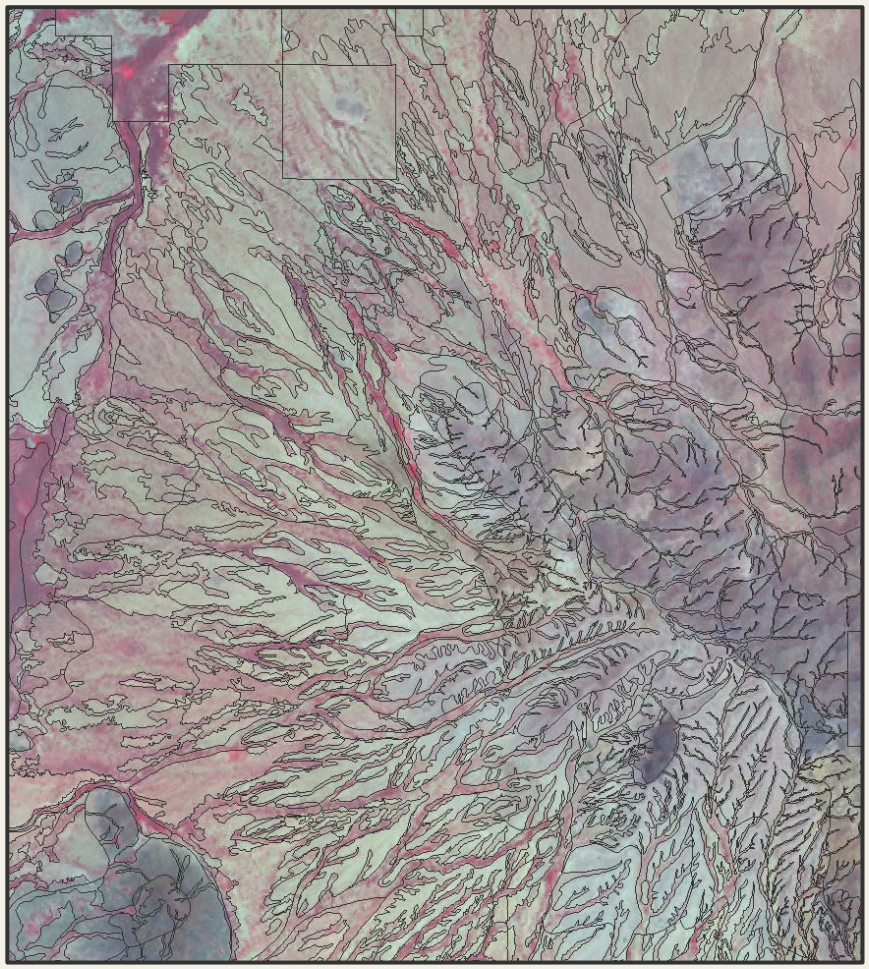
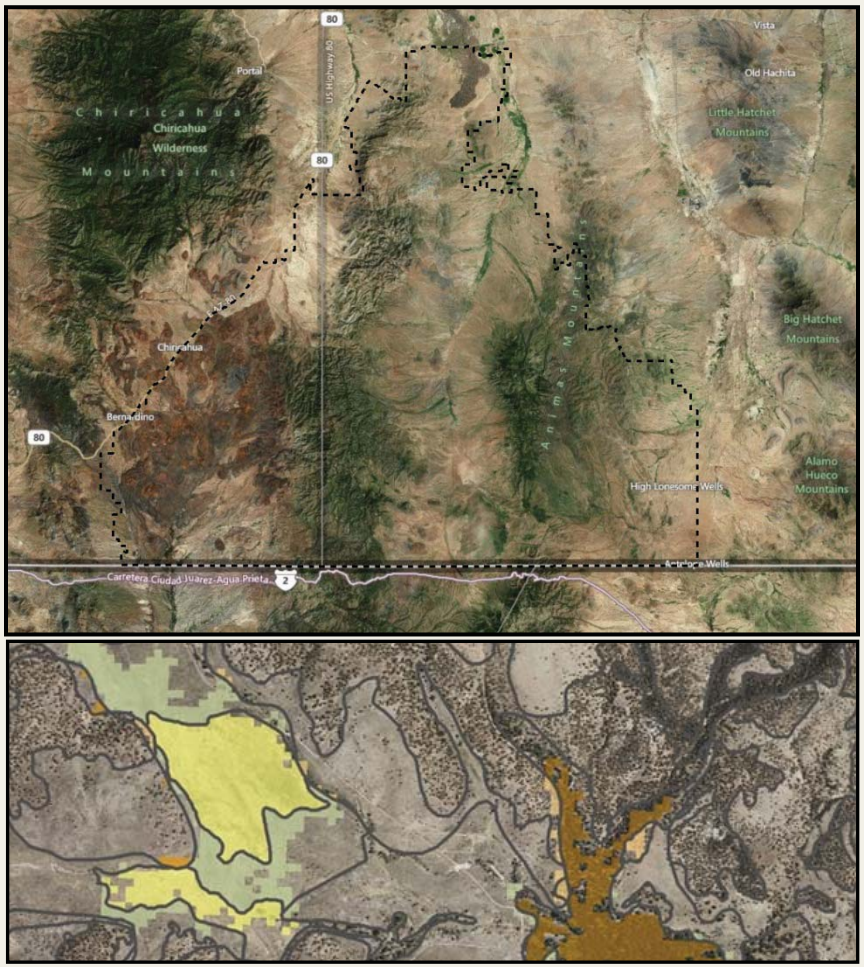




REMOTE SENSING ACTIVITIES

Caiti Steele

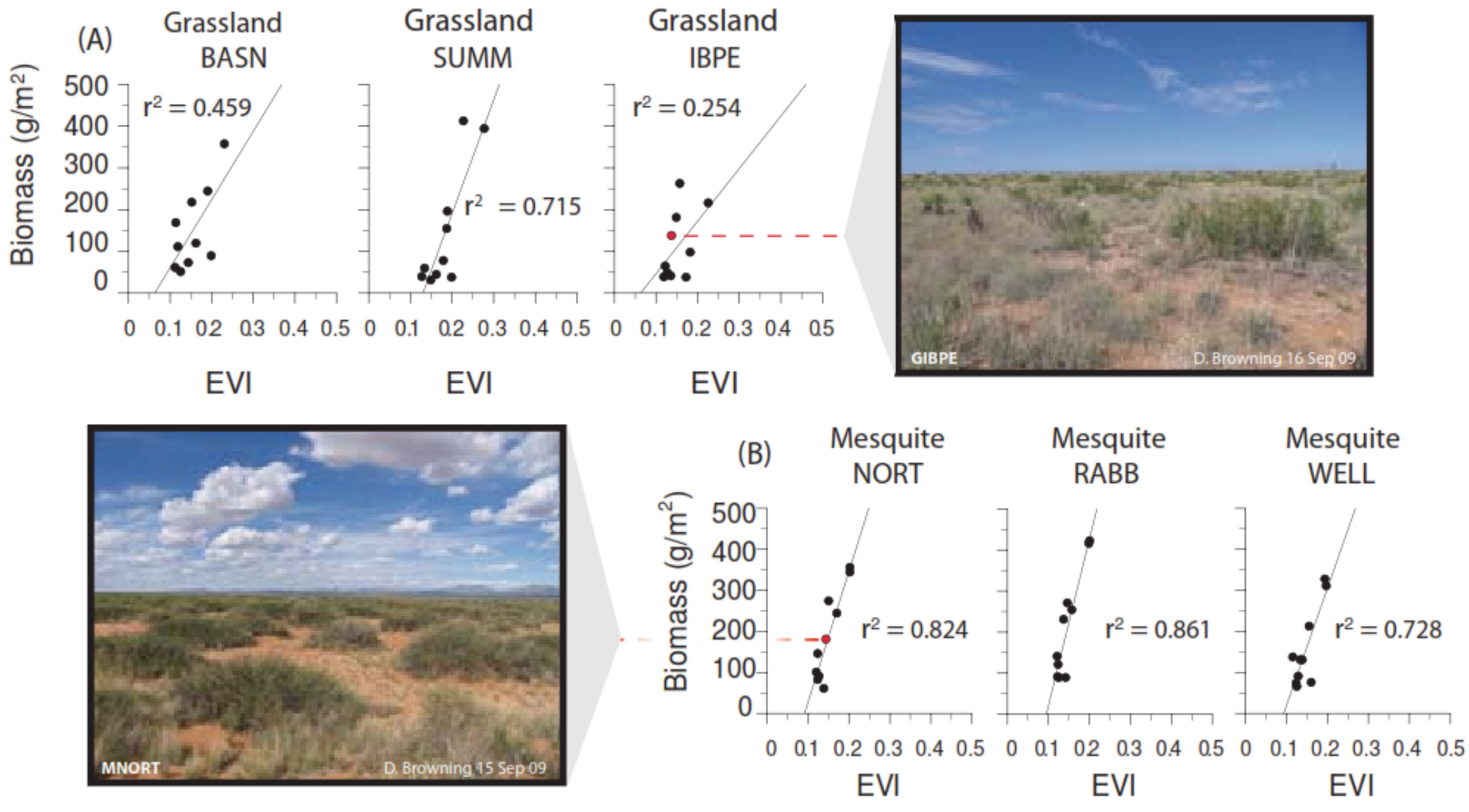
REMOTE SENSING ACTIVITIES

- Remote sensing of biomass: *Field Validation of Biomass Retrieved from Landsat for Rangeland Assessment and Monitoring* (Browning *et al.*, 2010)
- Remote sensing for mapping Ecological States: *Spatially-Explicit Representation of State-and-Transition Models* (Steele *et al.*, 2012)
- Malpais Borderland: Changes in NDVI: *Vegetation index differencing for broad-scale assessment of productivity under prolonged drought and sequential high rainfall* (Browning and Steele, in preparation)

REMOTE SENSING OF BIOMASS

- Can reflectance indices derived from Landsat Thematic Mapper (TM) data provide reliable and accurate estimates for vegetation biomass in the Chihuahuan desert ecosystem?
- Evaluated the relationship between seasonal field-based estimates of photosynthetic vegetation biomass to enhanced vegetation index (EVI) values
- Long-term field study of net primary productivity at Jornada LTER sites is conducted at 15 70-m X 70-m sites that represent three shrubland (mesquite, tarbush, creosote) and two grassland (upland and playa) plant communities. Biomass measurements are made three times annually (winter, spring and fall)

REMOTE SENSING OF BIOMASS



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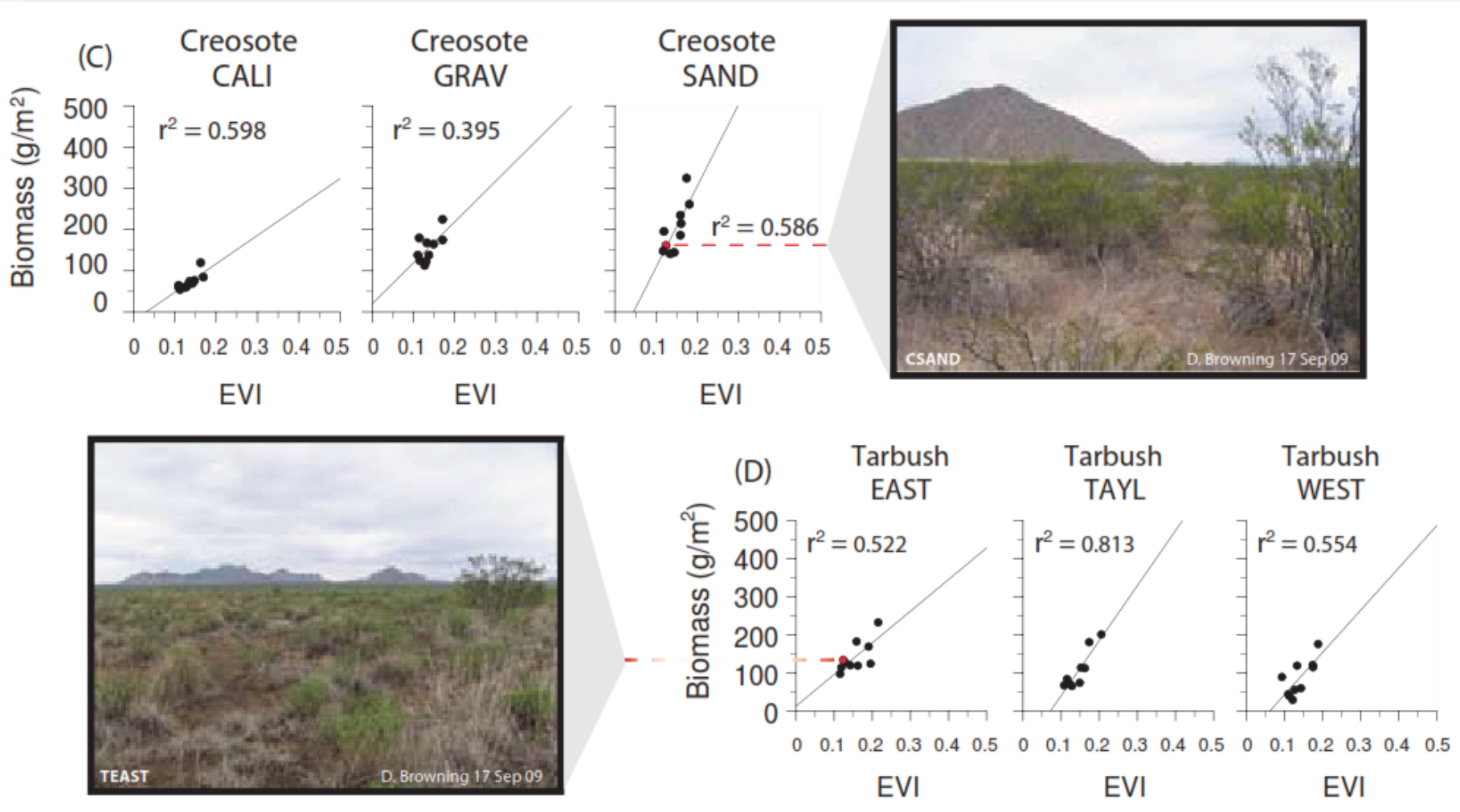
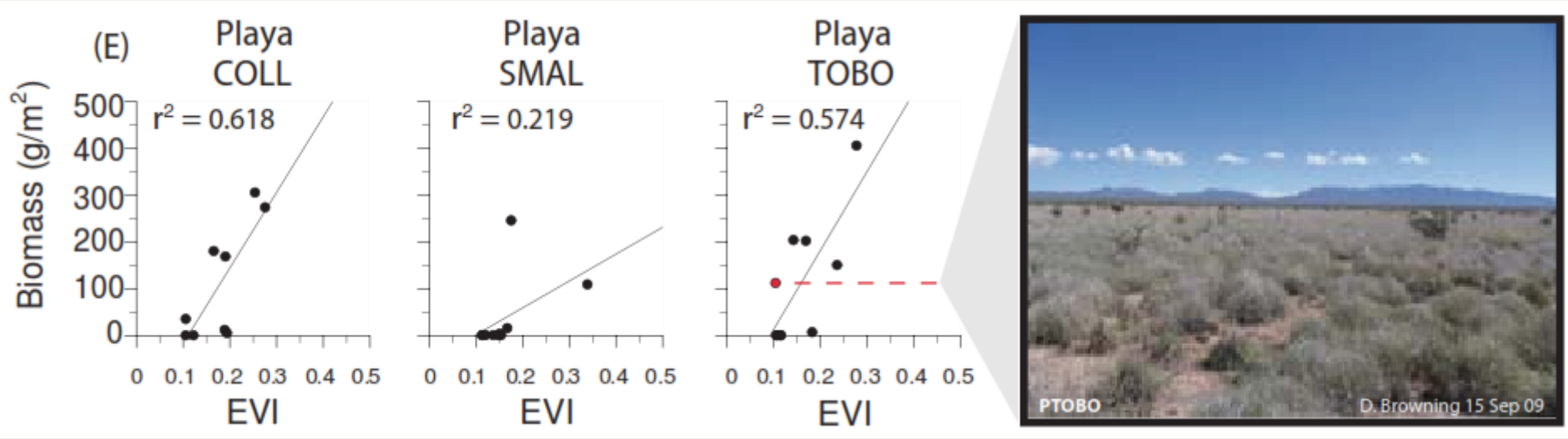


REMOTE SENSING OF BIOMASS



REMOTE SENSING FOR MAPPING ECOLOGICAL STATES

- Creating a spatial representation of generalized ecological state classes for public lands under the jurisdiction of the BLM Las Cruces District Office (Steele *et al.*, 2012)

- Method: Photo-interpretation of freely available Digital Orthophoto Quarter Quads (DOQQs) and other fine spatial resolution imagery. Interpretation assisted with use of other data sources including field data and expert knowledge of area

REMOTE SENSING FOR MAPPING ECOLOGICAL STATES

SSURGO: 3rd order soil map unit (SMU) polygons obtained for study area

↓

Ecological site attributes added to SMU polygons

↓

SMU polygons overlain on DOQQs / NAIP imagery

↓

SMU polygons cut to delineate soil features visible in the imagery at scales between 1:2k - 1:5k

↓

Ecological site attributes updated

↓

State code assigned by photo-interpretation and reference to other data sources

↓

Rapid field traverse to ascertain states of problematic areas

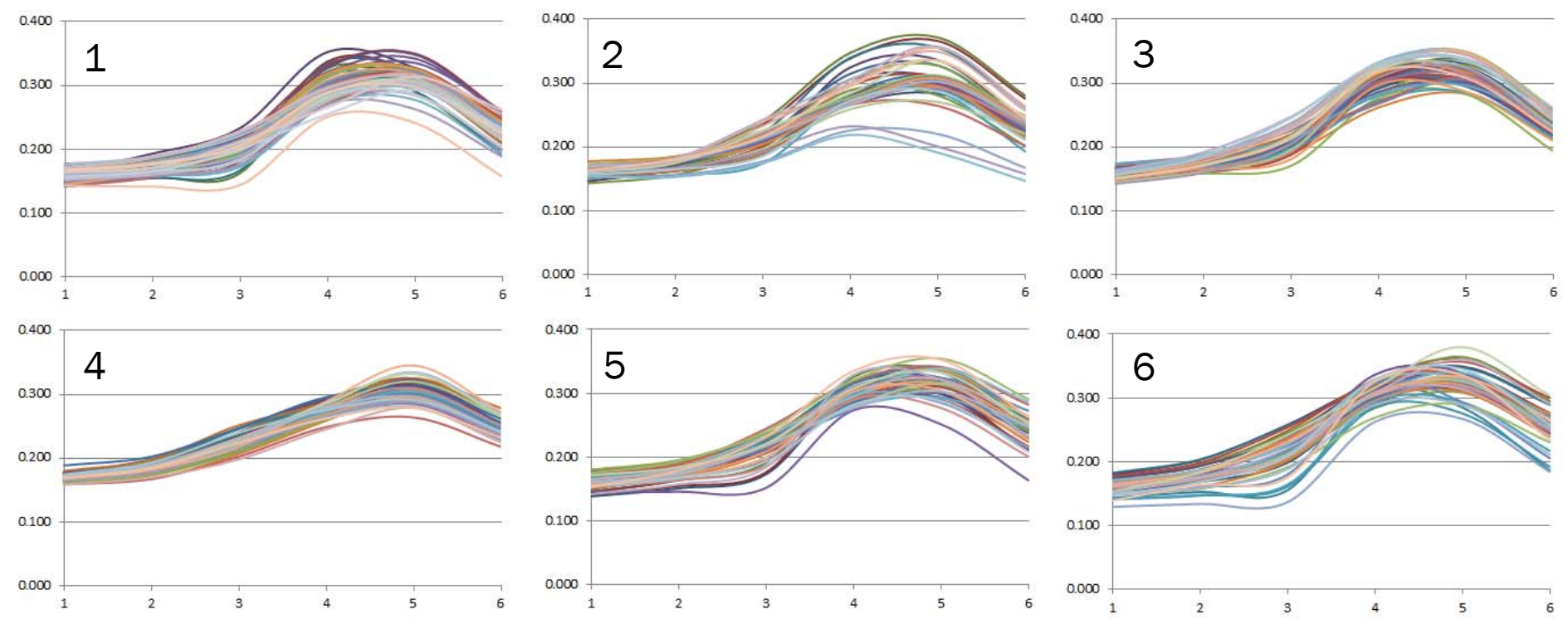
REMOTE SENSING FOR MAPPING ECOLOGICAL STATES

- Using automated image processing techniques to map ecological states in MLRA 42 (Southern Desertic Plains and Mountains) is particularly challenging because of:
  - sparse vegetation, strong soil reflectance
  - landscape complexity
  - indirect/complex relationships between classes and reflectance or spatial variables
  - spectral similarities between different ecological states
  - spectral differences between similar states

REMOTE SENSING FOR MAPPING ECOLOGICAL STATES

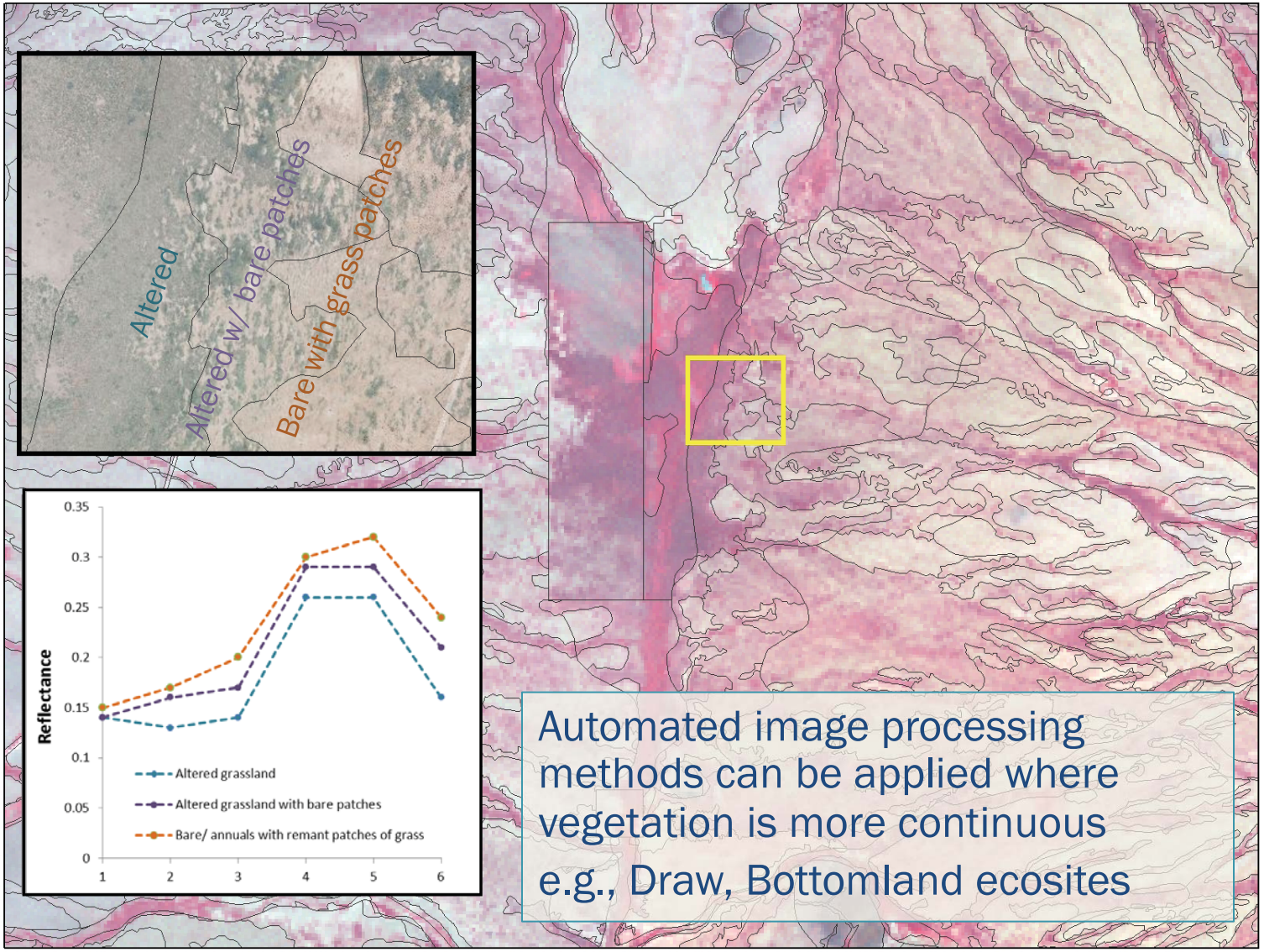
Reflectance (y axis) in Landsat TM Bands 1 - 5 and 7 (x axis) for:

(1) Historic Grasslands; (2) Historic Savanna; (3) Shrub-invaded grassland; (4) Shrub-dominated Savanna (5) Expansion shrubland; (6) Bare



Note: TM bands 1 - 5 and 7 are labeled 1 – 6, x axis)

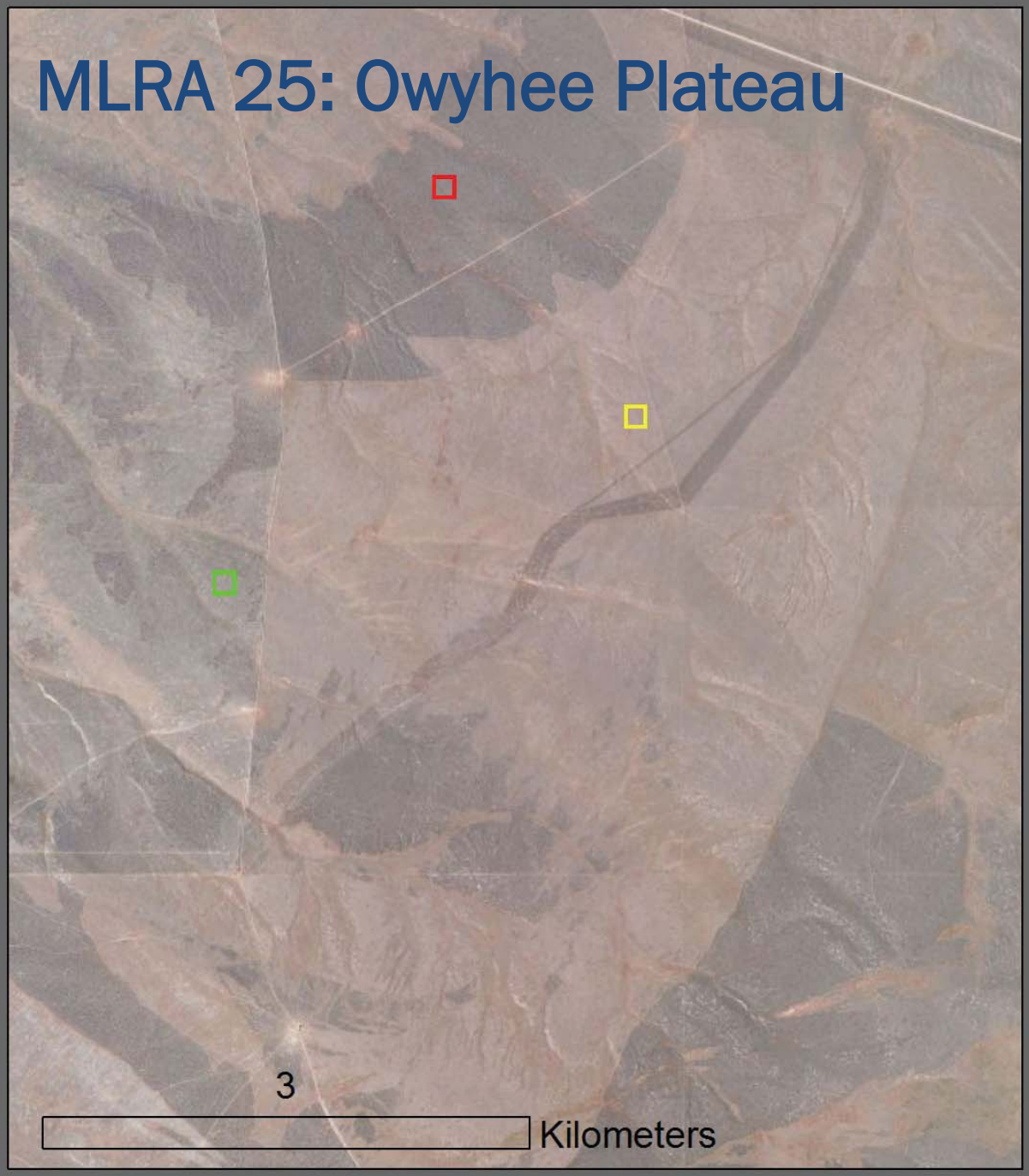
REMOTE SENSING FOR MAPPING ECOLOGICAL STATES

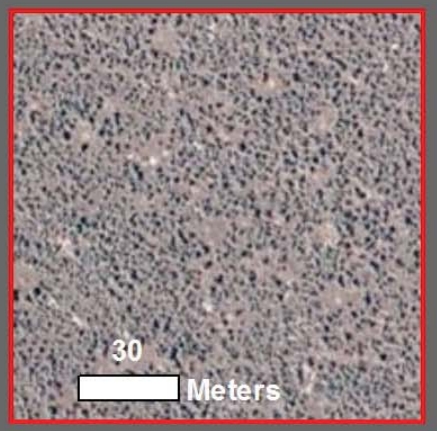


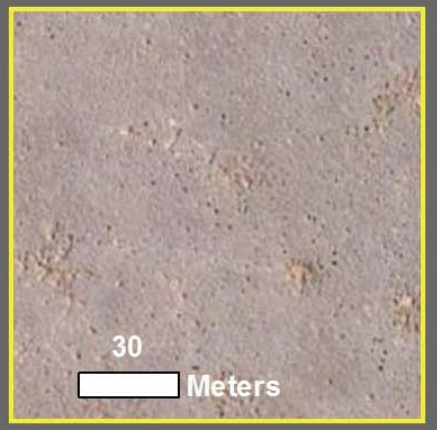
Automated image processing methods can be applied where vegetation is more continuous

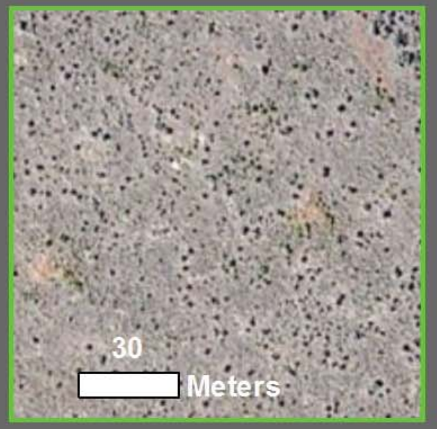
e.g., Draw, Bottomland ecosites

MLRA 25: Owyhee Plateau







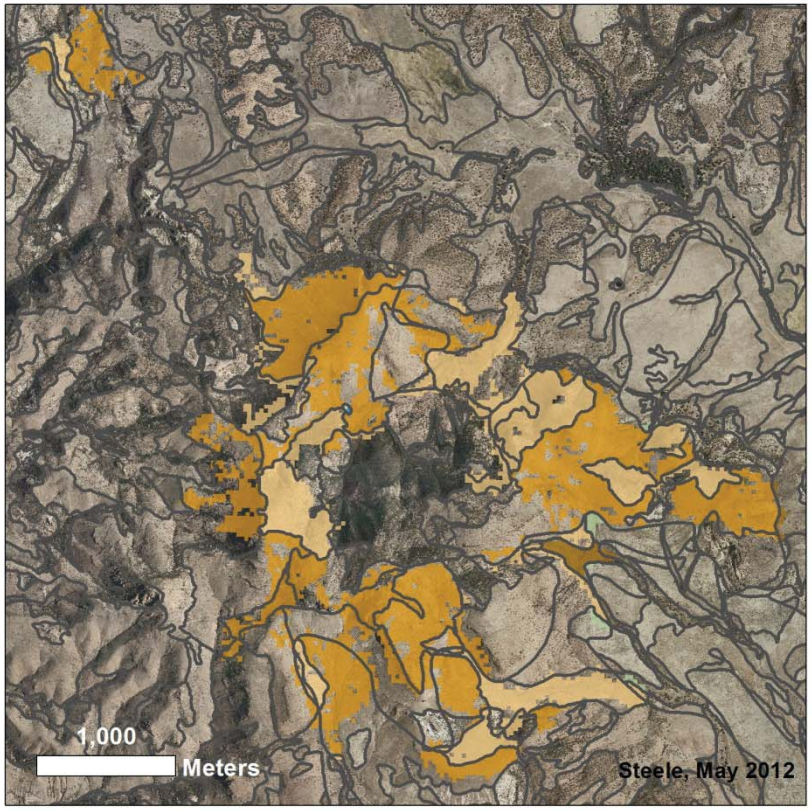


REMOTE SENSING FOR MAPPING ECOLOGICAL STATES

- Object-based image analysis, particularly promising for state-mapping:
  - Preserves SMU polygons and attributes
  - Can handle combinations of categorical and continuous data
  - Facilitates generation of textural variables
  - Can be applied with decision tree classifier (computationally efficient and mimics the decision-making process already being used by the analyst) e.g., Laliberte et al. 2007

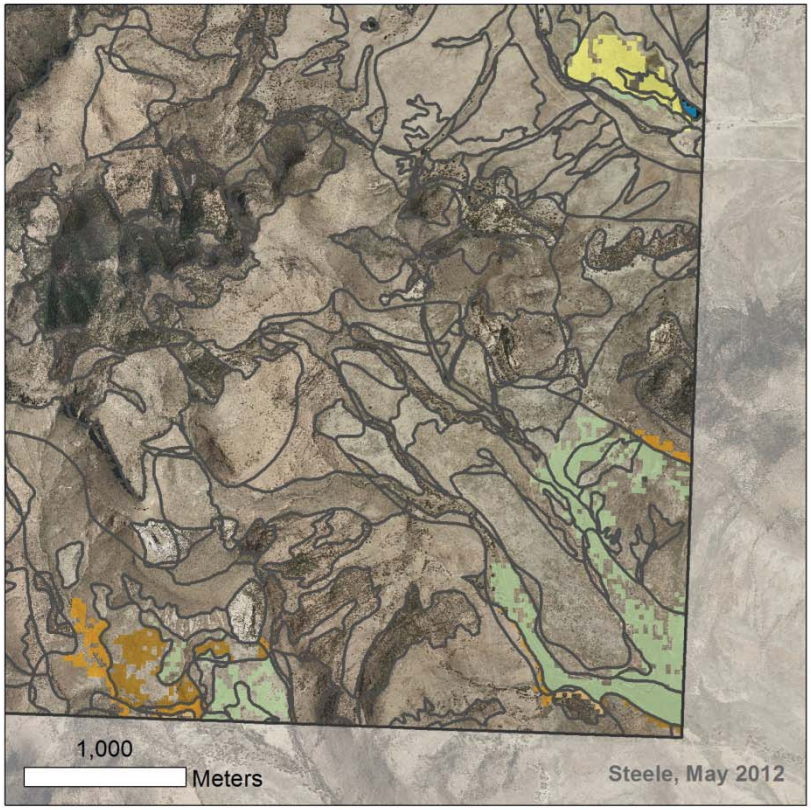
MALPAIS BORDERLAND: CHANGES IN NDVI

- Hypothesis: Reference, altered, and degraded ecological states respond differently under conditions of drought and moisture abundance
- Landsat TM imagery acquired for (i) 2003, a year following persistent below-average rainfall for the region and (ii) 2009, a year following two historically high rainfall years
- Examined the difference between pre- and post-growing season NDVI for different ecological sites / states in the Malpais Borderland Region
- Questions:
  - What ecological states exhibit most positive and negative change in NDVI after periods of above- and below-average rainfall?;
  - What can we infer from the pattern of NDVI responses with respect to state-specific vegetation dynamics?



Site 2: Ecological states showing significant decrease in NDVI in 2003

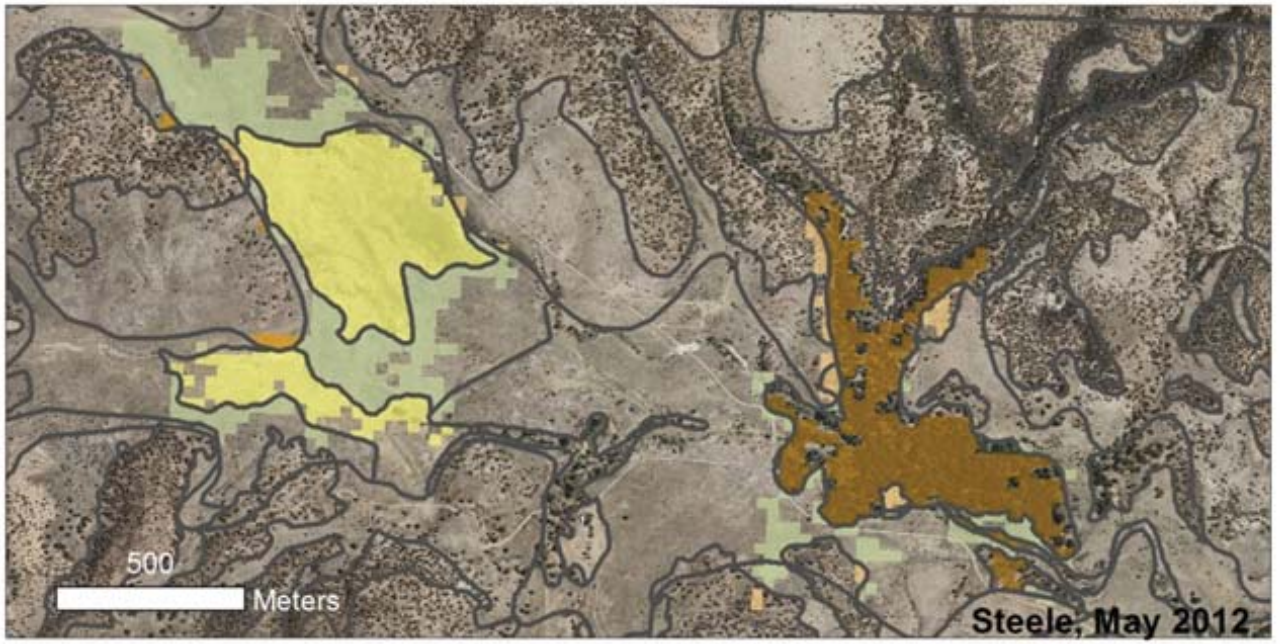
- Shrub-invaded grassland
- Altered savanna
- Shrub-dominated grassland



Site 2: Ecological states showing significant increase in NDVI in 2009

- Tank
- Shrub-invaded grassland
- Shrub-Tree savanna
- Shrub-invaded grassland
- Altered savanna
- Bare-annuals state

MALPAIS BORDERLAND: CHANGES IN NDVI



Site 2: Ecological states showing significant increase in NDVI in 2003

- Shrub-invaded grassland
- Shrub-Tree savanna
- Shrub-dominated grassland
- Altered savanna
- Bare-annuals state

MALPAIS BORDERLAND: CHANGES IN NDVI

Negative change 2003	**Ecological State**	**Area of change (Δ_{AS} [Ha])**	**Total State Area (A_s [Ha])**	**Δ_{AS} / A_S (%)**
Type 1 Ecological sites				
Clay Loam Upland, Gravelly Slopes, Hills (41.1), Loamy, Loamy Bottom	Reference grassland	110.60	1426.97	7.75
	Altered grassland	51.11	4111.58	1.24
	Shrub-invaded grassland	10.07	441.91	2.28
	Bare-Annuals	0.05	505.69	0.01
	Total area changed (Δ_A)	171.84		
Type 2 Ecological sites				
Hills (42.2)	Shrub-Tree savanna	323.03	1716.83	18.82
	Altered savanna	169.12	3007.03	5.62
	Shrub-dominated savanna	33.42	213.54	15.65
	Total area changed (Δ_A)	525.57		
Positive change 2003	**Ecological State**			
Type 1 Ecological sites				
Gravelly Slopes, Hills (41.1), Loamy Bottom	Altered grassland	27.31	4111.58	0.66
	Shrub-invaded grassland	21.94	441.91	4.96
	Bare-Annuals	27.04	505.69	5.35
	Total area changed (Δ_A)	76.29		
Type 2 Ecological sites				
Hills (42.2)	Shrub-Tree savanna	0.81	1716.83	0.05
	Altered savanna	4.20	3007.03	0.14
	Total area changed (Δ_A)	5.01		

MALPAIS BORDERLAND: CHANGES IN NDVI

Positive change 2009	Ecological State	Area of change (Δ_{AS} [Ha])	Total State Area (A_s [Ha])	Δ_{AS} / A_S (%)
Type 1 Ecological sites				
Clay Loam Upland, Draw, Gravelly Slopes, Hills (41.1), Loamy Bottom, Loamy Upland	Reference grassland	355.68	1426.97	24.93
	Altered grassland	2255.08	4111.58	54.85
	Shrub-invaded grassland	146.29	441.91	33.11
	Shrub-dominated grassland	10.73	16.85	63.70
	Bare-Annuals	168.40	505.69	33.30
	Total area changed (Δ_A)	2936.18		
Type 2 Ecological sites				
Hills (42.2)	Shrub-Tree savanna	16.97	1716.83	0.99
	Altered savanna	173.69	3007.03	5.78
	Shrub-dominated savanna	55.91	213.54	26.18
	Total area changed (Δ_A)	246.58		