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

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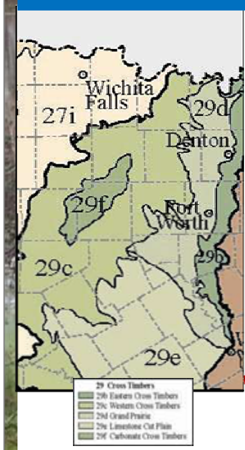
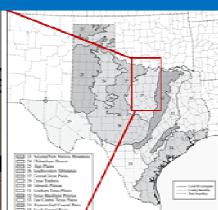
Abstract

There has been relatively little research on the relationships among vegetation, topography, and hydrology of hillslope seeps and headwater streams in the Fort Worth Prairie ecoregion. Unlike traditional descriptions of Midwestern tallgrass prairies, these riparian zones are often dominated by annuals. Due to the ephemeral or intermittent nature of headwater stream hydrology, the high variation of soil moisture restricts tallgrasses from dominating riparian zones. This study quantified the hydrologic regime of a Fort Worth Prairie hillslope hollow by analyzing the spatio-temporal response of soil moisture to precipitation and drying, its impact on runoff generation, and the vegetation-soil moisture relationship. The study occurred from August 2012 - March 2013, during drought-like conditions that prevented streamflow. Results show the hillslope completely saturates during wet periods and saturates along the hillslope base during dry conditions. Autumn vegetation most accurately aligns with moderate soil moisture conditions. This research describes Fort Worth Prairie headwater stream and seep habitats and provides a basis for how they function hydrologically to create a foundation for improved habitat management, protection, and restoration of riparian headwaters in North Central Texas.

Introduction



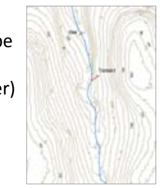


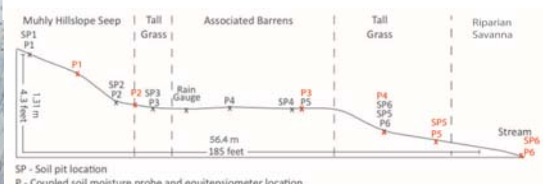
Over 75% of streams in Texas are ephemeral and intermittent. The Fort Worth Prairie, an open grassland unit between the Eastern/Western Cross Timber ecoregions, is a unique part of an endangered ecosystem: the tallgrass prairie. Unlike the classic tall-grass prairies described in the Midwest, footslope riparian seeps are often dominated by annuals which support "hyperseasonal" habitats unique to North Texas. "Hyperseasonal" refers to hydrology that alternates between complete soil water saturation and periods of intense drought. Riparian streams occur in low topographic positions and high variation of soil moisture restricts tall-grasses from dominating riparian headwaters. Weather patterns that fluctuate between rainy seasons and drought cause these areas to alternate between saturation and desiccation. Because this environment fluctuates between two extremes, there is limited diversity, as only a few species of plants can flourish in these conditions.

Methods & Materials

Three components analyzed to assess the system as a whole.

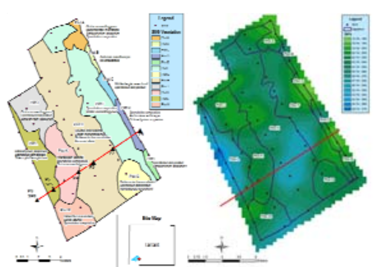
- ***Hydrology***
  - Soil moisture dynamics along transect
  - Soil Moisture Grid (SMG) across hillslope
  - Downstream streamflow conditions (90° v-notch weir & pressure transducer)
  - Precipitation
- ***Vegetation***
  - Plant communities across hillslope
- ***Soils***
  - Soil texture and properties

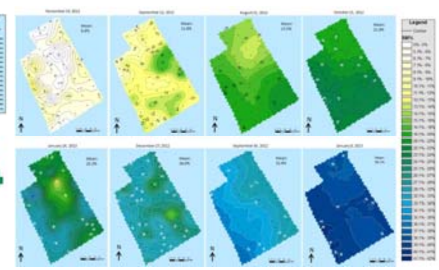




Results

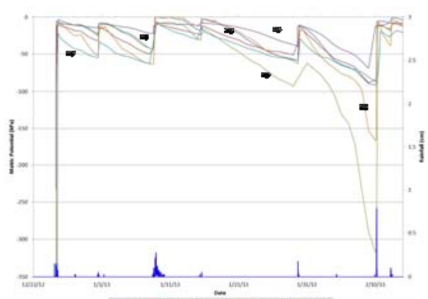
- ***Hydrology***
  - Soil moisture dynamics along transect
    - Soil moisture across the hillslope mimicked topography
  - Soil Moisture Grid (SMG) across hillslope
    - Barrens remained relatively wetter and the toe slope remained relatively drier than the rest of the transect
    - Saturation wedges across the lower portion the slope
  - Downstream streamflow conditions (90° v-notch weir with pressure transducer)
    - Study conducted during extreme drought conditions
  - Precipitation
    - Full saturation after storm events were the seep & colluvial footslope
- ***Vegetation***
  - Plant communities across hillslope
    - Sampling provides initial analysis of vegetation across the hillslope
    - The vegetation surveying cover classes are somewhat subjective
    - Cover classes provide a more repeatable standard
    - Vegetation along the base of SMG followed contours of lower hyperseasonality
    - Vegetation is better predictor of SM at moderate moisture regimes
- ***Soils***
  - Soil texture and properties
    - Deep colluvial soils at base of hillslope





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	13.06	-	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**



Conclusions

- The study was unique in that it was conducted during extreme drought conditions.
- The hydrologic conditions observed over the course of the study can provide a basis for understanding prairie headwater and seep environments, which can lead to better management of headwaters.
- Hyperseasonal stream systems could be used as templates for biomimicry designs and implementations.
- Additional research of this area will continue to improve the knowledge and understanding of these relatively understudied and overlooked hydrologic features within the Fort Worth Prairie landscape.

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