

2019 Annual Progress Report



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2019 Annual Progress Report

Chihuahuan Desert Rangeland Research Center

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INTRODUCTION

Mission

New Mexico State University operates the Chihuahuan Desert Rangeland Research Center to protect and ensure availability of its resources for teaching, research, and extension endeavors that benefit the citizens of New Mexico as originally declared by Congress in 1927. The Chihuahuan Desert Rangeland Research Center conducts educational, demonstrative, and experimental development with livestock, grazing methods, and range forage, including investigation of the sustainability and management of natural resources and environmental ecosystems.

Activities

Teachers, researchers and students from across campus benefit from the center. The [Department of Animal and Range Sciences](#) oversees the facility with help from a steering committee of scientists from the College of Agriculture and Home Economics and the College of Arts and Sciences. The center is part of the Jornada Basin Long-Term Ecological Research project - a National Science Foundation Ecology Network. Current research efforts include:

- Evaluating continuous and seasonal grazing strategies at different intensities to determine effects on livestock performance as well as plant cover and composition.
- Evaluating performance of breeds of cattle in relation to quality and quantity of forage in a hot, arid environment.
- Determining the influence of range conditions on wildlife populations.
- Autecology of plant species.
- Assessing competition and other interactions between common plant species.
- Ascertaining the role of small herbivores in a desert environment.

In addition to research conducted by the Department of Animal and Range Sciences, faculty and graduate students from other NMSU departments are conducting research at the Center. Currently much of the research is in conjunction with the Long-Term Ecological Research program, which is part of a nationwide program funded by the National Science Foundation. The CDRRC is used for teaching, demonstration and research projects with livestock, grazing methods and range forage, including investigations into the sustainability and management of natural resources and environmental ecosystems.

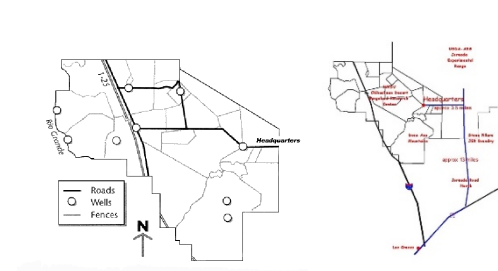
Due to its location and isolation, the CDRRC also is used by researchers from NMSU's Physical Science Laboratory (PSL), the U.S. Department of Defense, and private corporations for testing drones, telemetry, and radio interference.

History

Early hunting and gathering societies, part of the Jornada Mogollon culture, first roamed this area. Later, various Apache tribes made these lands their home. An eight-mile stretch of the Camino Real, the route established by the Spanish between Chihuahua, Mexico and Santa Fe, crossed the northern part of the Center. In 1887, the first Homestead was filed with the U.S. government for property now included in the Center. Several ranchers owned various portions of the land now constituting the Center, but in 1925 Max Vanderstucken, who then owned the land, was facing foreclosure and spoke to J.L. Lantow, head of the animal husbandry department at New Mexico A&M. He recommended the College buy his ranch, and in February 1926 the College acquired his land, with grazing rights on adjoining public lands. In 1927, Congress granted public lands to the College for research purposes. The last parcel was acquired in 1984 through a "land swap" between the federal government and the State of New Mexico.

Location and Description

The Center is located in Doña Ana County, New Mexico, at the southern end of the Jornada Plain. Now divided by Interstate 25, the Center encompasses almost 100 square miles, with one-fourth of the land west of the interstate.



Land on the Center varies widely, with elevations from 4,000 ft. on the Rio Grande flood plain on the west side to 5,840 ft. at the top of Summerford Mountain in the Doña Ana Mountains on the east side. The nearly level plains of the north and central parts of the Center are on the Jornada del Muerto basin, with several small playa areas where water collects after rainfall. Soils range from sandy loams to clays overlying caliche hardpan.

Several vegetation types occur on the center. Creosote bush dominates the upper slopes of the mountains and the hills along the river. At lower elevations, the creosote bush type grades into the mesquite type that grows on sandier soils, and into the tarbush type on heavier soils. The plains area, once dominated by black grama, today has been invaded by mesquite. These mesquite stands are interspersed with snakeweed and many species of grasses and forbs.

Wildlife populations on the Center are rich and varied. Among the larger mammals are mule deer, pronghorn antelope, gemsbok, bobcat, coyote, badger, and fox. Mountain lions have been sighted. There are also many rabbit and rodent species. Several bird species migrate throughout the area, but a large number also live and nest on the rangeland. Species such as roadrunners, hawks, and occasionally golden eagles are seen on the Center. Numerous lizard and snake species also inhabit these lands.

RESEARCH

Long-term breed comparison and precision ranching research summary

Background/ Objectives

The Chihuahuan Desert Rangeland Research Center (CDRRC) is host to one of the longest-term vegetation/grazing monitoring sites in the desert southwest. Pastures, exclosures, and precipitation have been monitored continuously for over 22 years. Weather data records for some sites date back to the 1930's. Research garnered from these long-term plots has greatly impacted our understanding of desert rangeland grazing ecology; many of the findings derived from studies at the CDRRC have influenced federal policies in the BLM and Forest Service. Work from these long-term pastures by Dr. Jerry Holechek, Dr. Reldon Beck, and their graduate students has described vegetation trends as well climate trends, and has determined suitable stocking rates, ranching economics, monitoring methods, and livestock breed performance. Continuing with the legacy of Drs. Holechek and Beck, Dr. Cibils and his graduate students will begin a new study in 2020 that will maintain and expand monitoring of these same long-term vegetation plots. The objective of this new study is to compare the effects of foraging behavior of two breeds of cattle, Raramuri Criollo and Brangus (each adapted to the Chihuahuan Desert), on vegetation and soil dynamics. Additionally, this study will seek to investigate use of new precision ranching technologies and their viability as a modern extensive ranching tool.

Study details:

Studies from the CDRRC and neighboring Jornada Experimental Range (JER) have shown that Chihuahuan Desert forages are in an apparent climate change-driven decline. In an effort to address this challenge, researchers have been investigating foraging behavior of Raramuri Criollo cows via GPS collars. These studies have shown a clear divergence in behavior of RC vs. improved beef cows across seasons and sites leading our team to speculate that RC and improved beef breeds impact rangeland resources differently. This new long-term study will allow us to test this hypothesis and monitor critical vegetation and soil variables in relation to cattle breed.

A recently funded USDA NIFA CAP grant will also allow us to use LoRa-WAN technology (Long Range Wide Area Network) and low-cost GPS collars to track cows grazing our study pastures in near-real-time as well as drinker sensors and rain gauges. NMSU computer scientists and engineers cooperating on the project plan to develop a dashboard app that producers can use to track and find their cows and monitor their welfare, as well as monitoring rainfall events and water troughs. This technology will allow us (and producers) to evaluate critically important infrastructure from afar in real time.

This study, at NMSU's CDRRC, will serve as a centralized hub within two larger study networks that will replicate these monitoring efforts on ranches throughout the intermountain west and in a trans-American evaluation in countries including Mexico and Argentina. Beyond the efforts

outlined above, production data from both breeds will be evaluated in the context of alternate supply-chains and through extension/cooperation efforts and economic analyses.

Impact

The efforts described above will continue to place the CDRRC at the forefront of rangeland grazing research and technology. The College Ranch will continue to be a laboratory for new ideas and tools for rangeland and ranch sustainability. Furthermore, because the study described above is part of a Pan-American long-term grazing study network, ensures that CDRRC will continue to be a world leader in science and technology solutions for arid lands.

2019 Publications

Peer reviewed:

McIntosh, M.M., J.L. Holechek, S. Spiegel, A.F. Cibils, R.E. Estell. 2019. Long-term Declining Trends in Chihuahuan Desert Forage Production in Relation to Precipitation and Ambient Temperature. *Rangeland Ecology and Management* 72: 976-987.

Spiegel, S., R.E. Estell, A.F.Cibils, D.K. James, H. R. Peinetti, D.M. Browning, K. Romig, A.L. Gonzalez. 2019. Seasonal divergence in foraging behavior of heritage and conventional cattle on a heterogeneous desert landscape. *Rangeland Ecology and Management* 72: 590-601.

Proceedings:

A. Cibils, R. Estell, A. Gonzalez, S. Spiegel, et al. 2019. El rol del bovino Criollo Raramuri como herramienta de adaptacion al cambio climatico en los desiertos del SO de los EE.UU. XII Simposio Internacional de Recursos Geneticos para Las Americas y el Caribe. December 8-11, Rocha, Uruguay, p. 22.

Abstracts:

M. McIntosh, J. Holechek, A. Cibils, R. Estell. 2019. Long-Term Trends in Perennial Grass Production, Precipitation and Temperature in the Chihuahuan Desert. 72nd Society for Range Management Annual Meeting, Feb. 10-13, Minneapolis, MN.

Popular press:

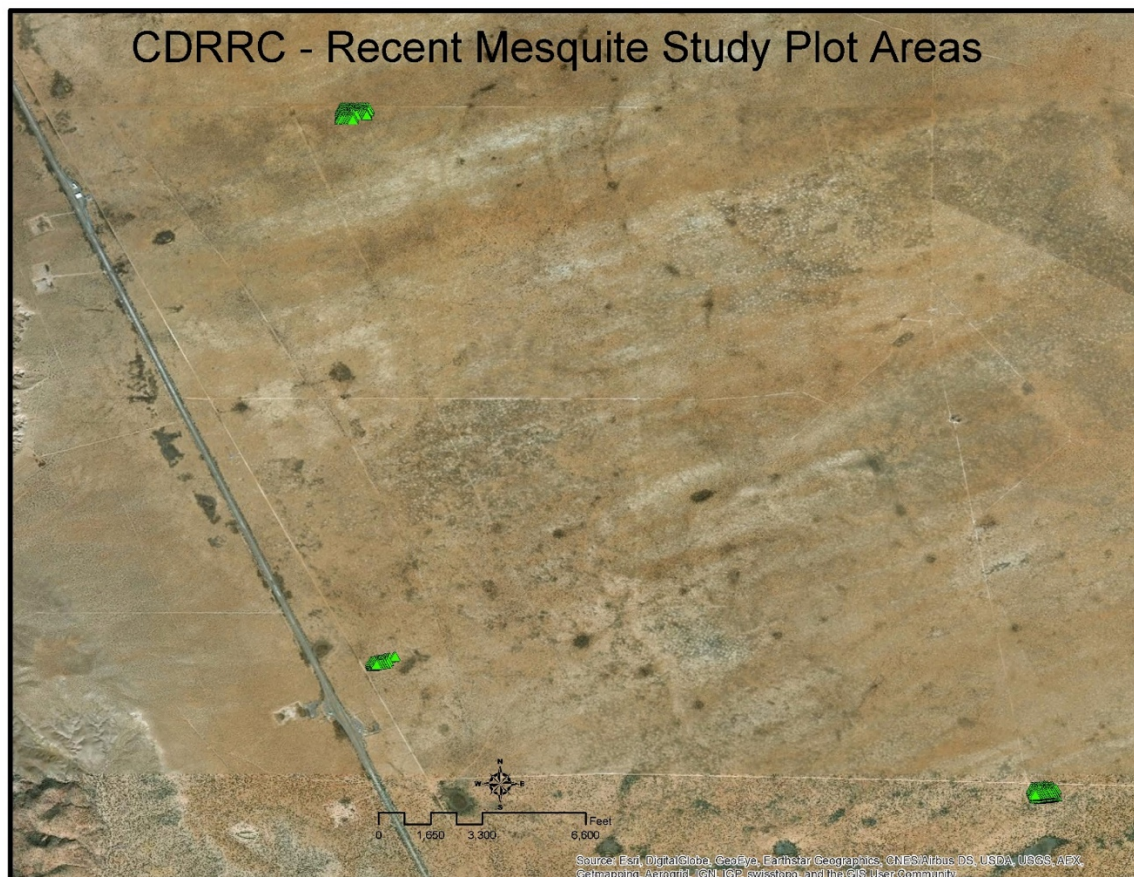
NMSU Planning to Research Sustainable Beef Production. Las Curces Sun News. Sunday, November 24, 2019.

Rangeland Brush and Weeds Program

Kert Young, Rangeland Brush and Weeds Program

The Chihuahuan Desert Rangeland Research Center (CDRRC) has provided research lands for the NMSU Rangeland Brush and Weeds Program for many years. Starting in 2016, Dr. Young started conducting brush management research on the CDRRC. Various combinations of herbicides and rates have been applied on plots with a CO2 sprayer to determine herbicide effectiveness at controlling mesquite. Dr. Young also remeasured more than 120 research plots that were treated by previous NMSU employees to determine long-term effectiveness of herbicides at controlling mesquite and other plants. The results of this research has helped countless producers in NM control invasive plants by informing them on the most effective means of invasive plant control. This has saved producers money because they did not have to try to control invasive plant with means that do not work or that are more expensive than necessary.

This research also supports rangeland health and restoration that benefits our society. The pesticide industry has shown of interest in the brush and weeds research conducted on CDRRC over the years and have used study results to inform their herbicide management practices and policies.



Succession of ruminal bacterial species and fermentation characteristics in pre-weaned Brangus calves

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Energetic efficiency of a cow-calf pair is difficult to determine due to lack of a timeline for beef calves to become functional ruminants. New-born calves do not function as a ruminant. As calves age, they consume forage and establish a bacterial population capable of fermenting forage. Rumen development is defined by organ anatomical changes, establishment of a bacterial population, and changes in fermentation end-products. Much of our current knowledge on rumen development was conducted in dairy calves. Dairy calves have a different production system and are weaned at an earlier age than are beef calves. Rumen development timelines thus may be different in beef calves.

The following objectives were tested in collaboration with the U.S. Meat Animal Research Center. Our objectives were to assess changes in rumen bacterial population and fermentation end-products in Brangus calves grazing native rangeland at the Chihuahuan Desert Rangeland Research Center in Las Cruces, NM. Sampling began at seven days of age and continued every 28 days until weaning, approximately 175 days of age. Two hundred fourteen bacteria were identified from calves' rumen fluid. *Bacteroidetes* and *Firmicutes* comprised approximately 72.2% of the rumen bacterial population, agreeing with previously reported data. By 35 days of age, calves had bacteria composition, volatile fatty acid (VFA), and ammonia concentrations comparable to mature ruminants on native rangeland. Based on this study, Brangus calves grazing native rangeland forage develop a functional rumen at 35 days of age.

Restore.net rangeland reseeding research

Akasha Faist, Animal and Range Sciences

Through testing unique seed mixes and application techniques as well as habitat modification efforts, we can better assess the efficacy of rangeland restoration in drylands systems both locally and more broadly. These efforts have clear ecological benefits to guide the improvement of rangeland health. They also have economic benefits through the enhancement of rangeland forage availability, which directly leads to enhanced livestock production. The social benefits of improving vegetation cover through restoration efforts is also demonstrated through the expressed goal for reduction of dust and soil erosion, both of which can have public health implications.

Research Report

Andres Cibils, Animal and Range Sciences

1. Effects of grazing Raramuri Criollo vs. Brangus cows on Chihuahuan Desert vegetation and soils (Hatch and NIFA funded project)

A number of reliable climate models now predict that the North American desert southwest will become hotter and drier, that variability in annual precipitation will increase, and that the onset of monsoon rains will occur later in the growing season. The viability of desert ranching enterprises will depend on their ability to adapt to these emerging conditions. An adaptation strategy that is gaining momentum among a growing number of ranchers in the SW United States involves raising drought adapted indigenous low-input beef cattle biotypes. The Raramuri Criollo (RC) cattle from Chihuahua's Copper Canyon in Mexico is one such biotype that has exhibited intriguing foraging behavior traits. When compared to British crossbreeds, RC cows exhibit higher plasticity in habitat and diet selection; they appear to respond to forage scarcity by ranging farther and broadening the menu of plant species they include in their diets. This has led researchers to speculate that raising RC cattle could lower the environmental footprint of desert beef production because the impact of herbivory appears to be spread out across the landscape during drought periods when vegetation and soils are most vulnerable. This hypothesis, however, has never been formally tested. Our goal is to investigate the effect of raising indigenous vs. introduced beef cattle breeds on long-term plant community dynamics in the Chihuahuan Desert. More broadly, our research addresses the fundamental question about whether innate differences in livestock foraging behavior are of any consequence to the structure and functioning of desert plant communities. The objective of this study will be to determine whether key Chihuahuan Desert soil and vegetation parameters respond differently to conservative stocking rates of Raramuri Criollo vs. Brangus cattle.

Unfortunately, due to the 2019 drought in southern NM we were unable to put cattle in the study pastures this year. Still, vegetation data were collected and will be used to provide a more robust characterization of initial conditions of the experiment pastures. We also analyzed and published results of a 59-year data set collected in our study pastures that includes forage production and weather data. These analyses showed that, at our research site, forage production has declined by about 40% over this time period likely due to higher temperatures, more frequent droughts and more variable rainfall patterns. We also analyzed and published data from related studies that examined: 1) the spatial distribution and behavior of Criollo vs. improved beef breeds; and 2) behavior and spatial distribution of nursing Criollo cows as influenced by the presence of young calves (this article is currently in press).

2. Use of LoRa WAN (Long Range Wide Area) enabled sensors to monitor livestock and pasture resources in real time (NIFA funded)

Monitoring livestock behavior in real time using GPS, movement sensors, and data-mining algorithms has potential to help improve animal wellbeing and livestock production on extensive ranches where daily observation of animals is usually unfeasible. We sought to: a) evaluate GPS fix rates (10-min intervals; expecting 144 fixes*d-1) of LoRa WAN-enabled GPS devices housed in water-tight Pelican™ cases fixed to Weaver™ nylon cattle collars or fixed

to the top of a Weaver™ nylon cattle halter; and b) test the capabilities of the manufacturer's dashboard and application program interface (API). We first tested two Abeeway™ industrial trackers deployed on cannulated beef steers for 13 d (Trial 1 [T1]: 4/18– 4/30, 2019) in a 2.4 ha planted pasture at the New Mexico State University (NMSU) Campus Farm. We later tested the same devices on two Brangus cows for 13d and 15d, respectively (T2: 6/29 – 7/7, 2019; T3: 8/27 – 9/10, 2019) at the NMSU Chihuahuan Desert Rangeland Research Center (largest pasture >1475 ha). We used a Kerlink™ LoRa antenna and gateway (with an expected 10 km reach) to receive and route GPS data from the trackers to the cloud. In T1 (planted pasture), the industrial tracker devices recorded $93\% \pm 1\%$ of the expected fixes whereas in T2 (rangeland pasture) trackers recorded $57\% \pm 4\%$ of expected fixes. In T3 (rangeland pasture) trackers recorded $77\% \pm 5\%$ of expected fixes and no GPS fix rate differences were found between the collar vs halter design (Student's t-test; $P > 0.40$). Differences in GPS fix rates among trials were possibly related to GPS battery and antenna location which was approximately 100 m away from the farm pasture (T1) and up to 5 -7 km away from the farthest points in our rangeland pastures (T2, T3). The dashboard developed by Abeeway™ and Actility™ allowed us to configure trackers, visualize GPS data on Google Maps™, and download comma-separated values (csv) files with GPS coordinates and their respective time stamp. Preliminary tests with the Abeeway™ API allowed us to retrieve raw sensor data (temperature, activity index, and GPS readings) from the cloud and to store them on a PC. The API also allowed us to configure GPS fix frequency and mode. Our preliminary results suggest that LoRa-enabled real-time GPS tracking is a promising technology for development of precision grazing tools for extensive pasture-lands. The flexibility provided by the API we tested will allow us to conduct data analytics in close-to-real time to detect behavioral anomalies and inform livestock management decisions to enhance cattle welfare and reduce production losses on western ranching operations.

Impact Statement

1. Long term data collected at the Chihuahuan Desert Research Center show that since the 1970s, forage production has decreased 38%, variability in annual precipitation has increased, summers have become hotter, and monsoon seasons are occurring later. Beef production in the desert SW will need to adapt to this evolving scenario if ranching is to remain viable. Feasibility of raising desert-adapted Criollo cattle is one alternative being researched. This research is expected to produce highly relevant climate adaptation science benefiting ranchers in New Mexico and beyond.
2. Real-time monitoring of livestock and other ranch resources has the potential to reduce ranching costs, free-up time for beef producers, and improve animal welfare. We anticipate that real time monitoring using LoRa WAN communication systems (currently being tested at CDRRC) paired with sophisticated data analytics will allow us to develop into the first precision ranching system in the western USA.

Jornada Basin Long-Term Ecological Research (LTER)

In collaboration with the [Jornada Experimental Range](#) (USDA ARS), we have incorporated studies initiated in 1915 into the JRN LTER program. Previous research focused on desertification, a state change from perennial grasslands to woody plant dominance (i.e., desertified shrublands) that occurs globally. Based on findings from growing **long-term databases**, the breadth of studies was expanded to include four additional state changes that occur in dryland systems:

- a reversal from desertified shrublands to grassland states,
- transitions among different states dominated by woody plants,
- invasion by non-native grasses leading to novel states, and
- transitions to human-dominated states.

Processes of interest include water mediated plant-soil feedbacks; patch-scale contagion by wind, water, and animals; landscape context; and time lags that are manifested as nonlinear dynamics and threshold behavior. These cross-scale interactions (the interactions between patterns and processes across scales) often lead to emergent behavior of broader scales that are not predicted from fine-scale patterns. Our study site is located in the northern Chihuahuan Desert, approximately 25 km northeast of Las Cruces, New Mexico, USA (+32.6 N, -106.7 W, elevation 1315 m). Annual precipitation is 24 cm and maximum temperatures average 13 C in January and 36 C in June. Our study site includes the 78,266 ha Jornada Experimental Range operated by the [USDA Agricultural Research Service](#), and the 25,900 ha [Chihuahuan Desert Rangeland Research Center \(CDRRC\)](#) operated by [New Mexico State University](#). The Jornada Basin LTER project was established in 1982, and is administered by New Mexico State University. This site is a member of the [LTER Network](#), one of 25 long-term sites funded by the [U.S. National Science Foundation](#). More information about the Jornada LTER and the research projects can be found at <https://jornada.nmsu.edu/lter>.