The Pawnee Buttes rise above the shortgrass steppe in northeast Colorado.

The shortgrass steppe of North America comprises a mosaic of native grassland and cropland adjacent to the eastern face of the Rocky Mountain chain. Motivation for careful evaluation and monitoring of this region at the end of the 20th century comes from two sources. First, the Great Plains contains the major wheat producing areas for the entire continent, in addition to important grazing lands for livestock. Second, current models of atmospheric circulation indicate that climatic change, as a result of increased greenhouse gases, will be relatively larger here than in most other parts of temperate North America. The combination of socio-economic importance and vulnerability of the region to both climatic fluctuations and climate change make it essential that we expand our understanding of long-term ecological relationships, particularly climate-land use-ecosystem interactions.

The Shortgrass Steppe Long Term Ecological Research (SGS LTER) program is housed in the College of Natural Resources at Colorado State University and is operated in close collaboration with the USDA Agricultural Research Service and the US Forest Service Pawnee National Grasslands. The SGS LTER is funded primarily through a grant from the National Science Foundation and is part of a coordinated network of LTER sites across North America (including two sites in Antarctica). The Shortgrass Steppe LTER focuses its research on understanding the long-term processes that affect the structure and function of shortgrass steppe ecosystems.

From 1982 until 1996, the Shortgrass Steppe LTER project was focused entirely on the Central Plains Experimental Range (CPER), a 6280-ha tract of shortgrass steppe located in the piedmont of north central Colorado approximately 61 km northeast of Fort Collins (lat. 40x49'N; long.104x46'W; elevation 1650 m). In 1996, we increased the spatial extent of our LTER site to include both the CPER and the 78,100 ha Pawnee National Grasslands. By expanding to our newly defined site, we increase our realm of inference to 23 percent of the U.S. shortgrass steppe.

The Field Station at Shortgrass Steppe

The Shortgrass Steppe LTER field station consists of the headquarters area located on 1.6 ha, a residence for the site manager, and a corral and pasture area of 53 ha. Three buildings are located in the headquarters area: a dormitory, a storage/workshed building, and an office/laboratory building.
The main SGS LTER headquarters building (214 m^2) has offices, laboratories, a dining/meeting room, and a kitchen. This multi-purpose building serves as the focal point for all activities at the site including conferences, meetings, and classes. Adjacent to the headquarters is a storage/sample processing building (134 m^2) with facilities for washing, drying, and storing samples. This building also serves as the workshop/garage for field station heavy equipment. The dormitory has six rooms; five capable of double occupancy and one with four beds.

Full moon setting over the shortgrass steppe.

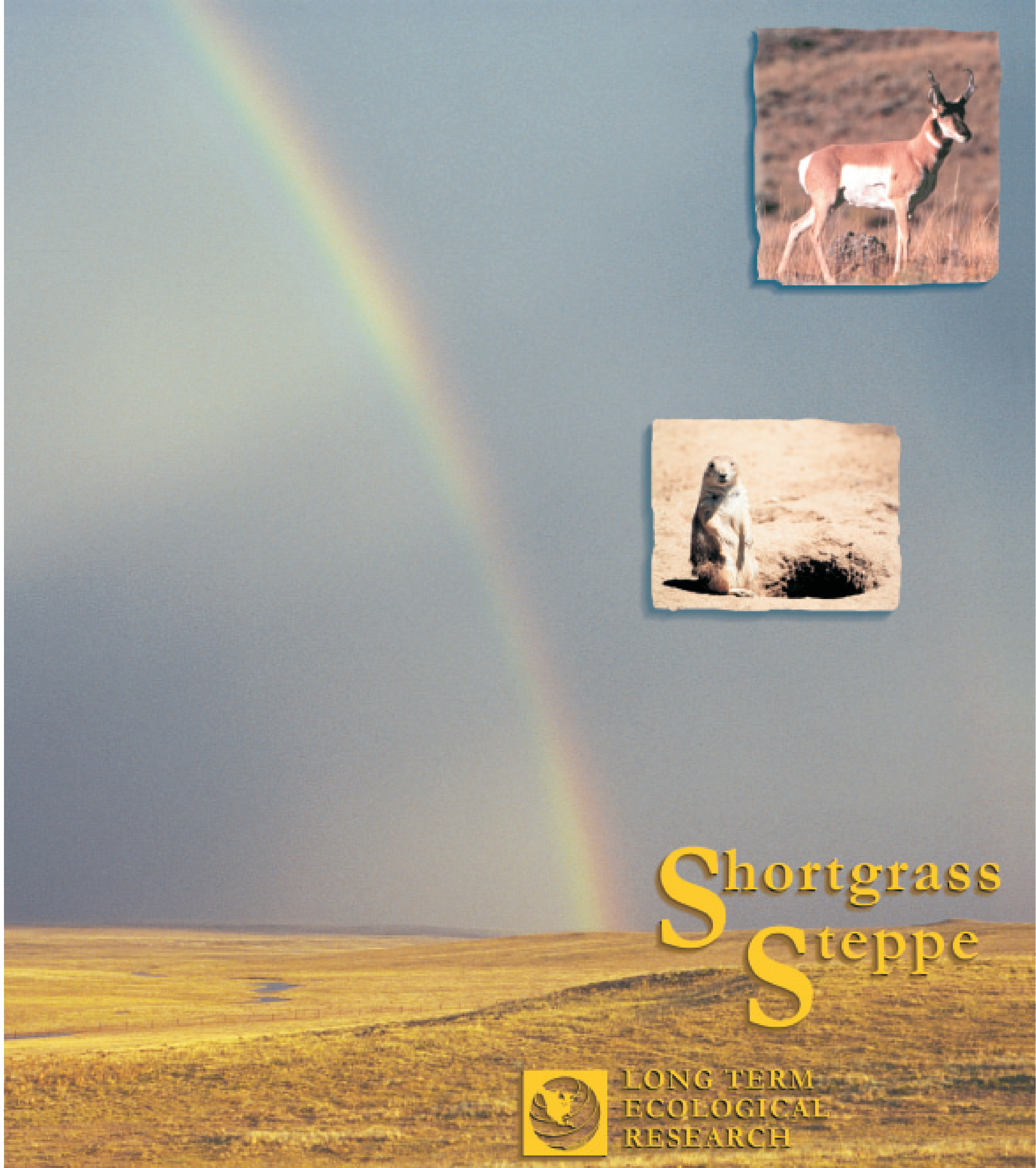
For More Information Please Contact

Shortgrass Steppe
Long Term Ecological Research
College of Natural Resources
Colorado State University
Fort Collins, CO 80523
Telephone: (970) 491-4996

http://sgs.cnr.colostate.edu

LTER
Long Term Ecological Research

Shortgrass Steppe



Shortgrass Steppe LTER

Populations and Processes

Work in this area is organized by the idea that two kinds of populations are most important in the long-term dynamics and sustainability of the shortgrass steppe. The first are dominant species, such as the shortgrass blue grama (*Bouteloua gracilis*), which overwhelmingly dominates the vegetation of the shortgrass steppe. The second type of important populations is those that have a large effect on the ecosystem because of their unique traits and not because of their dominance. Prairie dogs (*Cynomys ludovicianus*) and prickly pear cactus (*Opuntia polyacantha*) are such species in the shortgrass steppe.

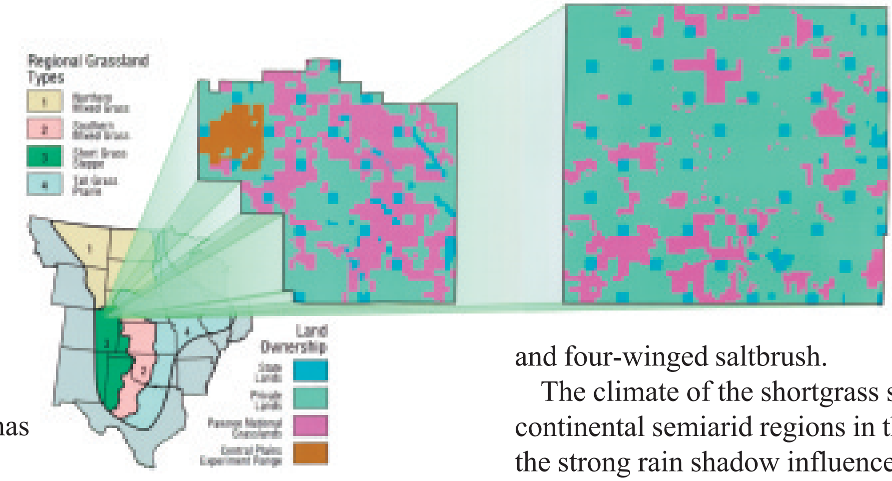
Swift fox are an important carnivore of the shortgrass steppe.

Biogeochemistry

Our research in this area focuses on the key abiotic and biotic variables that control biogeochemical dynamics, including primary productivity, nutrient cycling, and nutrient input and export, including trace gas fluxes. The key abiotic variables are water availability and temperature, as they vary in time and space, and soil texture as it varies across landscapes and regions. The key biotic variables are the presence and distribution of individual plants and the composition of plant communities. Continuing long-term experiments are designed to assess how precipitation, temperature, topography, and soil texture interact to control spatial and temporal patterns of primary productivity, nutrient cycling, and trace gas loss.

Trace gas measurement studies help to understand land-atmosphere interactions.

Located on the western edge of the Central Great Plains, the shortgrass steppe unique among North American grasslands for the character of its long evolutionary history of grazing by loarger herbivores and periodic drought. Over time, intense selection by both drought and grazing has created an ecosystem composed of organisms that are very well adapted to both. The unique vegetation and the concentration of belowground biological activity and organic matter are two distinctive features of the shortgrass steppe. The low-growing blue grama (*Bouteloua gracilis*), contributes 60 to 80 percent of the plant cover, biomass, and net primary productivity.

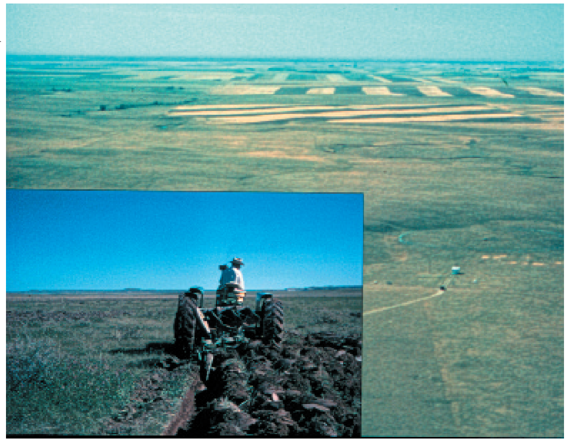


The main plant communities are shortgrass steppe, floodplain shrubland, and salt meadow. The shortgrass steppe is dominated by shortgrasses (64%), succulents (21%), and dwarf shrubs (8%). Other important plant species include: buffalo grass, plains prickly pear, rabbitbrush, and four-winged saltbrush.

The climate of the shortgrass steppe is typical of mid-continental semiarid regions in the temperate zone, except for the strong rain shadow influence of the Rocky Mountains approximately 60 km to the west. Mean monthly temperatures range from -4 to 22 degrees C seasonally and annual precipitation has averaged 322 mm over the past 51 years. Approximately 70 percent of the precipitation occurs during the April–September growing season.

Disturbance

Two key hypotheses organize SGS LTER work in the area of disturbance. The first is that small≤scale disturbances are the most important source of mortality for the dominant plant, blue grama, and as such, these disturbances represent a major influence on the sustainability of the shortgrass steppe. The second is that the distribution of biotic components, with a large bias towards the belowground portion of the system, leads to an ecosystem with a high degree of resistance to aboveground disturbances such as grazing or fire, but a high vulnerability to disturbances such as cultivation that disturb the soil system.



The shortgrass steppe is most vulnerable to disturbances such as cultivation, which alter the soil system.

Summer convective thundercloud

Water and Energy Dynamics

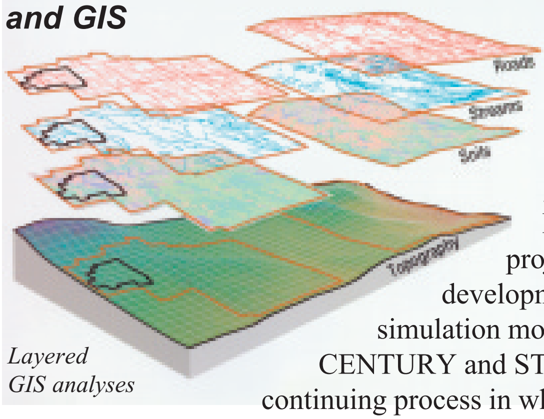
Water availability is the key variable controlling shortgrass steppe ecosystem structure and function. Measurements of precipitation, temperature, radiation, windspeed and soil water are part of our long≤term field sampling program. Because of the close link between water and energy dynamics, land uses that influence evaporation and transpiration can have important effects on the shortgrass steppe. We are using the Regional Atmospheric Modeling System (RAMS) to investigate the influences of land use change on mesoscale patterns of precipitation and other climatic variables.

Paleoecology

Over evolutionary time scales, climatic variation has been the major force influencing the structure and function of shortgrass steppe ecosystems. Buried soils, which formed in ancient landscapes, contain a record of the vegetation and climatic conditions which prevailed during the last 12000 years. To establish vegetation and climatic histories, the stable carbon and oxygen isotopic composition of organic matter, fossil plant cells, and calcium carbonate in buried soil layers is measured. This information, in addition to the size and orientation of the buried soil, its radiocarbon age and other attributes, reveals much about pre-historic climate and the earth's response to climate change.

Typical soil profile of the shortgrass steppe

Simulation Modeling and GIS



Layered GIS analyses

Simulation analysis is a key part of the synthesis activities for the Shortgrass Steppe LTER project. The development of simulation models, such as CENTURY and STEPPE, is a continuing process in which we incorporate our knowledge into models, test them against data, and modify the models. Our models have been useful for designing experiments and for extrapolating our understanding to long temporal and large spatial scales.

Geographic Information Systems (GIS) are utilized in the analysis of spatial data. Management of GIS data and metadata supports ongoing research projects, public access to GIS products, and a long-term data archive.

GIS analyses at the SGS LTER range from the study of root dynamics (milimeter resolution) to landscapes (hundreds of meters resolution), helping researchers better understand phenomena at each level.