# OKLAHOMA NSF EPSCoR

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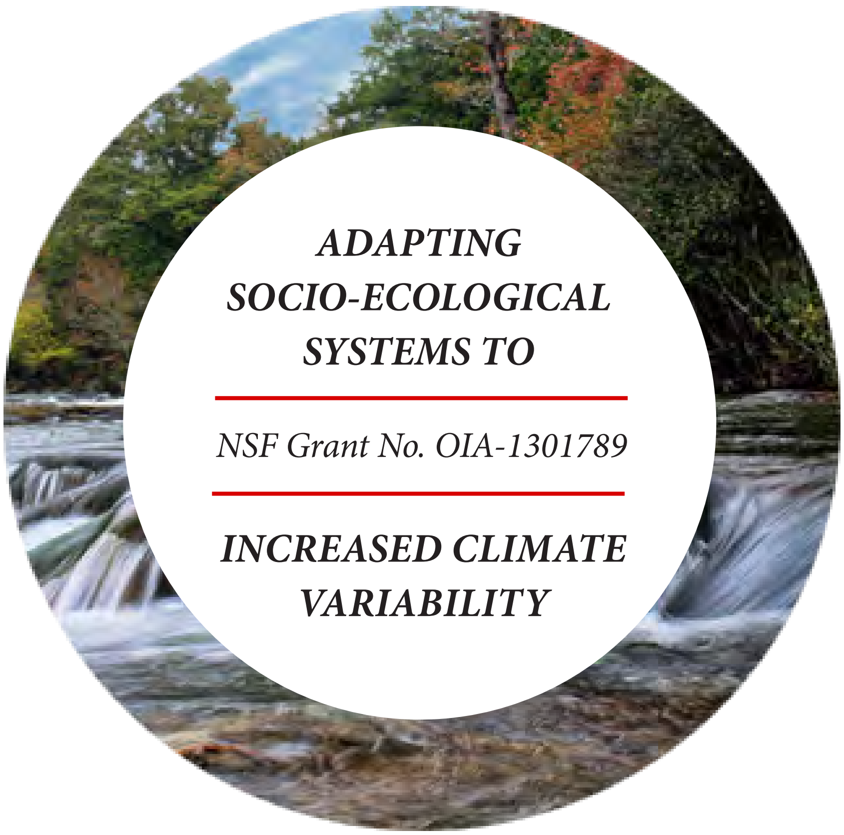

***ADAPTING SOCIO-ECOLOGICAL SYSTEMS TO***

*NSF Grant No. OIA-1301789*

***INCREASED CLIMATE VARIABILITY***

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***Advancing Climate Research & Education in Oklahoma & the Nation***

OKLAHOMA EPSCoR

OKLAHOMA STATE REGENTS FOR HIGHER EDUCATION

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# POSTER SESSION

## HIGHLIGHTING CLIMATE VARIABILITY RESEARCH

# ABSTRACTS

Abstracts may be accessed online after the conference at:
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# POSTER #1

## TRANSCRIPTOMIC SIGNATURES REVEAL BIOMARKERS FOR UNDERSTANDING AMPHIBIAN STRESS

Timothy A. Clay[1], Michael L. Treglia[1,2], Michael A. Steffen[1,3],
Ana Lilia Trujano-Alvarez[1], and Ronald M. Bonett[1]
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Global biodiversity is decreasing at an alarming rate and understanding the factors that negatively impact population health is fundamental to addressing this epidemic. Diverse biomarkers have been developed to monitor human physiology and health, yet relatively few of these methods have been applied to wildlife. Plasma glucocorticoids are often used as an indirect measure of physiological stress in vertebrates, but these measures can be extremely dynamic and impractical to measure in small organisms. However, many genes are the targets of glucocorticoids and therefore monitoring gene expression patterns may yield consistent long-term signatures of stress across different environmental conditions. We tested for transcriptomic differences in tail tissue of stream-dwelling salamanders chronically exposed to glucocorticoids and different temperatures. Transcriptomics resulted in the sequencing of over 2000 genes, of which 51 were differentially expressed when exposed to corticosterone, including several known to be involved in immune responses in model systems. Subsequent qPCR analysis of a subset of genes revealed that many genes are robust to variation found while sampling wild populations such as differences in temperature, age, life history, and tissue type. To our knowledge, this is the first time that transcriptomics has been applied to identify stress associated genes in an amphibian system. The identification of these genes could provide useful biomarkers for identification of wild populations experiencing chronic stress.

POSTER #2

## CONSTRUCTING GRIDDED DAILY OKLAHOMA MESONET DATA FOR AGRO-HYDROLOGICAL APPLICATIONS

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Most process-based agro-hydrological models require meteorological datasets with good spatiotemporal coverages. The study utilized daily weather data from 1997–2014, obtained from the Oklahoma mesonet, with an objective of creating daily gridded weather datasets for agro-hydrological applications. Daily meteorological variables were interpolated across Oklahoma using geoprocessing tools with python as scripting language. Ordinary kriging (OK) and empirical Bayesian kriging (EBK), with and without the use of climate imprints (CI – 30 yr mean). Due to unavailability of climate imprint for solar radiation (SRAD), only OK and EBK methods were implemented for prediction. Cross-validation metrics for all interpolation approaches showed R2 values of 0.99 and 0.98 for maximum (TMAX) and minimum temperature (TMIN), with mean absolute error (MAE) ranging from ±0.45–0.50°C for TMAX and ±0.77–0.80°C for TMIN. Likewise, R2 values of 0.94 and 0.93 showed overall good prediction accuracy for SRAD with MAE values 1.00 MJ m-2 d-1 and 1.01 MJ m-2 d-1for EBK and OK respectively. However, for rainfall, CI methods and IO methods yielded R2 value of 0.67 and 0.66. We also observed notable seasonal variation in different cross-validation metrics. Similar level of accuracy was observed among EBK-IO and EBK-CI outperforming OK-CI and OK-IO. Based on computational time and ease of interpolation, our comparisons suggest that Ordinary Krigging with a relatively straightforward approach may be sufficient to meet the need of daily gridded weather data set specific to the study area. Reconstructing of serially seamless datasets from this study can be valuable for regional agricultural, hydrological, and climate variability and change studies.

## POSTER #3

# RESPONSES OF IRRIGATED AND NON-IRRIGATED CROPLANDS TO DROUGHT AND DROUGHT RECOVERY

Russell Doughty[1], Xiangming Xiao[1], Yuanwei Qin[1], Yao Zhang[1], Xiaocui Wu[1], Zhenhua Zou[1], Rajen Bajgain[1], Yuting Zhou[1], and Jeff Basara[2]
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Terrestrial vegetation is the largest sink of atmospheric carbon at an annual net rate of about 2.6 GtC/yr$^{-1}$. Human management of Earth's land can impact the terrain's ability to sequester atmospheric carbon through land cover and land use change (LCLUC). Recent research has shown that climate variability is increasing in Oklahoma. Therefore, it is essential to understand how the cycling of carbon and water by managed lands is responding to drought and drought recovery at large spatiotemporal scales. Croplands cover approximately 29.4% of Oklahoma's total land surface and make up the state's largest proportion of human managed lands. The gross primary production of any plant or ecosystem is primarily reliant upon sunshine, temperature, precipitation, and available nutrients. For croplands, annual gross primary productivity is also determined by crop species, rotation, and irrigation. Using remote sensing satellite data, this study analyzes annual gross primary production and evapotranspiration of irrigated and non-irrigated croplands for Caddo County and the Washita River Watershed in western Oklahoma from 2000 through 2014. The results of the analysis illustrates that: 1) irrigation buffers croplands from the effects of drought, 2) farms can be heavily impacted by drought, despite access to water for irrigation, and 3) offers evidence why farmers with access to additional water resources during dry periods may not be as affected by drought as those who do not have access to additional water resources.

# POSTER #4

## EFFECTS OF CLIMATE VARIABILITY AND WETLAND CHARACTERISTICS ON WATER TEMPERATURE

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Wetlands produce a variety of ecosystem services, including water retention and storage, flood control, water purification, and provision of habitat for game and nongame species. Climate change's effects on precipitation and air temperature will likely alter the production of these services through changes water volume, hydroperiod (i.e., how long the wetland contains water), and water temperature. Water temperature in particular can alter ecosystem processes, water quality, and the survival and growth of aquatic organisms. Climate change is expected to alter the mean, variability, and extremes for air temperature, but it is unclear how this will translate to water temperature in wetlands. To investigate this, we deployed temperature sensors (ibuttons) in depressional wetlands to record surface and benthic temperatures in central Oklahoma. We wanted to characterize and examine the effects of wetland characteristics (e.g. size, depth, vegetation) on water temperature variability and extremes. As expected, preliminary results indicate that water buffers the more extreme changes in air temperature with greater buffering at the bottom of wetlands with increasing depth than surface water. Very shallow wetlands (< 5cm) have maximum temperatures that are 3°C cooler than air and minimum temperatures that are 4°C warmer than air, reducing the range in temperature at both extremes. Deeper wetlands (~30-50cm) buffer maximum temperatures more than shallow wetlands with temperatures that are 5°C cooler than air at depth but are similar to shallow wetlands in their minimum water temperatures. Surface water temperatures were much more similar to air temperature with maximums only 1°C cooler than the air. This work will help us understand the effects of climate change wetlands and the ecosystem services they provide.

## POSTER #5

# OKLAHOMANS' CONCEPTIONS OF RESILIENCE AND THE IMPORTANCE OF PREPAREDNESS AND SOCIAL CAPITAL

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The data analyzed in this study were drawn from semi-structured interviews with emergency planners, first responders, municipal employees, landowners, and others to understand their conceptions of resilience and the factors they think contribute to individual and community resilience. The interviews were collected in the Cimarron, North Canadian, and Washita watersheds and focused on these areas' responses to destructive weather events and earthquakes. Respondents identified preparedness and the ability to coordinate a network of relationships (i.e. effective use of social capital) as important factors in "bouncing back" from disasters. Using MSIS-Net survey data, we compared measures of preparedness and social capital between watersheds and statewide averages to assess opportunities to strengthen these important factors in advance of the next emergency.

## POSTER #6

# UTILIZING NATIVE ISOPODS TO ASSESS THE CONNECTIVITY AND QUALITY OF OKLAHOMA GROUNDWATER

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Understanding the distribution and connectivity of groundwater and its relationship to surface flow is critical for management and conservation. Aquifer borders typically follow the extent of drainage basins, but are not necessarily correlated with surface relief and can change with fluctuating water tables. This study aims to assess native groundwater isopod distributions as a method to delineate watershed boundaries, as a tool to identify surface-groundwater interactions, and as a possible indicator of water quality. Due to their abundance, ease of collection, and wide distribution, aquatic isopods provide an excellent utility for mapping watershed connectivity. DNA sequence data has become a powerful tool for assessing organism distributions and can provide high-resolution maps of habitat connectivity. Genetic differences between drainages and aquifers in both surface and subsurface populations can provide a biological map of geologic connectivity between watersheds and their local groundwater sources. The geographic genetic distribution of isopod diversity will likely mirror the hydrologic connectivity and discontinuity within the region. By developing distributional maps of both surface and subterranean species throughout Oklahoma, the limits of surface and sub-surface drainage systems can be delineated. Identification of species-level environmental limits can be used to evaluate their use as a tool for understanding water quality. Continued monitoring of isopod species composition and density could serve as an indicator of changing groundwater chemistry.

POSTER #7

## SOCIO-ECOLOGICAL MODELING AND PREDICTION: ECONOMIC IMPACT OF CLIMATE CHANGE ON THE IMPLEMENTATION OF BEST MANAGEMENT PRACTICES IN THE FORT COBB WATERSHED

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Climate change and non-point source pollution had led to an excessive sediment loads in the Fort Cobb Watershed. To reduce the amount of the sediment loads, extensive conservation practices such as using no-tillage management and conversion of cropland to grassland have been implemented in the Fort Cobb Reservoir watershed (Becker and Steiner, 2011). However, the economic impact of climate change on the optimal spatial distribution of these BMPs to reduce net revenue to producers is unknown.

The objective of this study is to determine the most cost effective selection and location of best management practices (BMPs) for farmland to reduce soil erosion and the delivery of sediment and phosphorus to the reservoir under current and future climate scenarios. Detailed conservation practices will be simulated with the Soil and Water Assessment Tool (SWAT) to determine yields, erosion, and phosphorus loss for each practice by each land use unit and location in the watershed. Linear programming will be used to determine the cost minimizing choice of BMP(s) for each land use unit that meets sediment and phosphorus targets for the watershed and the impact of climate change on this cost minimizing choice. This work will help guide policymakers and farmers in decision-making for the future regarding water quantity used and water quality downstream in the recreation area of Fort Cobb Reservoir.

*Key words: Watershed, Best Management Practices (BMPs), optimal choice, climate change, SWAT, linear programming.*

**References:**

Becker and Steiner. 2011. “Integrated Science to Support the Assessment of Conservation Practices in the Fort Cobb Watershed, Southwestern Oklahoma.” Scientific Investigations Report 2010-5257.

## POSTER #8

# RESPONSE OF TALLGRASS PRAIRIE TO DROUGHT

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Future climate will be characterized by increased frequency and intensity of extreme events, such as severe droughts. These unprecedented climate extremes will impact ecosystem functioning. However, the existing observations and experiments are not adequate to fully evaluate impacts of future climate extremes on ecosystem functions. We conducted a drought experiment at Kessler Atmospheric and Ecological Field Station (KAEFS) of the University of Oklahoma in 2016. The experiment was set up to study responses of prairie ecosystems to altered precipitation, specifically drought impacts. The seven levels of precipitation treatment: 0%, 20%, 40%, 60%, 80%, 100%, and 150% of ambient precipitation and nested clipping subplots aim to look at how the alterations of precipitation will interact with clipping to affect prairie ecosystem structure and function. The clipping treatment is to mimic hay harvesting, one of the dominant land uses in this region. During the first year's measurements, most of the variables examined, such as aboveground net primary production and carbon fluxes, did not exhibit significant changes in response to precipitation treatments. However, belowground net primary production increased with the reduction of precipitation, but started to decrease from -80% treatment. In both clipped and unclipped plots, biodiversity was higher with water addition, and lower under water reduction. The response to precipitation treatments was typically greater than that of clipping. Clipping, rather than water condition, promoted specific root length at shallow (0-15cm) but not deeper soils (15-45cm). More interestingly, in clipped plots, after clipping in early fall, coverage, NDVI and plant height all showed significant decline with the reduction of precipitation. Our results provided insight on responses of tallgrass prairie to gradient reduction of precipitation, including drought.

POSTER #9

## SPATIALLY EXPLICIT MODELING OF SWITCHGRASS NET ECOSYSTEM EXCHANGE IN OKLAHOMA


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Identification and development of carbon-neutral or carbon-negative alternative fuel is an urgent global priority to combat increasing atmospheric carbon dioxide ($CO_2$) concentration. Source-sink status of seasonal (April to October) spatial estimates of organic carbon available for storage in a switchgrass ecosystem in Oklahoma that is consistent from plot to regional scale was assessed. We used an empirical approach to calculate net ecosystem production (NEP) of switchgrass (*Panicum virgatum* L.) using detailed meteorological measurements at representative local sites, and analyzed its spatial and temporal patterns in potential switchgrass production sites in Oklahoma, USA. Estimates of NEE were based on the parameters inferred from half-hourly $CO_2$ flux measurements using eddy covariance technique. Approximation of potential switchgrass production area in Oklahoma was done reclassifying NASS Crop Data Layer in ArcGIS. Thirty-minute interval weather data for 120 weather stations across Oklahoma from 2008 to 2014 was processed from the Oklahoma Mesonet observations. Based on eddy covariance measurements, empirical models, a) rectangular hyperbolic light-response curve and b) temperature response functions were fitted to estimate gross ecosystem production (GEP) and ecosystem respiration (ER) on a seasonal scale. Seasonal average net ecosystem production (NEP) ranged from 2.3 t C $ha^{-1}$–6.9 t C $ha^{-1}$. Results based on a simple linear model analysis suggested that there were significant differences in NEP between years. The study indicates that this new scaling-up exercise involving high temporal resolution meteorological data may be useful tool for assessing spatiotemporal heterogeneity of the potential to sequester carbon in Oklahoma grasslands.

## POSTER #10

### MODELING IMPACT OF CLIMATE VARIABILITY AND CHANGE ON WINTER WHEAT PRODUCTION IN OKLAHOMA

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Winter wheat is grown in 2 M ha, about 75% of arable land, in Oklahoma. The variability in climate, latitudinal gradient in temperature and longitudinal gradient in precipitation and solar radiation, leads to average wheat yields of 3.5 Mg $ha^{-1}$ in west to about 7.0 Mg $ha^{-1}$ in east. Modeling the spatiotemporal variability in yield will help to understand the causes of yield variability, help to minimize yield gap, and develop options to improve wheat productivity and production in OK. We hypothesize that using environmental and climatic data from multiple geospatial data gateways, we can extrapolate results from field and plot based experiments to a regional scale in current and future climate scenario(s). Daily input climate data was developed from MESONET/DAYMET and CMIP5 for current and future climates, respectively. We derived soil data from gSSURGO and agronomic data from NASS Crop Data Layer and OSU wheat extension program. Crop-Model CERES-Wheat was calibrated using field studies with variety 'Duster' at Stillwater, OK and weather data from MESONET. Long-term daily weather data from Mesonet and DAYMET were used to simulate wheat yields from 1980-2015 in Oklahoma, and were compared with NASS wheat yields. Future wheat yields were simulated using downscaled daily weather data, from 2040-2060, derived from MarkSim Weather generator and CMIP5 projections, under RCP6.0 and RCP8.5, using four individual GCMs, ensemble of four GCMs, and ensemble of 17 GCMs used in CMIP5. Prediction accuracy ($R^2$) of NASS yield ranged from 0.3 to 0.8 depending on the production region in OK. Future climates resulted in 2-10% reduction in potential yield of cultivar 'Duster'. Further, adaptation options through breeding and agronomy can be explored along with crop models to improve wheat production in Oklahoma.

POSTER #11

## PROGRESS ON THE KIAMICHI ENVISION MODEL

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Water use, climate change and economic development are important in every region of Oklahoma, but these processes and their interactions influence human and natural systems at an individual and local scale. The agent-based modeling (ABM) approach is valuable for its ability to integrate environmental and socioeconomic data into a coupled model of the complex feedbacks between human and natural systems. The Oklahoma EPSCoR project identified ENVISION as a platform to systematically integrate models of environmental and human processes developed by various research universities, organizations and agencies. Kiamichi watershed resident and stakeholder concerns include economic development, water export, water supply and stream habitat quality. In addition, these issues are likely to be influenced by climatic changes. This poster will show how these issues are being integrated into the ENVISION platform to describe changes in the Kiamichi watershed, and how stakeholder-driven scenarios can be inputted into the platform to predict outcomes that can serve as the foundation for informed decisions.

POSTER #12

## COME RAIN OR SHINE: MULTI-MODEL PROJECTIONS OF CLIMATE HAZARDS AFFECTING TRANSPORTATION IN THE SOUTH CENTRAL UNITED STATES

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This work provides a future climate assessment for relevant climate hazards affecting the Department of Transportation's Region 6, in the South Central U.S. Expert input on key weather and climate hazards and their thresholds were established from a stakeholder survey. Two diverse statistically downscaled climate model datasets were used, for a total of 21 model projections, two couple model inter-comparisons (CMIP3, and CMIP5), and four emissions pathways (A1Fi, B1, RCP8.5, RCP4.5). Specific hazards investigated include winter weather, freeze-thaw cycles, hot and cold extremes, and heavy precipitation. Projections for each of these variables were calculated for the region, utilizing spatial mapping, and time series analysis at the climate division level.

The results suggest that cold-season phenomena such as winter weather, freeze-thaw, and cold extremes, decrease in intensity and frequency, particularly with the higher emissions pathways. Nonetheless, inter-model and downscaling method yields variability in magnitudes, with the most notable decreasing trends late in the 21st century. Hot days show a pronounced increase, particularly with greater emissions, producing average annual conditions by late 21st century analogous to the 2011 heatwave over the central Southern Plains. Return period frequencies of heavy precipitation show marked increases in frequency and magnitude, while the mean precipitation accumulations show much smaller, more regionally specific, and more inconsistent trends. Precipitation hazards (e.g., winter weather, extremes) diverge between downscaling methods and their associated model samples much more substantially than temperature, suggesting that the choice of global model and downscaled data is particularly important when considering region-specific impacts for precipitation.

These results are intended to inform region transportation professionals of the susceptibility of the area to climate extremes, and to be a resource for assessing and incorporating changing risk probabilities into their planning processes.
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POSTER #13

## HYDROLOGIC COMPARISONS OF OKLAHOMA RIVERS

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Water is essential for all life. Function capacities of aquatic systems are a current concern. A hydrological comparison of selected water sites for the Deep Fork Creek, Neosho, Arkansas, and North Canadian. The movements of water and drought concerns were the major focuses of the inquiry. Infiltration analysis included use of plots and watershed data. The results indicate that sources from the Arkansas and Neosho indicate move evidence of soil erosion potentially due to water movement.

## POSTER #14

# FIRE SHOWS PROMISE IN REDUCING WOODLAND EXPANSION IN AN EXPERIMENTAL RANGELAND WITHIN OKLAHOMA, USA

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Woodland expansion is a global phenomenon that despite receiving attention in recent years remains poorly understood. Landscape change of this magnitude has had several impacts on landscape processes, such as influencing fire regimes, habitat for wildlife and hydrological processes. Furthermore, woodland expansion is evident over numerous landscape types, on several continents under various climates. It is therefore imperative we seek a salient solution to reduce or slow down further woodland expansion and associated landscape change. We aimed to quantify woodland expansion in an experimental rangeland in central Oklahoma, USA under three treatments: 1) herbicide, 2) herbicide + fire and 3) control only within areas classified as "open grassland" in 1974. Thereafter, we identified these same areas in 2010 with remotely sensed imagery (LiDAR) to a) quantify total encroachment and b) by size three classes: i) 1-2.5m, ii) 2.5-4.5m and iii) >4.5m. Main results show that of the total area classified as "open grassland" in 1974 (277.64 ha), 31% had experienced an increase in woody plants by 2010. The herbicide-only treatment was 44% encroached but when fire was included, encroachment was 24%. The control (no fire, no herbicide) experienced 61% encroachment. Each treatment experienced a similar rate of encroachment across height classes. The 1-2.5m height class encroachment average was 23.46±2.29%, the 2.5-4.5m height class encroachment average was 31.53±1.10 and the >4.5 m height class encroachment average was 45±3.5%. Given the low variation within each height class suggests that active treatments (herbicide and fire + herbicide) were equally ineffective at controlling further woodland expansion. Costly practices such as herbicide application therefore do not provide a practical solution to reduce further woodland expansion. However, in combination with fire, woodland expansion was still evident, but considerably lower than in herbicide only treatments. Therefore, we conclude that fire can reduce further encroachment.

## POSTER #15

# ETHNOGRAPHIC RESEARCH IN THE NORTH CANADIAN WATERSHED OF NORTHWESTERN OKLAHOMA

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This poster summarizes the preliminary findings of ethnographic fieldwork in the North Canadian Watershed of northwestern Oklahoma. While living, and working in the North Canadian Watershed, ethnographic research has provided a body of data built on a methodology combining information from in-depth interviews, participant observation, and archival research. The geographic focus of this research has been primarily in Woodward, Harper, and Beaver Counties, an area of the watershed following the North Canadian/Beaver River from Canton Lake, northwest to the town of Beaver. This research focuses on the socio-ecological impacts of changing land and resource use patterns over time and how those changes have shaped perceptions of risk and subsistence strategies within the watershed. Ranching/farming is the dominant industry practiced by many interviewees but, oil and gas extraction, and wind energy are also important industries in the region. There is a complex interaction among social and ecological issues in the region that include a downturn in the oil and gas industry, uncertainties in the future of wind energy, water availability and allocation, and the impacts of drought and wildfires in the region.

## POSTER #16

### FIRE, FENCES, AND FRAGMENTATION: WOODY ENCROACHMENT AND THE ETHNOGRAPHY OF COMMUNITY COMPOSITION IN THE LOWER CIMARRON WATERSHED

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Encroachment of eastern redcedar (*juniperus virginiana*) onto rangelands in Oklahoma's Lower Cimarron Watershed (and elsewhere) has become a major concern among landowners, resource managers, and scientists. While the ultimate cause of this "green glacier" is most often attributed to fire suppression following Euro-American settlement of the region, scientific explanations for subsequent contributing factors often revolve around climatic and/or edaphic conditions. Multi-level, in-situ ethnographic research, however, has revealed that socio-cultural changes in intimate management practices, local micro-economies, and occupancy patterns are a major driver of shifting species compositions, especially redcedar encroachment in formerly utilized rangeland and/or cropland. This poster summarizes these finding, demonstrating the ways that applied social science research contributes to interdisciplinary understandings of socio-ecological systems.

## POSTER #17

# LAND USE PATTERNS IN AREAS OF SIGNIFICANT WATER-LEVEL DECLINE WITHIN THE HIGH PLAINS AQUIFER OF NORTHWESTERN OKLAHOMA

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The US Geological Survey estimates that total water storage in the High Plains Aquifer has decreased by eight percent since 1950, with 25 percent of the aquifer experiencing saturated thickness declines of over 10 percent. Despite policy interventions and conservation efforts water loss continues as farmers and ranchers rely on the aquifer to sustain production while managing the pressures of a variable climate. Examining the six Northwestern Oklahoma counties located within the High Plains Aquifer, this research analyzes linkages between spatial patterns of water-level change and land use. While prior research on this location identifies agriculture as a primary driver of total aquifer drain, studies have yet to statistically examine spatial-temporal patterns of water-level change and geographic variation in land use patterns within those areas. Linking land use patterns and the ecological process of water-level change will facilitate engagement with policy makers and community members ultimately responsible for management of this depleting commons resource.