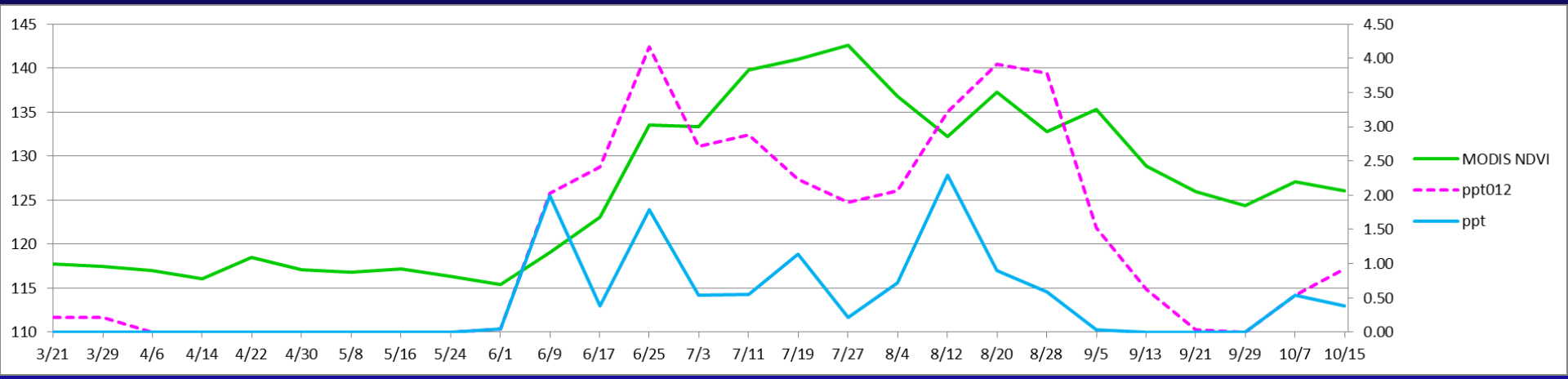


Buffelgrass Green-up: When?

Example: Pixel containing patch of high density buffelgrass at SNP-E



Monitoring precipitation and MODIS NDVI to optimize timing of herbicide treatment. The horizontal axis shows the month and day in 2011, beginning March 21. The left vertical axis is a rescaled NDVI value and the right vertical axis is inches of precipitation.

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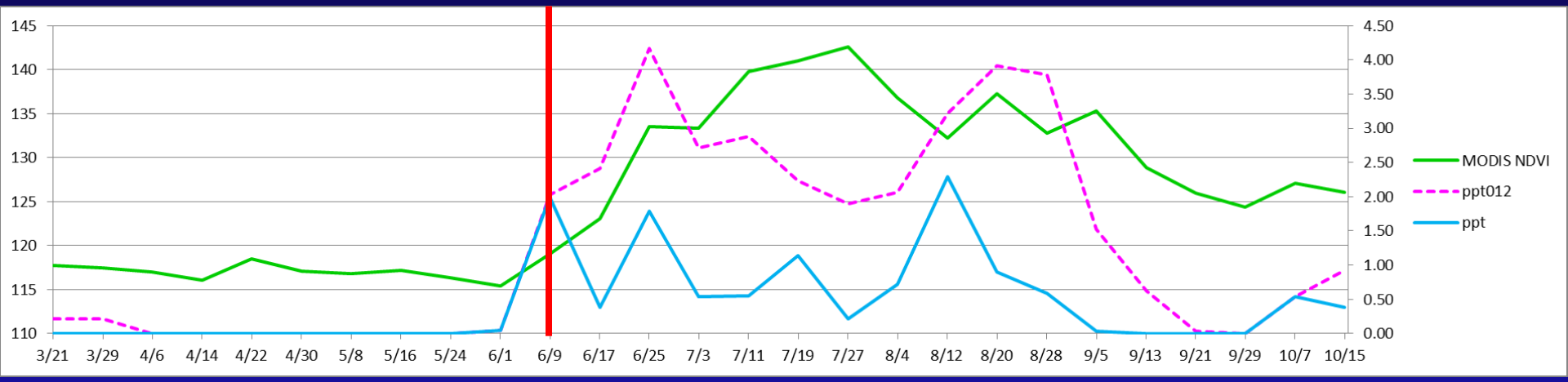

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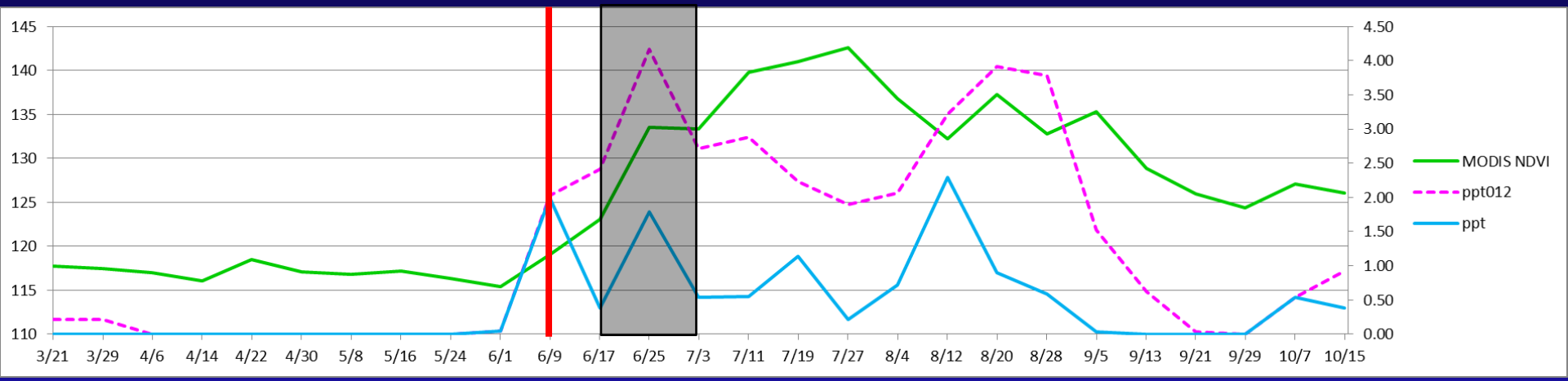

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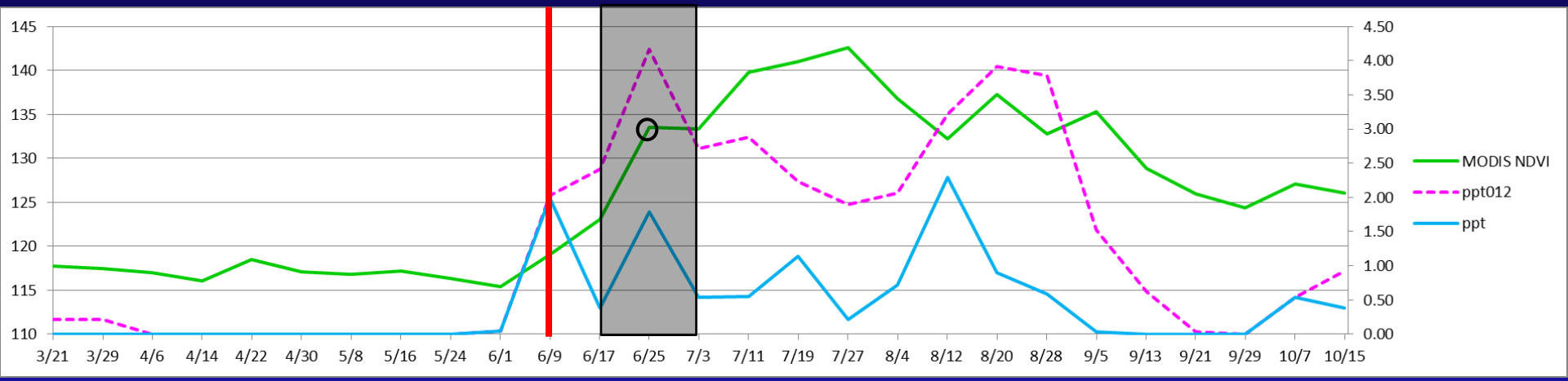

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1. Refine the model

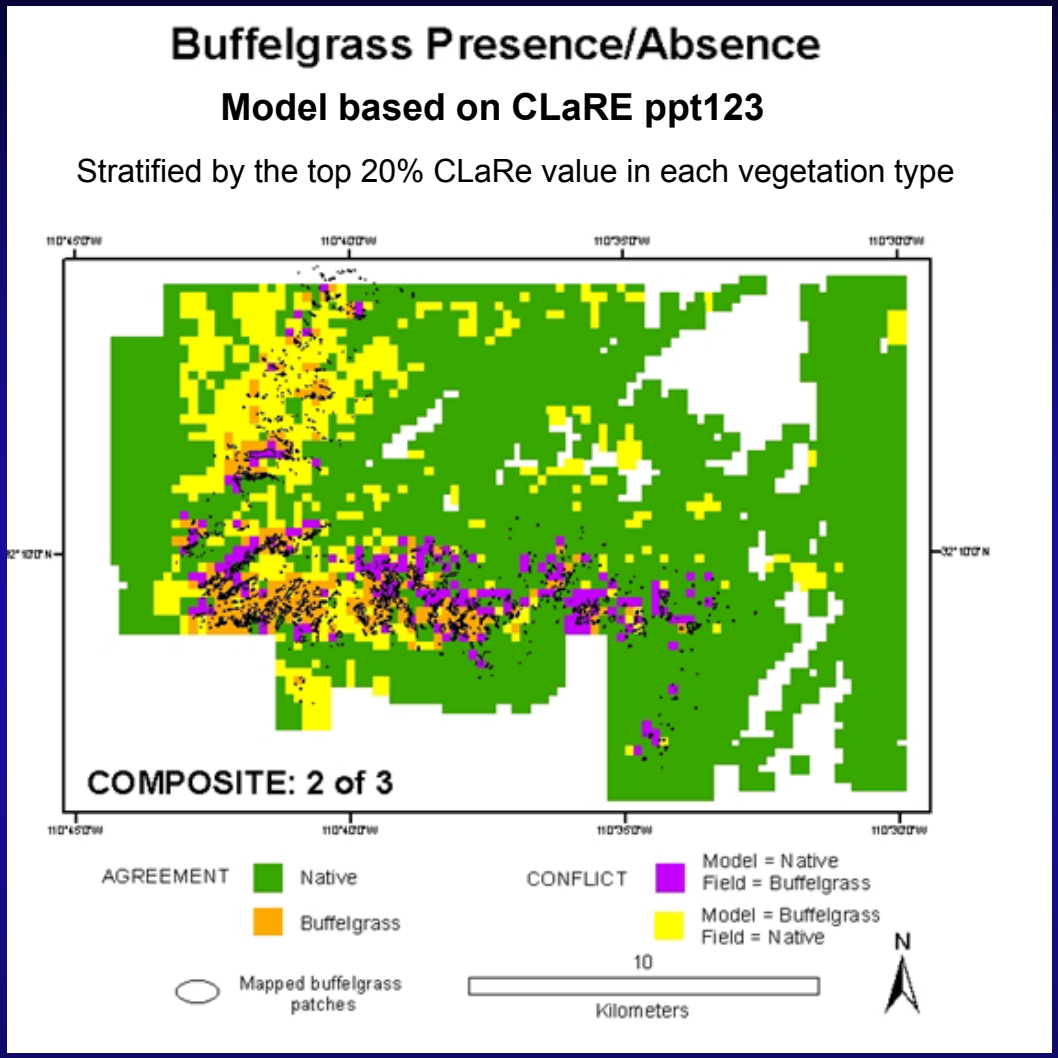
Topographic facets
Seasonal
Other invasives

2. Operationalize

eMODIS and PRISM
Prototype 2014 and 2015
Pattern of nascent population
Document treatment effectiveness

3. Extend Analysis

Outside the Park
Organpipe Cactus National Monument



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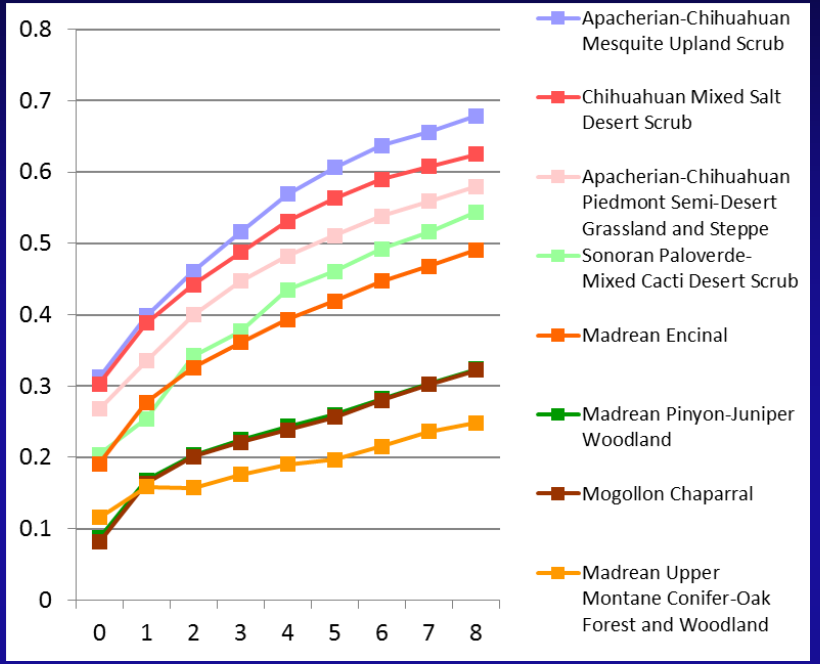
Climate Landscape Response (CLaRe) metrics

Additional projects to demonstrate application of CLaRe metrics:

1. Vegetation Mapping. Forbs/Grass>Shrubs>Trees
2. Irrigated vs. Rainfed agriculture; crop types (GDD vs. length of daylight)
3. Invasive species. Most display rapid response to precipitation. Explore the seasonal components of rainfall/invasives
4. Ecotones of forests based on understory vegetation.
5. Habitat preferences. e.g., cuckoo, pronghorn



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Thank you!