HYDROLOGIC RESPONSE OF HILLSLOPE SEEPS AND HEADWATER STREAMS OF THE FORT WORTH PRAIRIE

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HEADWATERS IN NORTH TEXAS

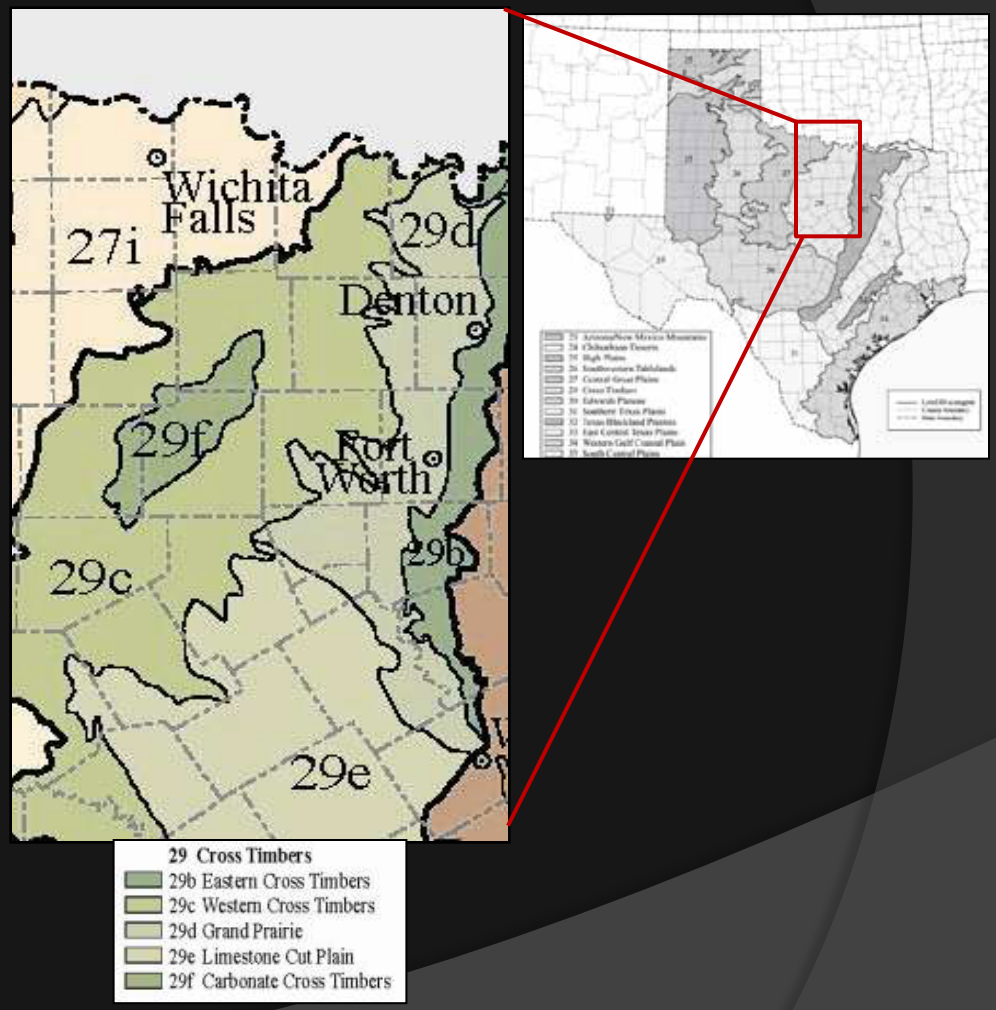
- > 75% of streams are ephemeral and intermittent (USEPA 2009)
- "Hyperseasonal" habitats are unique to North Texas
  - Hydrology alternates between complete soil saturation and drought
  - Term first used to describe the moisture regime of tropical savannas of Venezuela (Sarmiento 1984)
- Main source of water supply (Meyers 2003)
- Relatively little research has been conducted on the relationships among vegetation, topography, and hydrology along seeps and headwater streams of prairies (Llado 2011)

PRAIRIE HEADWATERS INFLUENCED BY…

- Geology
- Topography
- Soil Properties
- Vegetation

FORT WORTH PRAIRIE

- Northern section of the Grand Prairie (Hill 1901)
- Grassland unit between the East and West Cross Timbers
- Bounded north by Red River and south by Brazos River (Dyksterhuis 1946; Jue 2011)

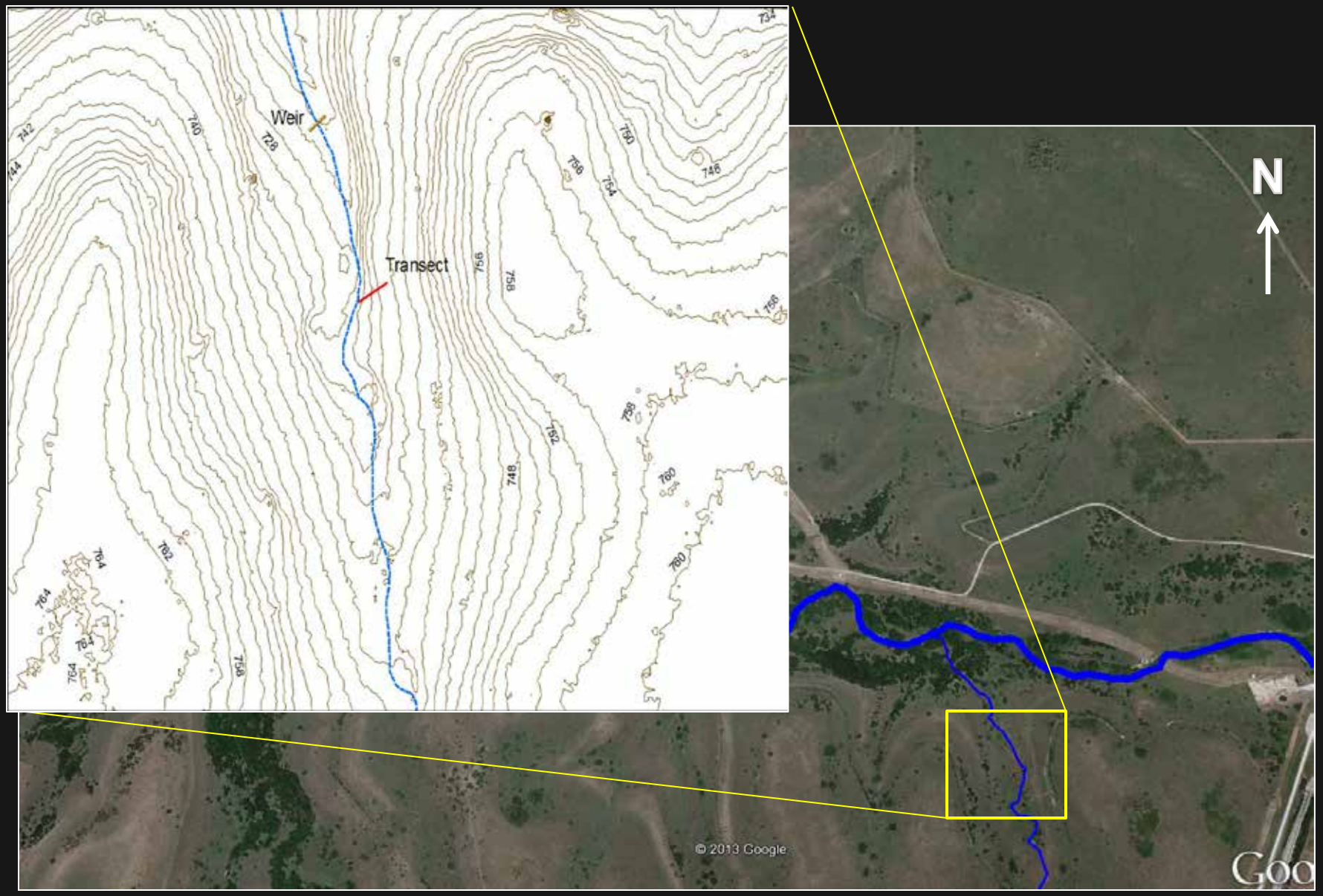


FORT WORTH PRAIRIE HEADWATERS

- Over interbedded hard limestone and soft marl
- Gently sloping valleys and narrow ravines
- Supports *hyperseasonal* vegetation

PURPOSE AND QUESTIONS

- Study seeks to:
  - Understand FW Prairie headwater stream systems
  - Quantify their behavior
- How soil moisture changes temporally and spatially?
- Do hillslope seeps impact and contribute to stream flow?
- To what extent does vegetation reflect the hydrology of the system?



USACE SITE EAST OF BENBROOK LAKE

MUHLY SEEPS

- Muhly seeps = common habitats
- Dominance of seep muhly (*Muhlenbergia reverchonii*)
  - *Carex microdonta*
  - *Eleocharis montevidensis*
  - *Eleocharis occulta*
- Dependent upon precipitation infiltrating through fractured limestone (Swadek and Burgess 2012)
- Hyperseasonality is a limiting factor
- Contribute to stream hydrology and productivity?
- Plant communities vary during year

Muhlenbergia Reverchonii

Muhlenbergia reverchonii **in bloom & of mounted specimen** **(LBJ Wildflower Center 2012)**

HEADWATER RIPARIAN ZONES

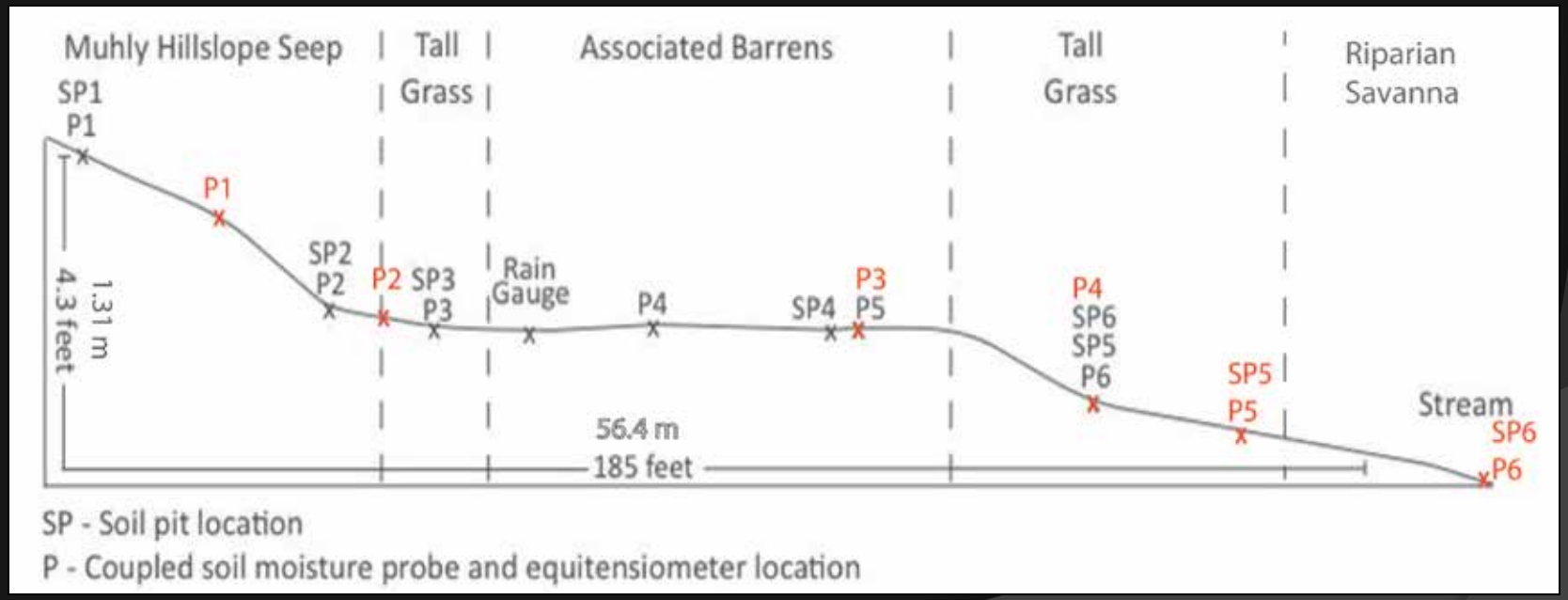
- Dependent on precipitation/access to shallow water tables
- Highly variable climate = highly variable ecosystems (Williams et al. 2006)
- Plants adapted to hyperseasonal environment
  - “Exist in a precarious balance between flood and drying”
- Neither typical wetlands, nor truly prairie grasslands

METHODOLOGY

- 3 components:
  - Hydrology
    - Soil moisture dynamics
    - Streamflow conditions
    - Precipitation
  - Vegetation
    - Plant communities across hillslope
  - Soils
    - Soil texture and properties

METHODOLOGY - HYDROLOGY

- Study extends Llado's (2011) transect
  - Monitored Muhly seep to colluvial footslope
- Monitored variablity of soil moisture across hillslope



METHODOLOGY - HYDROLOGY

- Soil moisture grid (SMG) across the hillslope
  - Handheld moisture meter
- 56 sampling points @ 5 m apart with 5 rows placed 10 m apart
  - Overlapped transect
  - capture SM variability across the hillslope
- Monitoring SM provides a baseline for common soil types in the FW Prairie

METHODOLOGY - VEGETATION

- Fall sampling across SMG
  - Survey of dominant species in plots
- U.S. National Vegetation Classification
  - Height, density, cover class, physiognomy, & habitat characteristics recorded

METHODOLOGY – GIS ANALYSIS

- Provided range of spatial analysis tools useful for analyzing field data
- Raster created using kriging
- Vegetation shapefiles overlayed SMG rasters
  - Determine vegetation and soil moisture patterns

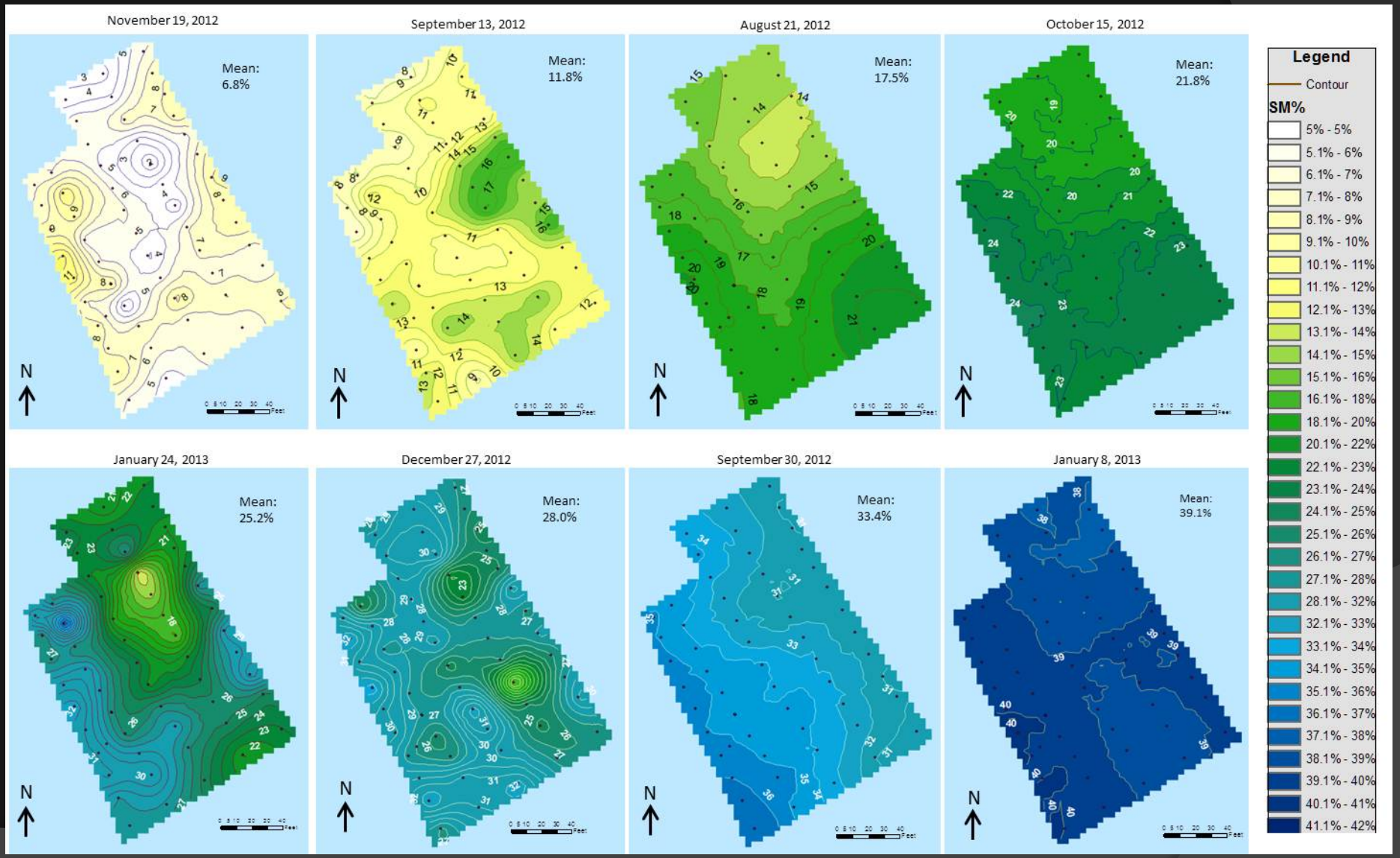
RESULTS - RAINFALL

Rainfall (cm)

MONTH	SRCC 40 year Historic Data	2010	2011	2012	2013
January	4.83	-	3.05	15.90	8.36
February	6.02	-	0.05	5.84	3.68
March	7.77	-	0.00	13.49	2.08
April	8.1 3	-	0.10	9.04	-
May	13.08	-	0.05	1.73	-
June	8.20	7.62	0.00	-	-
July	5.38	6.86	0.00	-	-
August	5.16	2.03	0.00	-	-
September	6.15	19.81	3.73	5.94	-
October	10.44	2.03	15.27	1.02	-
November	6.53	3.05	7.87	0.05	-
December	6.53	3.30	2.34	3.07	-
Year Total	**88.21**	**44.70**	**6.99**	**56.08**	**14.12**

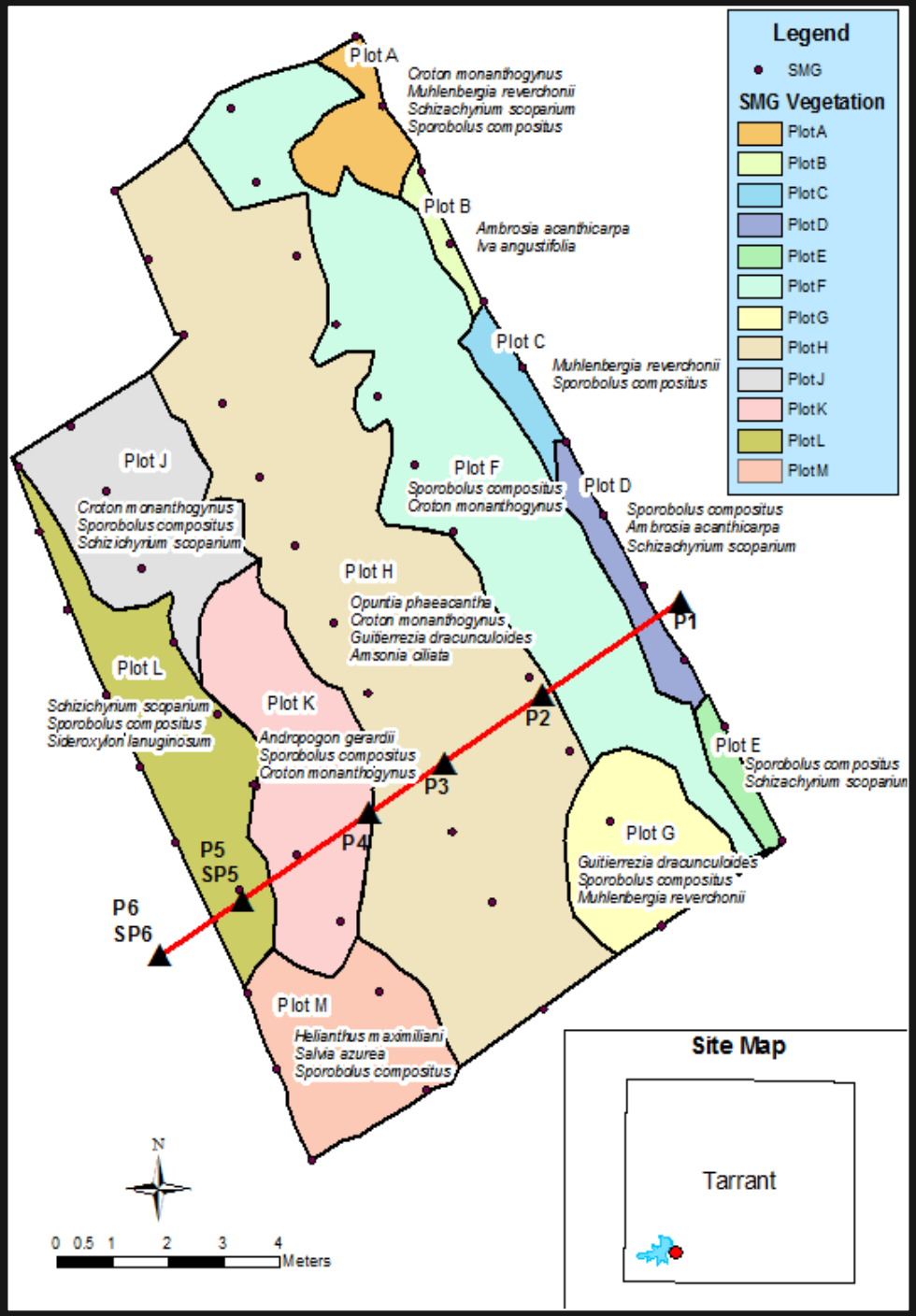
RESULTS - STREAM-FLOW

RESULTS – SOIL MOISTURE

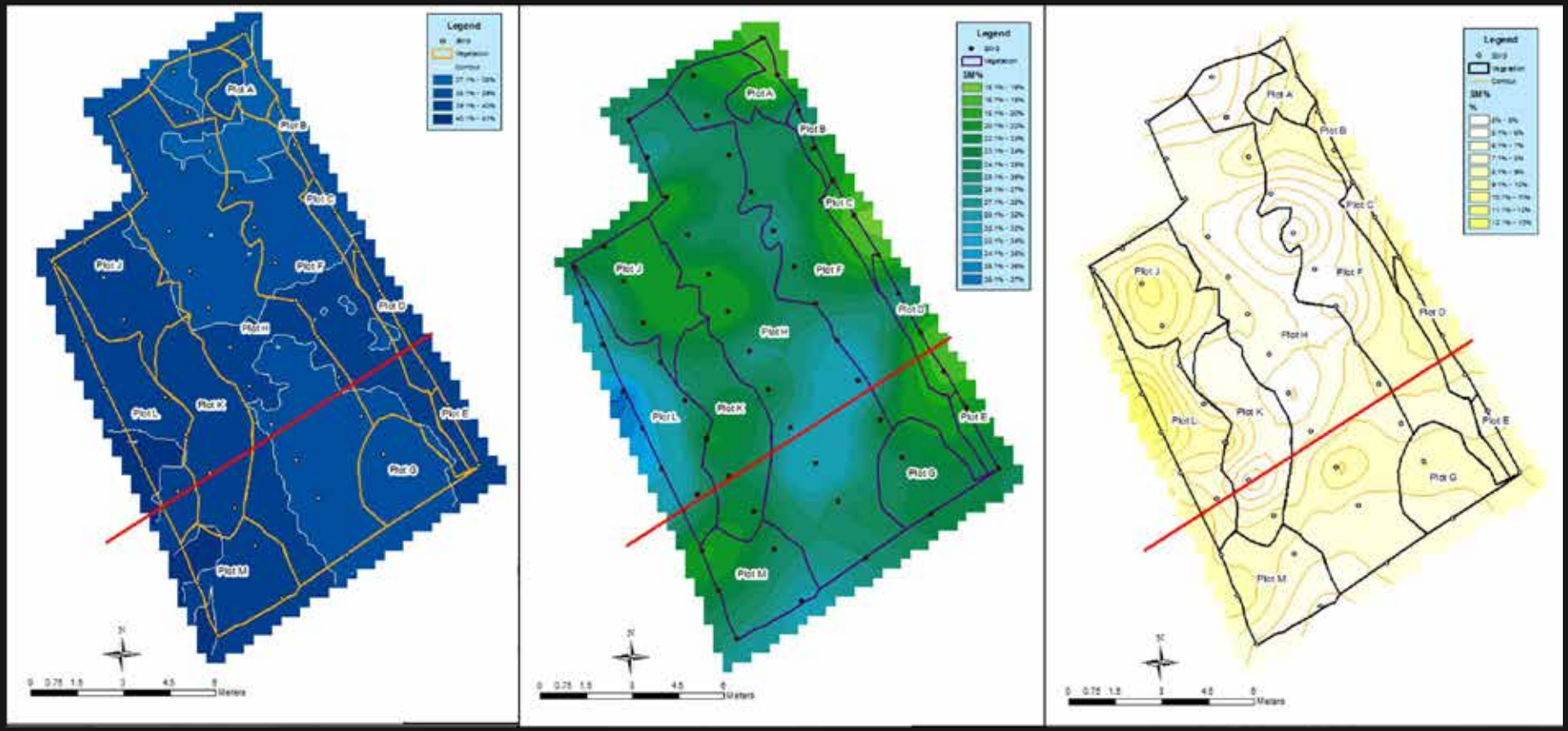


RESULTS – VEGETATION/SOIL MOISTURE RELATIONSHIP

- *Sporobolus compositus* was dominant in 9 out of 13 plots
- Barrens had highest diversity



RESULTS – HYPERSEASONALITY



Vegetative plots overlaying SMG. Red line indicates the linear transect. (Left) Full saturated (Middle) Moderate saturation (Right) least saturation recorded. Vegetation plot are labeled alphabetically and correspond with the letters assigned to the plot code.

CONCLUSIONS - HYDROLOGY

- Conducted during extreme drought conditions
- SM mimicked topography
- Barrens remained relatively wetter and the toe slope remained relatively drier than the rest of the transect
- Saturation wedges across the lower portion the slope
  - Seep & colluvial footslope reached full saturation

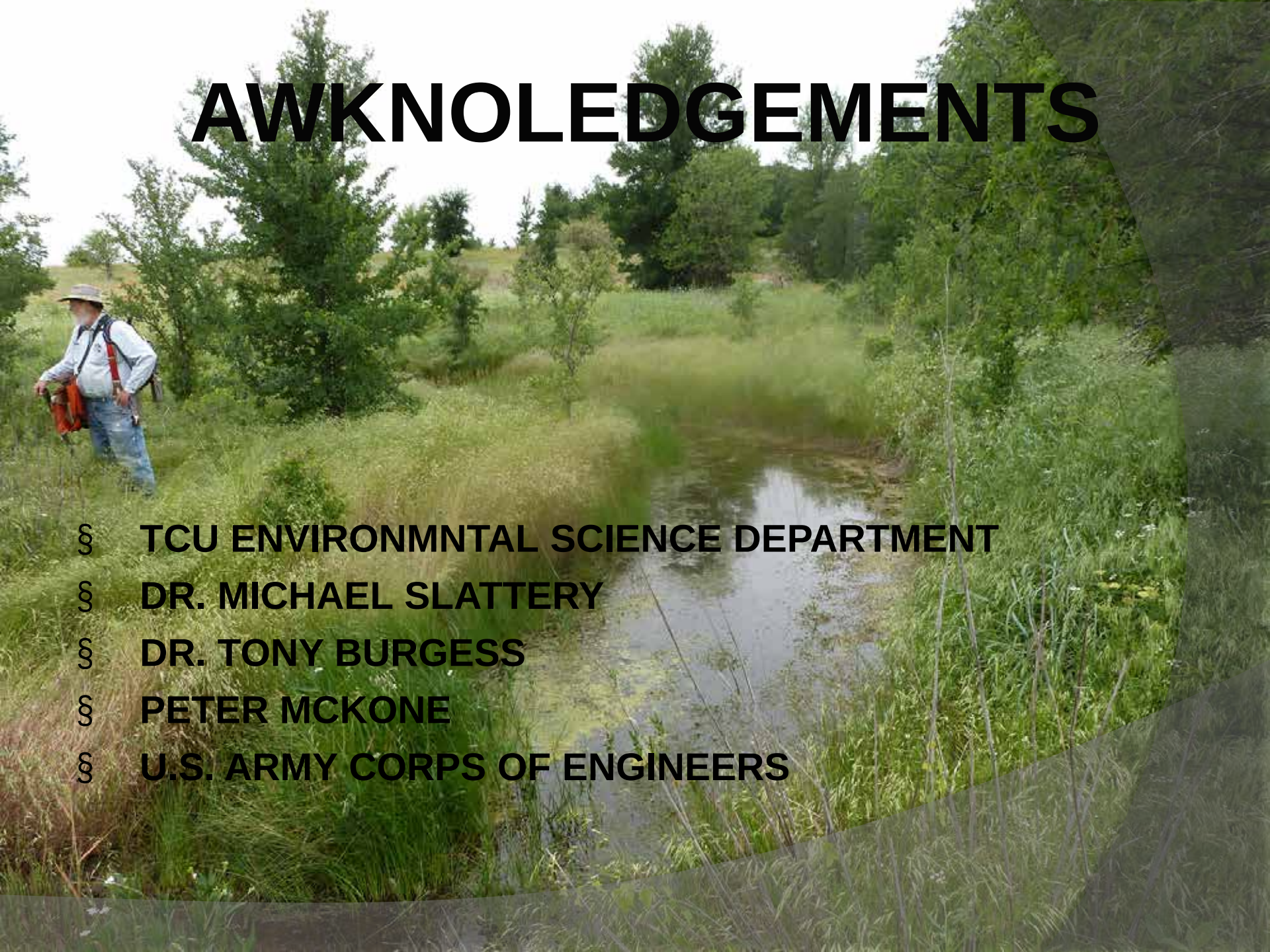
CONCLUSIONS - VEGETATION

- Vegetation best predicts SM at moderate moisture regimes
- SM poorly aligned with vegetation
  - Vegetation along the base of SMG followed contours of lower hyperseasonality
- Vegetation surveying:
  - Cover classes somewhat subjective
  - Classes provided more repeatable standard
  - Sampling provides initial analysis of vegetation across the hillslope

SUMMARY

- Regionally unique headwater stream ecosystems in the Fort Worth Prairie
- These reference sites are needed for locally appropriate restoration designs
  - Traditional stream management practices have limitations (concrete armor, gabions)
- Better insights from combining vegetation study with hydrology, soils, and geology

AWKNOLEDGEMENTS



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