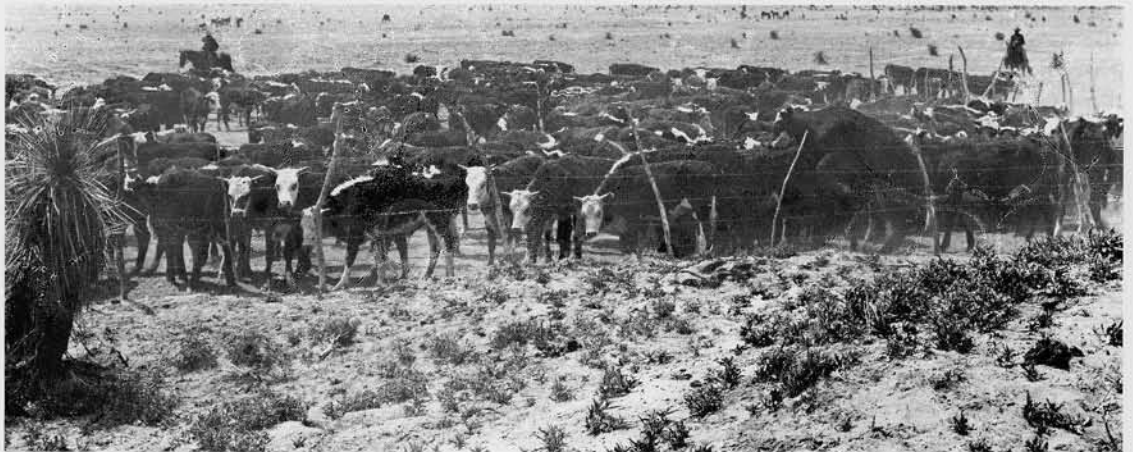
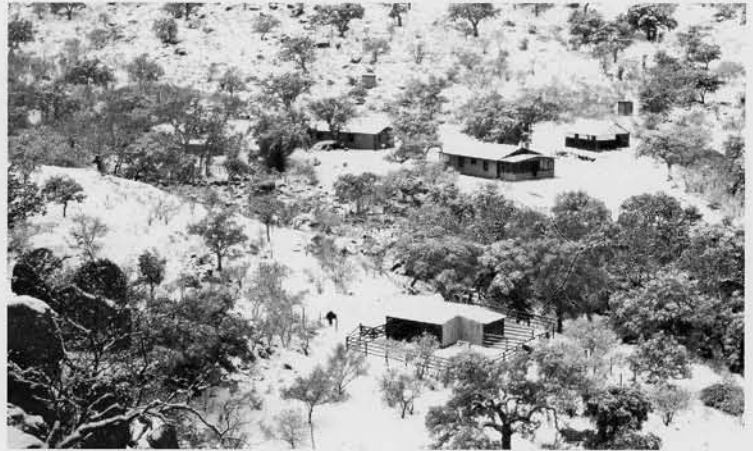


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# *Range Research Areas in the Western United States*

*Western Regional Coordinating Committee 40*



*Station Bulletin 671  
May 1988*

*Agricultural Experiment Station, Oregon State University*

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## *About WRCC-40 and its work . . .*

The Western Regional Coordinating Committee on Western Rangeland Research (WRCC-40) is composed of representatives of the Experiment Stations in the western United States and those in North Dakota and South Dakota. Also part of the committee are representatives of the USDA Agricultural Research Service, U.S. Forest Service, Bureau of Land Management, and USDA Soil Conservation Service.

The committee was formed for two purposes. First, to encourage communication among western range scientists about progress and new developments in western range research. Its second purpose is to improve communication among range scientists, educators, managers, and producers regarding research needs and technology transfer. The committee coordinates its interests with those of a number of other coordinating and technical committees as well as with the Western University Rangeland Extension Committee.

The committee regularly sponsors workshops at its annual meeting and repeats them as symposia at annual meetings of the Society for Range Management. In recent years, workshops have dealt with the subject of monitoring the effects of management (vegetation, soils, water, etc.) on rangelands. This publication brings together information about the major research areas where rangeland studies are conducted.

William A. Laycock, Administrative Advisor to WRCC-40  
Department of Range Management  
University of Wyoming  
1988

### ABOUT THE COVER

The buildings in the top photo are the headquarters of the Santa Rita Experimental Range in Arizona, the oldest experimental range in the United States. Located some 40 miles southeast of Tucson, the range was established in 1903.

Another early range research area is the Jornada Experimental Range in New Mexico (bottom photo). These yearling steers were photographed on the Jornada in 1913, a year after it was established. They sold for \$27 a head at the railroad.

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# FOREWORD

The descriptions of range research areas in the western United States were compiled by members of Western Regional Coordinating Committee WRCC-40. The major objective of the project was to provide a source of long-term data bases on climate, vegetation, and fauna in the western United States. These data bases are important sources of information on western rangelands and can be used in modelling efforts. A secondary objective was to provide information and a description of the areas that could be used by individuals or groups interested in visiting experiment stations while touring the western range states.



## ACKNOWLEDGMENTS

*Editors:* M.R. Haferkamp, United States Department of Agriculture, Agricultural Research Service, Squaw Butte Station, Eastern Oregon Agricultural Research Center, Burns, Oregon; P.O. Currie, United States Department of Agriculture, Agricultural Research Service, Fort Keogh Livestock and Range Research Laboratory, Miles City, Montana; J. Menke, Department of Agronomy and Range Science, University of California, Davis, California; B. Zamora, Department of Forestry and Range Management, Washington State University, Pullman, Washington.

*Cooperating agencies:* The Agricultural Experiment Stations of Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, North Dakota, Oregon, Utah, Washington, and Wyoming; the Agricultural Research Service, United States Department of Agriculture; Cooperative States Research Service, United States Department of Agriculture; Soil Conservation Service, United States Department of Agriculture; Forest Service, United States Department of Agriculture; and Bureau of Land Management, United States Department of Interior.

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# ARIZONA

**Santa Rita Experimental Range  
USDA-Forest Service  
Rocky Mountain Forest and  
Range Experiment Station**

PO Box 1389  
Green Valley, Arizona 85614  
OR

**Rocky Mountain Forest and  
Range Experiment Station  
Forestry Sciences Laboratory  
Arizona State University**

Tempe, Arizona 85287  
Telephone: 602-625-2121 (Green Valley)  
602-261-4365 (Tempe)

**Location:** 40 miles southeast of Tucson, Arizona.

**Facilities and accommodations:** Housing, which includes five residences and a bunkhouse. An office building containing a library, herbarium, and a minimally equipped laboratory.

**Size:** 50,617 acres.

**Establishment:** Established in 1903, withdrawn from public domain by Presidential Executive Orders 1222 (July 1, 1910); 4261 (July 3, 1925); and 4602 (March 2, 1927). The Santa Rita is the oldest experimental range in the United States.

## Description

**Climate:** Average yearly rainfall ranges from about 9.84 inches at 2,885 feet to almost 19.68 inches at 4,262 feet. Approximately 60 percent of the annual precipitation falls during convectional storms between July 1 and September 30. Rainfall during April, May, and June is generally so deficient that it rarely produces growth in plants. Average daily temperatures exceed 89°F in June and July. Daily minimum temperatures average below 39°F in December, January, and February. The frost-free period is about 240 days at upper elevations of the Range, but growth of herbaceous plants usually is limited by lack of moisture to about 56 days.

**Physical features:** Located on a broad bajada that slopes northwestward from the Santa Rita Mountains to the Santa Cruz River. Elevation varies from 2,787 feet at the northwest corner to 4,918 feet along the foothills of the mountains. Soils are composed of Pliocene alluvium from mixed rock sources that form the gently sloping bajada. About half the soils are classified as Aridisols, one-quarter as Mollisols, one fifth as Entisols,

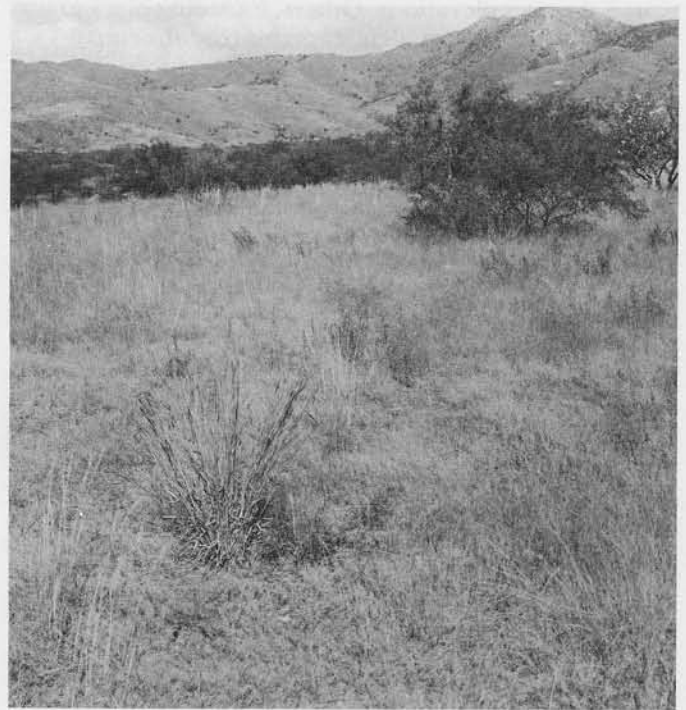


Figure 1. Santa Rita Experimental Range, pasture 7 on upper Helvetia Road, looking northeast.

and the remainder as gravelly alluvium or rock. Paleocene granitic rocks and Upper Cretaceous quartz monozonite and granodiorite occur near the mountains. Small areas underlain by limestone are in the northeastern portion of the Range.

**Vegetation:** Vegetation has changed since the Range was established. Velvet mesquite (*Prosopis juliflora*) now dominates between 20,000-30,000 acres that were essentially shrub-free grasslands 80 years ago. Lehmann lovegrass (*Eragrostis lehmanniana*), introduced from South Africa, has spread and formed pure stands over large areas in the southern and southeastern parts of the Range. Perennial vegetation over most of the Range is dominated by mesquite, cactus, and other shrubs. Burroweed (*Haplopappus tenuisectus*), mesquite, and *Opuntia* spp. reach their highest densities between 3,200 to 3,600 feet elevation; mesquite and Englemann prickly pear (*Opuntia engelmannii*) are major species even above 4,000 feet. Other shrubs, including catclaw acacia (*Acacia greggii*), wait-a-bit (*Mimosa biuncifera*), velvet pod mimosa (*M. dysocarpa*), and false-mesquite (*Calliandra eriophylla*), make up only 21 percent of the shrub cover below 3,200 feet, but comprise 65 percent of the shrub cover above 4,000 feet. Ocotillo (*Fouquieria splendens*) occurs at all elevations, mainly on rocky sites.

The abundance and composition of perennial grasses vary with rainfall and elevation. Santa Rita threeawn (*Aristida glabrata*) and rothrock grama (*Bouteloua rothrockii*) are major species at the middle and lower elevations, but are minor species above 4,000 feet. Bush muhly (*Muhlenbergia porteri*) makes up a greater part of the grass stand at lower than at middle elevations, and is scarce at upper elevations. Others, including black grama (*Bouteloua eriopoda*), slender grama (*B. filiformis*), sprucetop grama (*B. chondrosioides*), and hairy grama (*B. hirsuta*) make up more than 60 percent of the stand at upper and middle elevations. Other grasses, mesa three awn (*Aristida hamulosa*), spidergrass (*A. ternipes*), and Arizona cottontop (*Digitaria californica*), are common throughout the range.

**Research emphasis:** Rangeland ecology.

**Importance of site:** Long-term data bases on precipitation and vegetation.

**Climatic data:**

Precipitation—Monthly from 25 standard rain gauges scattered throughout range; some from 1922. Daily interpretations from 8 recording rain gauges established in 1958. Also daily from standard gauge at Florida Headquarters site since 1913.

Temperature—Minimum-maximum from headquarters site since 1928.

**Vegetation and soils data:** None.

**Available records include:**

Longtime records of stocking, forage production, vegetation cover, and utilization on 26 pastures.

A series of photographs, some taken in 1903, from 332 permanently marked photo stations.

321 permanent transects.

238 intensively studied areas, including 50 exclosures.

Complete soil, geological, and groundwater surveys.

Complete sets of aerial photographs taken in 1936, 1956, 1966, and 1978.

**Livestock data:** Twelve years of calf weight data comparing Barzona, Hereford, Barzona x Hereford crosses, from 3, 3 pasture 1 herd rotation grazing systems and 3 yearlong grazed pastures.

**Wildlife data:** Wildlife information centers on species that influence range production such as the antelope jackrabbit (*Lepus alleni*) and the black tailed jackrabbit (*L. californicus*) and several rodents. Additional work has been done on species sought by sport hunters such as mule deer (*Odocoileus hemionus*), white tailed deer (*O. virginianus*), javelina (*Tayassu tajacu*), and Gambel's quail (*Lophortyx gambelii*) or for fur as the coyote (*Canis latrans*). Little information is available on non-game wildlife.

**Research thrusts:** Grazing systems, noxious plant control, controlled burning, wildlife-livestock relationships, plant ecophysiology, livestock behavior.

**Southwest Rangeland Watershed  
Research Center  
Walnut Gulch Experimental Watershed  
USDA-Agricultural Research Service**

PO Box 213  
Tombstone, Arizona 85638  
2000 East Allen Road  
Tucson, Arizona 85719  
Telephone: 602-629-6037 (FTS 762-6037)

**Location:** Near Tombstone, Arizona (Cochise County, Arizona); 75-mile drive from Tucson.

**Facilities and accommodations:** Location has limited housing for visiting research staff members and graduate students from the Southwest Rangeland Watershed Research Center in Tucson. There are office space, machine shops, an electrical shop, and field laboratories for soil and water analyses.

**Size:** 36,900 acres.

**Establishment:** 1955. Legal source of establishment and current legal ownership: Mostly state leased land; some small portions are privately owned, and some are government leased (approximately 80 percent state and government leased, 20 percent private ownership). Mineral rights: Some active mining within the watershed boundary, also some working claims and patented claims.

**Description**

**Climate:** This area is characterized by mild temperatures, limited rainfall, and high evaporation rates (low relative humidity). The average frost-free season in Tombstone at an altitude of 4,580 feet is 237 days and has ranged from 205 to 277 days in the past 17 years. For January, the coldest month, the mean temperature is 47.1°F, and the mean minimum is 34.1°F. For July, the mean daily temperature is 79.0°F with a mean maximum daily temperature of 92.7°F. The mean maximum temperature for June is the highest, 94.1°F, but the monthly mean is lower than for July, reflecting the lower nighttime temperatures. From July through September, moist unstable air masses generally advance into Arizona from the Gulf of Mexico and help produce a greater cloud cover. These air masses almost always produce moderate to intense thunderstorms, which develop most readily during the afternoon over the heated terrain. This moisture and the associated cloud cover cause an abrupt decrease in the pan evaporation for July through September. The temperature extremes recorded for Tombstone are 6° and 100°F. Evaporation-transpiration rates can be high during these hot summer months.

**Physical features:** The soils of the Walnut Gulch Experimental Watershed are strongly influenced by the parent materials from which they were formed and the past and present climatic regime of the area. In general, most of the soils are gravelly or stony at the surface and change to coarse textured with depth, and usually contain a lithic contact at a shallow depth. The



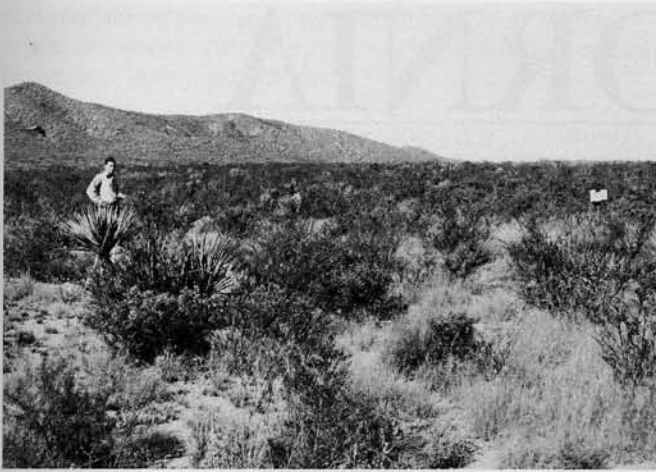


Figure 2. Mixed brush and grass occurring on the middle portion of the Walnut Gulch Watershed.

exceptions are in the southeastern igneous hills, where finer-textured soils occupy both swales and slopes.

**Vegetation:** The climax vegetation of the Walnut Gulch area is Desert Plains Grassland. The xeric and most widespread grasses are black grama (*Bouteloua eriopoda*), found mainly on the uplands, and tobosa grass (*Hilaria mutica*) in the swales. The more moist plant community is dominated by curly mesquite (*Hilaria belangeri*), black grama, and other *Bouteloua* species on the upland and tobosa grass in the swales. Today, much of the country, described by early settlers as grass covered, is predominantly brush. Nearly 60 percent of the Walnut Gulch Watershed now supports desert shrubs, with varying amounts of the original grass species growing among them. The remainder of the area is grass-covered, with a few scattered shrubs of the same species found in the shrub-dominated areas. Whitethorn (*Acacia constricta* var. *vernica*) is the most prevalent shrub; creosotebush (*Larrea divaricata*), tarbush (*Flourensia cernua*), and sandpaper bush (*Mortonia scabrella*) are other major brush species.

**Livestock management:** The watershed is grazed by cattle managed by the grazing leasee.

**Research emphasis:** The mission of the Southwest Rangeland Watershed Research is to study the hydrologic characteristics of rangeland watersheds and the effects of changing land uses and practices on the hydrologic cycle. This includes the rainfall, which is natural input to the watersheds, the quality and movement of water on the surface and below the surface, erosion from the watersheds and channels within the watersheds, sedimentation within the channels and reservoirs, and the present and potential uses of available water. Primary emphasis is on: Understanding and evaluating the effects of changing land use, including range renovations and conservation practices, and developing the principles for such understanding so the results and findings from research areas can be applied to areas having little or no research data.

**Climatic data:** Extensive precipitation data from a recording rain gauge network on the watershed (30 years of record). Also, temperature, relative humidity, pan evaporation, etc., from Class A weather station located at the research field station headquarters. Precipitation, runoff, and water quality data are available on magnetic tape; weather station data are available from analog record or record books.

**Plant data:** Species composition line-intercept vegetation transects have been done on the watershed. Limited data are available on small watershed areas within the research area.

**Livestock data:** Very limited data because of limited control of grazing on private lands.

**Wildlife data:** None.

**Hydrology data:** Excellent hydrologic data, with long-term records available. Streamflow at Walnut Gulch is measured at 11 gauging stations with eight tributaries, and three on the main channel of Walnut Gulch. Of the three flumes in the main channel, flume #1, with a capacity of 20,000 cubic feet per second, has a drainage area of 44 square miles. Flume #2, with a capacity of 18,000 cubic feet per second, has a drainage area of 42 square miles, and flume #6 has a capacity of 18,000 cubic feet per second and a drainage area of 37 square miles. Seven channel segments within the Walnut Gulch Experimental Watershed have been isolated so transmission loss magnitude can be measured. This can be accomplished by comparing flow event hydrographs at the upstream and downstream stations at a channel reach; all runoff originated above the upper station. Depth-integrated sediment samples are taken from small flows in the main channels by wading. Larger flows necessitate sampling from cableways. Experimental automatic sampling equipment is being field tested to determine equipment performance in ephemeral streams, and other equipment is being developed by staff members to improve data collection. Precise gully measurements are being made on small watersheds to determine direct and indirect gully contribution to watershed erosion and sediment transport. Sampling of sediment transport above and below major headcuts is also being continued. These data are vital to research efforts on updating and improving existing predictive equations, such as the Universal Soil Loss Equation (USLE), and for developing new models, such as a field scale model for chemicals, runoff, and erosion from agricultural management systems (CREAMS). Equations have been developed to predict hydraulic geometry and erosion rates in small channels as functions of discharge, shear stress distribution, and soil properties. These data are available on magnetic tapes, microfiche, or computer printouts.

**Research thrusts:** Analysis and modeling of rainfall-runoff erosion in relation to soil and vegetation; development of USLE for rangelands; nutrient cycling and chemical transport on rangelands.

# CALIFORNIA

## University of California Hopland Field Station

4070 University Road, Hopland, California 95449  
Telephone: 707-744-1424

**Location:** One-hundred miles north of San Francisco, 40 miles inland from the Pacific Ocean and 5 miles east of Hopland and U.S. Highway 101 at latitude 39°00' North and longitude 123°4' West.

**Facilities and accommodations:** Office building with library, meeting room, and microcomputer; laboratory for analysis of plant, soil, and animal material; autopsy room, walk-in refrigerator, plant drying, grinding and weighing equipment, shops and two equipment storage buildings; two sheep barns approximately 12,000 square feet, with working corrals, two feed storage barns for hay and pellets; greenhouse approximately 950 square feet, lysimeter facilities with 72 tanks, and 25 miles of all-weather access roads. Dormitory with cooking facilities for researchers and students; housing for limited number of permanent staff.

**Size:** Total area of 5,358 acres include 32 sheep-proof fenced pastures ranging in size up to 650 acres; 12 deer-proofed fenced pastures totaling 250 acres; livestock-free areas, established in 1957, total 468 acres and represent major vegetation types, exposures, and elevations; an irrigated pasture of 20 acres on the valley floor of the Russian River drainage was established in 1979.

**Establishment:** 1951. Legal source of establishment and current ownership: Regents of the University of California purchased 4,638 acres from Roy L. Pratt in July 1951, acquired 640 acres in September 1965 from the Bureau of Land Management under the Recreation and Public Purposes Act of June 14, 1926, and purchased 80 acres from J. Beasley in July 1969.

## Description

**Climate:** The climate is Mediterranean characterized by hot, dry summers (June through September) and mild, rainy winters. The rainfall season normally occurs between October and May, but 75 percent falls from November through February. Annual precipitation averages 37 inches at 800 feet elevation and 45 inches at 2,000 feet. Snow is infrequent, generally not persisting more than a few days. Mean average temperature July through September is 70°F, and the mean maximum is 92°F. July is generally the hottest month and daily maximums occasionally reach 115°F. Nights are usually cool. With the onset of fall, temperatures drop to a mean of 44 to 47°F from December through February. The frost-free growing season averages about 250 days and

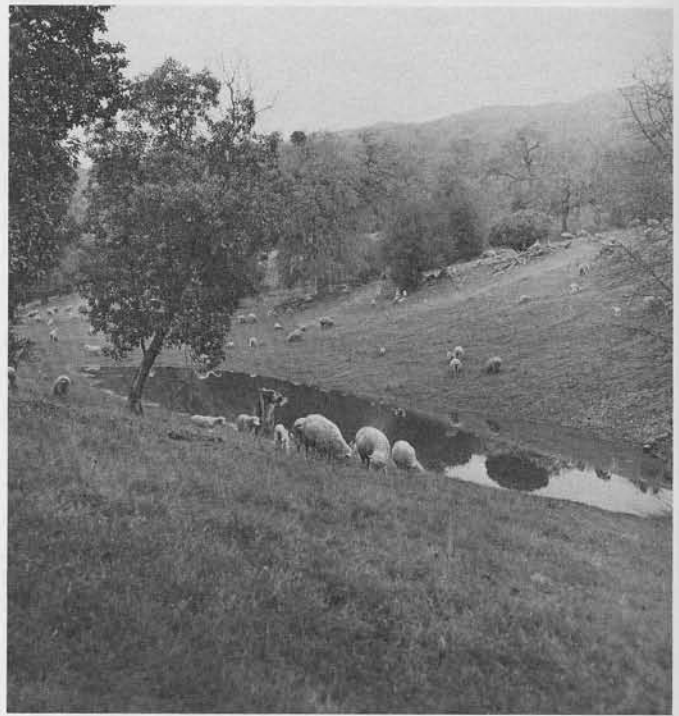


Figure 3. Ephemeral lake during wet winter conditions in the oak woodland/annual-type grassland at the University of California Hopland Field Station.

the first frost sufficient to cause soil heaving usually occurs in mid-November. Rainfall limits herbaceous forage growth more than temperature, limiting the growing season to about 180 days (November through April).

**Physical features:** Elevation ranges from 500 to 3,000 feet.

**Soils:** With the exception of the Yorkville series, which is derived from glaucophane schist, the six most common soil series on the field station are derived from hard sandstone and shale. Three of these series are covered with grass and woodland-grass vegetation. Laughlin (*Ultic Haploxerolls*), 1-3-foot depth, fine sandy loam to loam, slightly acid; Sutherlin (*Ultic Haploxeralfs*), 2-4-foot depth, loam with rocky lower horizons, moderately acid; Yorkville (*Typic Argixerolls*), 1-5-foot depth is highly variable because of landslipping and seep areas, loam surface horizon with clay subsoil, slightly acid. Two series are shrub-covered with chaparral vegetation: Maymen (*Lithic Xerochrepts*), less than 1-foot depth, gravelly to nearly stoney and medium textured, moderately acid; Los Gatos (*Typic Argixerolls*), 1-2-foot depth, steeply sloping, medium textured, and gravelly, moderately acid. Finally, the Josephine series (*Typic Haploxerults*) is covered with moderately dense



to dense hardwoods and has characteristics of 3-5-foot depth, medium textured, slightly acid. Ten other series are present in limited amounts.

**Vegetation:** Four principal vegetation types including more than 600 species make up 95 percent of the area. These are grass, woodland-grass, dense woodland, and chaparral. The grass vegetation type consists mostly of annual grasses and forbs; many are introduced. Some of the annual species are slender oat (*Avena barbata*), soft chess (*Bromus mollis*), ripgut (*B. diandrus*), foxtail fescue (*Vulpia megalura*), broadleaf filaree (*Erodium botrys*), foothill filaree (*E. brachycarpum*), Mediterranean barley (*Hordeum geniculatum*), silver hairgrass (*Aira caryophyllea*), medusahead (*Taeniatherum asperum*), bur clover (*Medicago polymorpha*), tarweed (*Madia* spp.), and common gold fields (*Lasthenia californica*). Perennial grasses include purple needlegrass (*Stipa pulchra*), California melic (*Melica californica*), blue wildrye (*Elymus glaucus*), and pine bluegrass (*Poa scabrella*). Woodland grass occupies the greatest area and mainly differs from the grass type by the presence of oak trees (*Quercus* spp.). The ground cover is similar to the grass type but is less dense, depending on the density of overhead canopy. Tree cover is dominated by blue oak (*Quercus douglasii*), valley oak (*Q. lobata*) and interior live oak (*Q. wislizenii*). Less numerous are Pacific madrone (*Arbutus menziesii*), California laurel (*Umbellularia californica*), and California buckeye (*Aesculus californica*). Trees dominate the dense woodland vegetation area with California black oak (*Q. kelloggii*) interior live oak, Pacific madrone, and California laurel as the major species. The tree canopy is generally complete allowing only shade-tolerant shrubs and herbaceous plants in the understory. Plants growing in chaparral are predominately evergreen, shrubby, and represented by chamise (*Adenostoma fasciculatum*), buckbrush ceanothus (*Ceanothus cuneatus*), wavy-leaf ceanothus (*C. foliosus*), manzanitas (*Arctostaphylos* spp.), leather oak (*Quercus durata*), scrub oak (*Q. dumosa*), and shrub forms of interior live oak.

**Livestock management:** Sheep, including 1,300 ewes, are owned by the University of California. Animals in excess of research needs are sold by auction; wool is sold by a cooperative marketing association. Approximately 44 percent of the flock is ewes, 2 percent rams, 17 percent replacement yearlings, and 37 percent lambs sold in May and June.

**Research emphasis:** Range forage and soils: Range plant and animal nutrition (includes trace mineral studies); range fertilization; evaluation of subclover cultivars; biological and economic responses and interactions of plants and animals to grazing systems; influence of integrated use of irrigated pasture; testing herbaceous plants for emergency revegetation.

**Animal science:** Selection for growth and prolificacy of sheep; sheep nutrition with emphasis on range supplementation; production of improved rams; behavior patterns of ewes to alien lambs; comparison of sheep breeds and crosses for lamb and wool production;

forage intake studies; physiological parameters and nutrition content studies of native and improved pastures used by grazing sheep.

**Wildlife:** Management of coyotes in relation to sheep production; biological control and dispersal of rodents and ground squirrels; productivity and yield of deer.

**Entomology and public health:** Biology and pest management of arthropods of public health and veterinary importance; studies of tick-borne diseases; evaluation of Q-fever vaccine.

**Importance of site:** Long-term data bases on climate, hydrology, plant, livestock, wildlife, and insects; a national atmospheric deposition measurement station.

#### **Climatic data (four weather stations):**

Headquarters—800-foot elevation, 1951-present.

Coon Lake—1,500-foot elevation, 1960-present.

Orchard Pasture—2,900 feet, 1953-present. Precipitation: Standard and recording rain gauge. Temperature: Hydrothermograph and maximum-minimum.

Lambing pasture—1,100-foot elevation, 1960-present.

Precipitation: Standard and recording rain gauge.

Temperature: Hydrothermograph, maximum-minimum, wet bulb, dry bulb, soil at 6-inch depth, black globe.

Wind: Anemometer at 72 inches, direction, velocity.

**Hydrology data:** 1952-1972: Runoff from two watersheds, before and after woody-plant removal; sediment yield from one watershed.

**Plant data:** 1952-present: Production of resident annual forage plants (total) and seeded annual legumes. February (leaf stage) and April-May (heading stage) square foot plot clippings (oven dry). Visual cover and step point cover. Seasonal nutrient content analysis, February-April.

**Livestock data:** 1952-present for 1,300-head ewe flock: Weights four times per year, breeding (August), late fall (December), spring (April), cull (June). Daily gains on lambs (120-day weights); wood weights and grades. Stocking rates recorded on all pastures, on and off dates. Set stocking and rotation grazing systems. Sheep breeds—originally a Corriedale x Blacktop Merino flock, graded up to a Targhee base flock by 1970. Suffolk used as terminal sire breed. Other breeds evaluated in crosses include Rambouillet, Dorset, Finn, and Barbados.

**Wildlife and insect data:** Number of sheep killed by coyotes, 1974-present. Deer kill by public, station, and research, 1955-present. Fawn:doe:buck herd composition counts, 1958-1974 and 1980-present. Deer tick, mite, flea, and other parasite loads, 1965-present.

**Research thrusts:** Range improvement; sheep management, nutrition, and breeding; range plant nutrition; predator control.



**San Joaquin Experimental Range**  
**USDA Forest Service**  
**Pacific Southwest Forest and Range**  
**Experiment Station**

24075 Highway 41, Coarsegold, California 93614  
Telephone: 209-868-3349

**Location:** About 25 miles north of Fresno, California, on Highway 41 in Madera County.

**Facilities and accommodations:** Limited dormitory facilities; most summertime visitors prefer to obtain food and air-conditioned lodging in Fresno or Madera (both about 25 miles away). Shop and limited laboratory facilities are available for routine plant drying, sorting, and weighing. Restrictions on facilities imposed by previously scheduled use.

**Size:** Approximately 4,500 acres (including an 82-acre livestock enclosure built in 1934), cross-fenced into 35 range units varying in size from 18 to 720 acres.

**Establishment:** 1934. Legal source of establishment and current ownership: Purchased by the U.S. Department of Agriculture, Forest Service. Managed by California State University, Fresno, for research and educational purposes, under a long-term agreement with USDA, Forest Service, Pacific Southwest Forest and Range Experiment Station.

## Description

**Climate:** The climate is typically Mediterranean, with moist, mild winters and dry, hot summers. Annual precipitation ranges from 10 to 32 inches with a mean of 19 inches, most of it falling as rain between October and April. Mean monthly air temperature ranges from 42°F in January to more than 80°F in July. Monthly minimum temperatures vary from a low of slightly above freezing in January to more than 60°F in July. Monthly maximum temperatures range from about 50°F in January to almost 100°F in July.

**Physical features:** Elevation ranges from 700 to 1,700 feet. Soils are of granitic origin and most are less than 2.5 feet deep. On upland sites, Ahwahnee series (Mollic Haplustalf) are common, covering about 96 percent of the San Joaquin Experimental Range. These typically have A horizons that are grayish brown to brown, slightly acidic, and low organic matter content. Visalia series soils (Cumulic Haploxeroll) are found on alluvial or swale sites and are generally darker, deeper, and more productive.

**Vegetation:** Vegetation on the San Joaquin Experimental Range includes annual grasslands and blue oak woodlands. Annual grasslands consist largely of introduced grass species, such as wild oat (*Avena fatua*), soft chess (*Bromus diandrus*), red brome (*Bromus rubens*), wild barley (*Hordeum* spp.), and foxtail fescue (*Vulpia megalura*). Common forbs include broadleaf filaree (*Erodium boytrys*), redstem filaree (*Erodium cicutarium*), true clovers (*Trifolium* spp.), popcorn flower (*Plagio-*



Figure 4. Typical blue oak savanna with understory of annual grasses and forbs, USDA Forest Service San Joaquin Experimental Range.

*bothrys notbofulvus*), turkey mullein (*Eremocarpus setigerus*), and many others. In the blue oak woodland, the most common trees are blue oak (*Quercus douglasii*), interior live oak (*Quercus wislizenii*), digger pine (*Pinus sabiniana*), and California buckeye (*Aesculus californica*). Wedgeleaf ceanothus (*Ceanothus cuneatus*) shrubs are also common.

**Livestock management:** Cattle on the San Joaquin Experimental Range include a breeding cow herd (about 275 cows with or without calves), owned by California State University, Fresno. Except for grazing systems experiments, grazing is continuous yearlong, with supplemental feeding often necessary during the dry summer months when mature annual plants provide insufficient forage quality, and during the winter, when mature forage has been leached and new green forage is scarce.

**Research emphasis:** Animal science and range management.

**Importance of site:** Long-term data bases on climate, vegetation, and livestock.

**Climatic data (1934 to present):** Daily precipitation and daily temperatures (minimum and maximum).

**Plant data (1934 to present):** Peak forage production. For some years detailed seasonal production and composition data are available. For 3 years (1973-75), a wide variety of producer and consumer data are available from the San Joaquin Experimental Range as the Annual Grassland Biome Site for the U.S. International Biological Program.

**Livestock data (various years):** Stocking rates, weight gains.

**Wildlife data (various years):** Biological data for California quail (*Callipepla californicus*), Beechy ground squirrels (*Spermophilus beecheyi*), avian community structure, and other wildlife aspects.

**Research thrusts:** Animal science, range plant studies.

## University of California Sierra Foothill Range Field Station

PO Box 28  
Browns Valley, California 95918  
Telephone: 916-639-2306

**Location:** On Scott-Forbes Road, 19 miles east of Marysville via State Highway 20 and Peoria Road at latitude 39° 15' North and longitude 121° 17' West.

**Facilities and accommodations:** Office building with conference room, and microcomputer; small laboratory with plant drying, grinding, and weighing equipment; walk-in refrigerator, shops, warehouse; two feed and equipment storage buildings, livestock barns and four sets of cattle handling corrals with scales; 21 miles of all-weather access roads, and 58 miles of fencing. Dormitory with cooking facilities for researchers and students; housing for a limited number of permanent staff.

**Size:** Total area of 5,720 acres includes 4,930 acres of dryland pasture crossfenced into 70 fields varying in size from 3 to 996 acres; 165 acres irrigated pasture crossfenced into 20 pastures from 1 to 16 acres; 272 acres of livestock-free areas established in 1972; 353 acres in roads, corrals, and storage.

**Establishment:** 1960. Legal source of establishment and current ownership: Regents of the University of California purchased 5,014 acres from the Forbes, Wright, and Burris families in 1959, and 706 acres from the Marty family in 1965.

### Description

**Climate:** The climate is Mediterranean, characterized by hot, dry summers (June through September) and mild, rainy winters. Annual precipitation has ranged from 10 to 44 inches with a mean of 29 inches, most occurring as rainfall between October and May. Snow is rare. Lowest mean monthly minimum air temperatures typically are in the low 50°s F and occur in December and January, while mean maximum temperatures typically are in the low 90°s F in July and August. Recorded extremes are 14 and 109°F. Rainfall limits herbaceous forage growth more than temperature.

**Physical features:** Five soil series are dominant on the station and elevation ranges from 230 to 2,020 feet. The Auburn series is most extensive, and being intermingled with three other series, it is almost always mapped in complex with them. These four series are covered with grass and woodland-grass vegetation, and all are



Figure 5. Blue oak savanna with annual-type grassland understory on the University of California Sierra Foothill Range Field Station.

developed from basic metavolcanic rocks ("greenstone"). The Auburn series (*Ruptic Lithic Xerochrepts*) is loam in texture, 1-2 feet in depth, well drained, and slightly acid. Sobrante (*Mollic Haploxeralfs*) soils are like Auburn soils, but are deeper (1.5-3 feet) and have slightly more clay in the subsoil. Las Posas (*Typic Rhodoxeralfs*) and Argonaut (*Mollic Haploxeralfs*) soils are like Auburn soils but are moderately deep (1.5-3.5 feet) and have clayey subsoils. Finally, the Wyman series (*Typic Haploxeralfs*), now mostly in irrigated pasture on the station, is formed in alluvium from the series discussed above. These soils are 4-5 feet deep, loam with clay-loam subsoil, slightly acid to neutral, and naturally covered with annual grassland vegetation and oak trees (*Quercus* spp.) including valley oak (*Quercus lobata*).

**Vegetation:** Several unmodified and modified vegetation types are present: Unmodified foothill woodland-grass has from 40 to 100 + trees per acre with associated brush, grasses, and forbs. Major trees are blue oak (*Quercus douglasii*) and interior liveoak (*Q. wislizenii*) with some digger pine (*Pinus sabiniana*) and, at higher elevations, some black oak (*Q. kelloggii*) and ponderosa pine (*P. ponderosa*). Common shrubs include buckbrush (*Ceanothus cuneatus*), toyon (*Heteromeles arbutifolia*), and poison oak (*Toxicodendron diversilobum*); the major forbs include filaree (*Erodium* spp.), annual clovers (*Trifolium* spp.), and geranium (*Geranium* spp.). Most common annual grass species are soft chess (*Bromus mollis*), red brome (*B. rubens*), Spanish brome (*B. madritensis*), ripgut (*B. diandrus*), slender oat (*Avena barbata*), and medusahead (*Taeniatherum asperum*). Perennial grasses include purple needlegrass (*Stipa pulchra*) and blue wildrye (*Elymus glaucus*). Foothill woodlandgrass which has been partially cleared, leaving approximately four to 50 trees per acre, has some areas planted to improved plant varieties, including one or more of the following species: rose clover (*Trifolium birtum*), subterranean clover (*T. subterraneum*), hardinggrass (*Phalaris tuberosa*), and orchardgrass

(*Dactylis glomerata*). Many resident annual species remain but most shrubs have been removed. Portions of the foothill range have been cleared of trees and shrubs. Most of this range has been seeded to rose and subterranean clover which now make up typically 15 to 35 percent of the species composition with the remainder being made up of resident annuals. Riparian ecosystems exist along several permanent and intermittent waterways. Approximately 165 acres of the station is flood and sprinkler irrigated pasture seeded to perennial grasses and legumes.

**Livestock management:** A fall-calving breeding herd of approximately 300 mature cows, including a 60-head purebred unit, is owned by the Department of Animal Science, University of California at Davis, and maintained on the station throughout the year. Cows are rotated among fields and supplemental fed from calving until adequate range forage is present (approximately March 1). Raised and purchased stocker cattle (150 to 400 head) are grazed during the winter-spring green forage season, the number varying with forage production and research requirements.

**Research emphasis:**

Range forage, soils, and hydrology—Range fertilization, forage species evaluation for range seeding, oak canopy cover effects on understory forage production, water quality, erosion and/or sediment production, and nutrient cycling in natural and improved annual range.

Animal science—Supplementation and range fertilization effects on range beef production, energy balances, and grazing behavior of beef cattle on range, integrated management of beef cattle on improved annual ranges and irrigated pastures, parasite effects on beef cattle, and effects of parasite control.

Importance of site—Long-term data bases on climate, soil erosion, hydrology, nutrient cycling, plant, livestock, and deer.

**Climatic data (two weather stations):**

Headquarters—675-foot elevation, 1974-present. Precipitation: Standard and recording rain gauge. Temperature: Hydrothermograph and maximum-minimum, wet bulb, dry bulb, soil at 6-inch depth, black globe. Wind: Anemometer at 84 inches—direction, velocity. Evaporation: Standard pan.

Haworth—400-foot elevation, 1966-present. Precipitation: Recording rain gauge.

**Hydrology data (two watersheds, 1978-present):**

Rainfall amount, intensity and nutrient content. Hourly runoff, Ca, Mg, Na, K, NO<sub>3</sub>, PO<sub>4</sub>, SO<sub>4</sub>, pH, EC, suspended sediment, bed load.

**Plant data:** (1) Total production of resident annual forage plants under blue oak (*Quercus douglasii*) canopies compared with open grassland and three oak removal treatments, (2) botanical composition from permanent transects in 1966-1981. A 520-acre cleared site, which has been managed under various livestock grazing and fertilization treatments, 1974-present.

**Livestock data:** Beef cattle fertility, disease, and production levels, 1972-present. Gains of stocker cattle at 21-28 day intervals (various years). Stocking rates recorded on all pastures, on and off dates, 1976-present.

**Deer data, 1966-present:** Deer kill by public, station, and research.

**Research thrusts:** Range improvement, beef cattle management, range nutrition, cow health and reproduction.



# COLORADO

**Central Plains Experimental Range  
USDA-Agricultural Research Service  
Forage, Range, and Livestock  
Management Research  
Crops Research Laboratory  
Colorado State University**

Fort Collins, Colorado 80523  
Telephone: 303-484-8777 (FTS: 323-5227)

**Location:** About 7.5 miles north of Nunn, Colorado, on U.S. 85, about 34 miles northeast of Fort Collins, 25 miles south of Cheyenne, Wyoming, on U.S. 85; 40°50'N latitude, 104°44'W longitude.

**Facilities and accommodations (including Long-Term Ecological Research):** 2 office-laboratories; 2 bunkhouses for employees and cooperators; storage buildings; 3 corrals with scales; 11 small corrals; 2 weather stations; lysimeter.

**Size:** 15,500 acres.

**Establishment:** 1937. Legal source of establishment and current legal ownership: Memorandum of understanding between U.S. Forest Service, first administrator, and Resettlement Administration established station on lands acquired by the latter under Bankhead-Jones Act. Ownership: U.S. Department of Agriculture, Agricultural Research Service, except for about 800 acres provided through Crow Valley Livestock Cooperative.

## Description

**Climate:** The mean 45-year annual precipitation is 12.3 inches, with a range of 4 to 20 inches and a distribution of about 80 percent during April through September and about 65 percent during May through August. Mean monthly temperature extremes are 26°F in January and 70°F in July with a mean frost-free period of 133 days.

**Physical features:** Elevation ranges from about 5,200 to 5,600 feet. Location is on Colorado Piedmont, created by erosion of the High Plains surface. Exposed surfaces are primarily Tertiary sediments. Soils are predominately Aridic Argiustolls and Ustollic Haplargids and are predominately loams, sandy loams, and clay loams formed shale and siltstone outcrops of Pierre sedimentary formation or on fluvial outwash materials. Topography is mostly gently rolling plains, but includes eroded breaks and buttes. The range is dissected by several stream beds, some with flood plains or saltgrass meadows.

**Vegetation:** Central Plains Experimental Range is on the western edge of the shortgrass prairie, Kuchler's shortgrass steppe. On native range, blue grama



Figure 6. Yearling replacement heifers grazing sandy shortgrass range on the Central Plains Experimental Range. Most of the shrubs in picture are fourwing saltbush common on sandy plain and floodplain range sites. Fenced area is a permanent enclosure.

(*Bouteloua gracilis*) is the predominant grass. Other important grasses include sand dropseed (*Sporobolus cryptandrus*), red threeawn (*Aristida longiseta*), buffalo-grass (*Buchloe dactyloides*), western wheatgrass (*Agropyron smithii*), needle-and-thread (*Stipa comata*), bottlebrush squirreltail (*Sitanion hystrix*), and inland saltgrass (*Distichlis spicata stricta*). Important forbs include scarlet globemallow (*Sphaeralcea coccinea*), slimflower scurfpea (*Psoralea tenuiflora*), scarlet gaura (*Gaura coccinea*), and Russian thistle (*Salsola kali tenuifolia*). Fourwing saltbush (*Atriplex canescens*), woody buckwheat (*Eriogonum effusum*), and plains prickly pear (*Opuntia polyacantha*) are important shrubs. Several areas were farmed and have revegetated naturally, or after reseeding. Forage yield from grasses and forbs averages about 650 pounds per acre, oven dry.

**Livestock management:** Cattle, owned by members of the Crow Valley Livestock Cooperative, consist mostly of yearling and 2-year-old cattle. About 600 yearlings are received in late April for summer grazing, and about 200 of them are retained through the winter and summer. About 7 pounds of high-protein meal per head are fed weekly during winter, and salt is fed year long. Hay is fed only when snow makes grazing impossible for maintenance of body weight.

**Research emphasis:** Range and range cattle management.

**Importance of site:** Long-term data bases on climate; vegetation; and livestock. Long-term data on heavy, moderate, and light summer grazing; moderate year-long grazing, and non-grazing. Range is site of a Biosphere

Reserve and Long-term Ecological Research Program. It was the primary site of Grassland Biome of the International Biological Program.

### **Climatic data (1939 to present):**

Precipitation—Daily from standard rain gauges and chart data for some years.

Gauges in most pastures are read during summer.

Ambient temperature—Daily minimum-maximum.

Wind—Totalizing anemometer at 3 feet until about 1978, then at 2 meters.

Radiation—Net since about 1978.

Soil moisture—Weekly or biweekly 1940-42, 1960-74, and since about 1978.

Soil temperature—Weekly since about 1967.

### **Plant data:**

Site description—Shortgrass uplands (blue grama-buffalo), flood plains, salt meadows.

Species composition—From square-foot density and frequency data.

Yield—Taken to ground level, oven-dry; phenological stage mature. Since 1939.

Cover—Square-foot density, 1939-1967; line transect 1941, 1943, 1949, 1950; some other by projects.

Seasonal nutritive quality—For various years.

Density—Limited, by project.

Frequency—Nested 16 × 16 inch and 2 × 2-inch quadrats since about 1965, by projects.

Utilization—1939-present.

Plant mapping—1940, 1941, 1946-48.

**Livestock data:** Primarily for yearling and 2-year-old cattle (average 800 summer, 200 winter), a few cows-calves by project. Daily gains, fertility, meat/area—1939—present, mostly monthly weights and meat/area; fertility of first calf heifers, about 1974-present. Stocking rate—1939-present. Season of use—1939-present.

**Predators, insects, wildlife data:** Various inventories made by cooperators, especially since 1967 when some were comprehensive.

**Research thrusts:** Grazing management, range improvements, animal nutrition, animal behavior, range plant ecophysiology, range ecology.

## **San Juan Basin Research Center Hesperus Station**

18683 Highway 140, Hesperus, Colorado 80326  
Telephone: 303-385-4574

**Location:** Fifteen miles southwest of Durango, 4 miles south of Hesperus on Highway 140.

**Facilities:** Housing for staff, support personnel, and graduate students. Office, buildings for hay and equipment storage, maintenance shops, calving facilities, and working corrals. The Four Corners Beef Cattle



Figure 7. Mechanical manipulations of Gambel oak at the San Juan Basin Research center.

Improvement Association bull test facility is also on the Research Center.

**Size:** 6,300 acres.

**Establishment:** The Research Center is on the site of Fort Lewis, a U.S. Army outpost established in the 1880s. The property was used as State of Colorado School of Agriculture from 1911 to 1956. The site has functioned as a branch research center of Colorado State University since 1956.

### **Description**

**Climate:** Average annual precipitation is 18.8 inches, more than 60 percent occurring during the winter as snow. May and June are normally very dry. The summer months are characterized by convection thunderstorms, with precipitation amounts being quite variable. The frost-free period is usually about 100 days.

**Physical features:** The elevation of the Research Center is 7,600 feet. Soils are deep Plome fine, sandy loams formed in aeolian material weathered from red sandstone and shales. Available water capacity is high, but permeability is moderately slow. Effective rooting depth is more than 60 inches.

**Vegetation:** The vegetation is dominated by clumps of Gambel oak (*Quercus gambelii*). Dominant forb species include western yarrow (*Achillea lanulosa*), sulfur flower eriogonum (*Eriogonum umbellatum*), redroot eriogonum (*Eriogonum racemosum*), lupine (*Lupinus* spp), Carruth sagewort (*Artemisia carruthii*), and hairy golden-aster (*Chrysopsis villosa*). Major grasses are



Kentucky bluegrass (*Poa pratensis*), western wheatgrass (*Agropyron smithii*), needle-and-thread (*Stipa comata*), squirreltail (*Sitanion hystrix*), Arizona fescue (*Festuca arizonica*), and blue grama (*Bouteloua gracilis*). Rabbitbrush (*Chrysothamnus nauseosus* and *C. depressus*) and big sagebrush (*Artemisia tridentata*) are common shrubs.

**Livestock management:** Cow-calf.

**Research emphasis:** Range and livestock.

**Range data:** Primary emphasis of the range science projects has been to evaluate methods of Gambel oak control, to measure effects of control on the understory vegetation, to determine the adaptability of oak rangeland to reseeding, to measure responses in livestock production, and to establish management alternatives for oak rangeland. Biological, chemical, and mechanical oak control methods are being evaluated.

Stocking rate studies are being conducted on oak rangelands. Numerous species of dryland grasses and several alfalfa varieties have been tested for adaptation and production under southwestern foothills conditions.

**Livestock data:** A 275-cow herd is used for this phase of the research. The herd consists of Hereford, Angus, Red Angus, Brangus, and Simmental cattle. The Hereford cattle are the most highly inbred herd of beef cattle in the world. Studies include a) selection responses within inbred lines and in a linecrossing scheme, b) effects of intensive inbreeding on important traits, c) a comparison of mating systems, and d) comparisons of biochemical and physiological measurements on inbred and linecross genetic stocks.

**Research thrusts:** Range improvements, grazing management, biological and chemical control of target species, animal genetics and breeding.

# IDAHO

## Northwest Watershed Research Center USDA-Agricultural Research Service

270 South Orchard  
Boise, Idaho 83705  
Telephone: (FTS) 554-1363  
(COM) 208-334-1363

**Location:** Main Office—270 South Orchard, Boise Idaho. Soil, Water Quality Electronics Laboratory—Gowen Field, Boise, Idaho. Reynolds Creek Headquarters—Reynolds, Idaho (50 miles southwest of Boise).

**Size:** Reynolds Creek Watershed, 90 square miles.

**Establishment:** Field installations establishment began in 1960. Legal source of establishment and current legal ownership: Reynolds Creek Watershed—Public and private lands, small tracts are leased by Agricultural Research Service. Gowen Field—Leased land for laboratory and storage areas. Main office—GSA leased space.

### Description

**Climate:** The average annual precipitation on Reynolds Creek Experimental Watershed ranges between 9.44 inches at the low elevation (3,900 feet) in the northeastern area to 44.23 inches at the high elevation (7,100 feet) in the southwestern areas of the watershed. Precipitation on the watershed increases with elevation and shows a seasonal pattern, with lowest amounts in July and greatest amounts in December and January. About 44 percent of the average annual precipitation falls from May through October at the low elevation areas; only 22 percent falls during the same period at the high elevations. These percentage differences show that a greater proportion of the annual precipitation falls during the winter at high elevations. The annual precipitation has varied between 4.66 and 12.95 inches at the lowest annual precipitation site to 32.61 and 57.95 inches at the high elevation site. The mean annual temperature ranges between 47°F at the lowest weather station (3,910 feet) to 39°F at the higher elevation station (6,840 feet). The mean January temperatures at these same sites are 29°F and 23°F and the mean July temperatures are 69°F and 62°F for the low and high elevation stations, respectively.

**Physical features:** The Reynolds Creek Experimental Watershed encompasses a complete basin of about 90 square miles with elevations ranging from 3,600 to 7,200 feet. The watershed is on the northern extreme of the Owyhee Mountain Range and drains northward into the Snake River about 20 miles upstream from Marsing, Idaho. Soils are primarily aridisols and molli-



Figure 8. Reynolds Creek Experimental Watershed a major study area for the Northwest Watershed Research Center.

sols on mixed volcanic, sedimentary, and granitic geologic material.

**Vegetation:** Vegetation on the watershed is principally big sagebrush (*Artemisia tridentata*, subspecies *vaseyana*, and *wyomingensis*) and related woody species with an understory of annual and perennial grasses. Forested areas comprising only about 2 percent of the watershed are restricted to patches of fir-aspen at the highest elevations in protected snowdrift areas. About 1,500 acres of irrigated hay are grown along the main channel in the lower reaches of the basin. In addition to big sagebrush, Shadscale (*Atriplex confertifolia*) and greasewood (*Sarcobatus vermiculatus*) are common at the lower elevations of the watershed. Low sagebrush (*Artemisia arbuscula*) and antelope bitterbrush (*Purshia tridentata*) are also common on the watershed. A wide spectrum of grass and forbs species is found in the Reynolds Creek Watershed. Squirreltail (*Sitanion bystrix*) is common throughout the entire watershed with bluebunch wheatgrass (*Agropyron spicatum*) and sandberg bluegrass (*Poa sandbergii*) occurring in most areas. At the higher elevations, Idaho fescue (*Festuca idahoensis*) and needle-and-thread (*Stipa comata*) are common. Cheatgrass (*Bromus tectorum*) is abundant at the lower elevations. Indian ricegrass (*Oryzopsis hymenoides*) and basin wildrye (*Elymus cinereus*) are scattered throughout the watershed. Arrowleaf balsamroot (*Balsamorhiza sagittata*) and species of lupine (*Lupinus* spp.) are some of the main forb species.

**Livestock management:** Most of the grazing on the Reynolds Creek Watershed occurs in BLM-managed allotments under various rest-rotation grazing plans. A few small tracts are privately owned. Turnout at the

lower elevation begins in April with the cattle moving to the higher elevations in late spring or early summer. Cattle are removed from the range about mid-October and winter in valley fields that are primarily privately owned.

**Research emphasis:** Rangeland watershed management.

**Rangeland hydrology data:**

Precipitation—daily, 1962-present for 19 sites.

Temperature—daily maximum-minimum, 1964-present at the Quonset Station; 1967-1983 at 2 other stations.

Pan evaporation—most data for 1974-present at 2 weather stations and 1977-present at other weather stations.

Soil water—about every 2 weeks at selected sites, 1973-present.

Soil frost—data from selected sites, 1972-present.

Radiation—data from Quonset Weather Station, about 1972-present.

Runoff—there are data depending on watershed, 1963-present.

Sediment—4 sites, 1967-present.

Water quality—23 sites, 1973-79.

**Rangeland vegetation data:**

Annual herbage production at peak standing crop by species at 9 sites, 1971-79.

Cover data—foliar, basal, rock, and litter—at peak standing crop by species at 9 sites, 1972-80.

Complete flora list of the Reynolds Creek Watershed.

Plant evaluation nurseries were established at low, medium, and high elevation sites in 1974 and 1975 and establishment and survival were monitored through 1981.

Phenological observation of key plant species at 4 sites, 1981-present.

Data sources and experimental sites for model development, testing, and validation.

**Cooperative research:**

Bureau of Land Management—Watershed management research and rangeland model application.

Soil Conservation Service—Water supply forecasting and rangeland model application.

University of Idaho—Rangeland hydrology, ecosystem, and soil frost modeling.

Utah State University—Economic component of simulation of production and utilization and rangelands (SPUR) and ground water modeling.

ARS-Beltsville—Use of remote sensed data for: SCS curve numbers for rangeland, range biomass determination, soil properties and infiltration modeling.

ARS-Tucson—Precipitation modeling.

**Research thrusts:** Development, testing, validation, and application of rangeland, hydrologic, and ecosystem models.

**University of Idaho Lee A. Sharp  
Experimental Area\***

University of Idaho Department of Range Resources  
Moscow, Idaho 83843 or  
General Delivery, Malta, Idaho 83342  
Telephone: 208-885-7305

**Location:** Twelve 80-acre pastures are in Section 8 and the west one-half of Section 9, Township 13 South, Range 28 East. The area is approximately 28 miles east of Malta, Idaho, or approximately 2 miles south of the Sublett-Malta interchange off Highway 80N. An additional 7,000 acres lying southwest and northwest of the experimental pastures also are used for extensive grazing trials.

**Facilities and accommodations:** The experimental location has a 16- by 16-foot wooden structure for cooking and sleeping, a two-room trailer for sleeping and office space, a metal shop and storage building, a water storage tank, scale house, and scales for weighing the livestock.

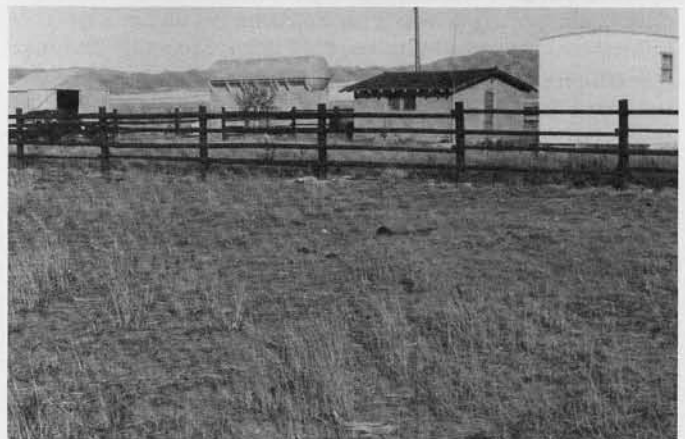


Figure 9. Top photo shows office, living and storage facilities, and water distribution system to 6 pastures in 1955, and bottom photo shows a modernized headquarters and water distribution system that accommodates 12 pastures.

\*Formerly named Point Springs Experimental Area—renamed by the Bureau of Land Management in 1984.



**Size:** Experimental pastures—960 acres; holding pasture—approximately 100 acres; and approximately 7,800 acres used in extensive grazing trials.

**Establishment:** Approximately 7,054 acres, known as the Point Springs seeding, were planted to standard crested wheatgrass (*Agropyron desertorum*) and fairway crested wheatgrass (*A. cristatum*) in fall 1952 with funds provided under the Halogeton Control Act. This land area is administered by the Burley District of the Bureau of Land Management. Part of this area (960 acres) was set aside in 1954 for experimental grazing studies. Basis of establishment and current legal ownership: The experimental area was set aside and studies initiated under a Memorandum of Understanding with the Bureau of Land Management, University of Idaho, and the Point Springs Grazing Association participating. The land, fencing, corrals, and the trailer house are the property of the Bureau of Land Management. The University purchased the water troughs, the metal shop building, the water pump, scale house, wooden sleeping quarters, installed an electrical line, and paid for part of the fencing material. The Point Springs Grazing Association owns the livestock and has invested in fence maintenance and installation of water troughs.

## Description

**Climate:** During the period of record, precipitation at the Lee A. Sharp Experimental Area has averaged about 12 inches annually. Approximately 40 percent of the precipitation comes in the 6-month period from October through March and approximately 40 percent during the April-May-June period. Annual precipitation has varied from 6-18 inches. The daily range in temperature is great during all seasons of the year because of the altitude and aridity of the climate. Winter temperatures are only mildly severe, although a low temperature of -28°F was recorded at Strevell, Idaho, in 1963. Strevell is about 20 miles south and west of the experimental area. The last date in the spring when temperatures fall to 32°F or below ranged from May 7 to June 25 at Strevell. The first freezing temperatures in late summer or fall occur between August 14 and October 16. The frost-free period averages about 93 days.

**Physical features:** The Lee A. Sharp Experimental Area is on the east side of Raft River Valley, which is bordered on the east by the Black Pine and Sublett Mountain ranges, on the south by the Raft River Range, on the west by the Malta or Cottrell Range, and by the Snake River Plains on the north. The experimental area is on the upper one-third of an alluvial fan coming from the Sublett Range at an elevation of about 4,800 feet. The general relief is gentle with a one-to-three percent slope to the west. Shallow intermittent streams pass through the area. Soils of the area are Aridisols and form a complex in which the tentatively designated Point Springs series (Solidized Solonetz) is interspersed with a tentatively designated Sublett series. Parent material of the soils is a mixture of alluvium and loess. Soil texture is

mainly silt loam. Depth to a restrictive layer varies from 12 to 19 inches. The pH values are relatively high (above 8) in these soils.

**Vegetation:** Evidence indicates that the original vegetation on the site to be that associated with the Wyoming big sagebrush/bluebunch wheatgrass (*Artemisia tridentata* ssp. *wyomingensis*/*Agropyron spicatum*) habitat type. Wyoming big sagebrush and bluebunch wheatgrass were the two most important species. Sandberg bluegrass (*Poa sandbergii*) was a common constituent and a few annual plants contributed to the spring flora. Perennial forbs such as death camas (*Zigadenus paniculatus*) and Beckwith's milkvetch (*Astragalus beckwithii*) are scattered in the area. Greasewood (*Sarcobatus vermiculatus*) and green rabbitbrush (*Chrysothamnus viscidiflorus*) occur frequently in some locations. The area supports a seeded stand of desert and crested wheatgrass.

**Livestock management:** The area is grazed by cattle in the spring and fall of the year. The livestock for grazing trials in the 80-acre pastures are provided by members of the Point Spring Grazing Association in numbers requested by University investigators. Cattle used in the extensive modified deferred rotation grazing are the animals permitted by the Bureau of Land Management under regular grazing permit. Animals move to Forest Service and BLM summer range areas about the third week of June and return in the fall of the year.

**Research emphasis:** Range and Livestock.

**Climatic data:** Precipitation data obtained using a 2-gallon gasoline can with a 10-inch funnel attached at the top. Maximum minimum air and soil thermometers record air and soil temperatures at the headquarters site. Since the station is not manned all year, precipitation and temperature records are accumulated through the winter.

**Plant data:** Forage production and utilization were obtained from 1955 to 1970 as well as species frequency of all vegetation. Numerous general and plot photos have been obtained before and after grazing in each year of the study.

**Livestock data:** Livestock weights have been obtained, both spring and fall on the 80-acre pastures since 1955. Through the years, investigations of animal-mineral relationships, salt consumption, forage-nutritive value, forage digestibility, and animal behavior have been conducted.

**Other data:** Through the years, investigations of soil compaction, water infiltration, and the economics of range improvements have also been conducted.

**Research thrusts:** Grazing management, animal nutrition, animal behavior, soil compaction, water infiltration, salt consumption, variability in forage production, economics of range improvement.

## U.S. Sheep Experiment Station USDA-Agricultural Research Service

Dubois, Idaho 83423  
Telephone: 208-374-5306

### Location:

Headquarters—6 miles north of Dubois, on I-15.  
Humphrey ranch—30 miles north of Dubois on I-15.  
Henninger ranch—35 miles northwest of Dubois on county road A2.  
O'dell Creek range—44 miles northwest of Dubois, in Montana.  
Tom's Creek range—50 miles northwest of Dubois in Montana.  
Meyers Creek allotment (U.S. Forest Service)—44 miles northwest of Dubois, adjacent to Tom's Creek.  
Miners Creek allotment (U.S. Forest Service)—18 miles north of Dubois on I-15.  
Winter Range allotment (U.S. Forest Service)—30 miles west of Dubois on Highway 22.  
Bernice allotment (Bureau of Land Management)—58 miles west of Dubois on Highway 26 near Howe.  
Mud Lake feedlot—35 miles southwest of Dubois on Highway 33.

**Facilities and accommodations:** The Henninger ranch, O'dell Creek, Tom's Creek, Meyers Creek, Miners Creek, and winter ranges are primarily range areas and have no facilities or accommodations. The other 3 locations have housing for support personnel, and the headquarters has additional accommodations for graduate students and seasonal employees. Headquarters is also the location for the administrative offices, library, and computer facilities. Working corrals are at headquarters, Humphrey and Henninger ranches and at the Mud Lake feedlot. Lambing facilities are at headquarters. The range laboratory facilities are equipped to perform some forage and soil analyses.

### Size:

Headquarters	27,832 acres
Humphrey ranch	2,600
Henninger ranch	1,200
O'dell Creek range	11,345
Tom's Creek range	4,905
Meyers Creek range	3,591
Miners Creek range	6,733
Winter range	15,000
Bernice allotment	23,327
Mud Lake feedlot	740
	<hr/> 81,346

**Establishment:** The Station was established in 1917 under direction of the Bureau of Animal Industries. The U.S. Forest Service was invited to initiate range research in 1923 and terminated research in 1973. The Agricultural Research Service reintroduced range research to the Station in 1977. The Humphrey and Henninger ranches were acquired in 1941.



Figure 10. Shed lambing facilities, U.S. Sheep Experiment Station.

## Description

**Climate:** Over a 60-year recording period, the mean annual total precipitation at the Station is 11.6 inches. The months with the highest precipitation are rainy May and June; precipitation in November through March is primarily snow. The total precipitation extremes recorded at the Station have been 5.6 and 20.6 inches. The mean annual temperature at the Station is 42.8°F with recorded temperature extremes of -28 and 102°F. The frost-free period generally extends for 75-95 days, but freezing temperatures can occur on any day of the year.

**Headquarters: Physical features**—Elevation on the Station varies from 5,300 feet at the southern end to 6,100 feet at the northern end. Soils have been classified and generally consist of calcixerolls and argiustolls. **Vegetation**—The Station species list contains nearly 300 species and major components of the vegetation are sagebrush, bunchgrass, and several forbs. The sagebrush component consists of two species, mountain big sagebrush (*Artemisia tridentata* subsp. *vaseyana*) and three-tip sagebrush (*Artemisia tripartita*). The three-tip sagebrush occupies the southern portion of the Station with lower elevations, and the mountain big sagebrush occupies the northern portion and higher elevations. The major grass species are: bluebunch wheatgrass (*Elytrigia spicata*), thickspike wheatgrass (*Elymus lanceolatus*), Sandbergs bluegrass (*Poa sandbergii*), and Nevada bluegrass (*Poa nevadensis*). The forbs of importance are: arrowleaf balsamroot (*Balsamorhiza sagittata*), tapertip hawksbeard (*Crepis acuminata*), and lambstongue groundsel (*Senecio integerrimus*). Approximately 18,000 acres of the Station burned in 1981. Another important aspect of the headquarters range is the maintenance of some very long-term exclosures and the presence of a natural area that is registered with the National Directory of Natural Areas.

**Summer Range: Physical features**—Elevation on the summer range varies from 7,000 to 9,500 feet. The soil types present are primarily cryoborolls. **Vegetation**—Plant communities consist of timber, grasslands, wet and



dry meadows, and a tall-forb type. Most of our work has been done in the tall-forb-community type where the major forbs are: sticky geranium (*Geranium viscosissimum*), cinquefoil (*Potentilla gracilis*), lambstongue groundsel, and thickstem aster (*Aster integrifolius*). The major portion of the grass components consists of showy oniongrass (*Melica spectabilis*), mountain brome-grass (*Bromus carinatus*), and thickspike wheatgrass.

**Livestock management:** The Station sheep are owned by the University of Idaho. Spring lambing ewes are wintered on the range and at the Mud Lake feedlot then moved to headquarters to lamb in March. Fall lambing ewes are kept under range and/or cultivated forages throughout the year. About July 1, spring-lambing ewes and lambs are taken to the summer ranges until weaning about September 10. Ewes are returned to winter range at headquarters and eventually back to the feedlot in Mud Lake. Fall lambing ewes begin spring grazing after breeding about May 1. These ewes are taken to the summer range and returned to cultivated forages during the lambing and nursing periods. After weaning in mid-November, ewes are maintained on winter range.

**Research emphasis:** Livestock and Range.

**Importance of site:** Long-term data records on climate, vegetation, and livestock.

**Climate data (1924 to present):**

Precipitation—Daily with standard rain gauge.

Temperature—Daily minimum-maximum.

**Plant data:**

*Headquarters (1923 to present)*

Species composition—changes after treatments of burning and herbicides.

Yield—clipped to ground level by species and weight estimates.

Species trials—testing species developed by the USDA-ARS Crop Laboratory, Logan, Utah.

Fire effects—long history of prescribed burning projects.

Herbicide evaluation—influences on yield and composition.

Grazing influences—season of grazing and systems of grazing as they affect yield, composition, and condition.

*Summer range (1935 to present)*

Range surveys—1935, 1959, 1978.

Dietary studies—1959-1964.

Grazing studies—1959-1964.

Yield—clipped to ground level by species (1977 to present).

Succession—1962 to present, measured periodically.

Herbicide effects—measuring yield, density, phenology, light interception. Small mammal and bird surveys over habitat types.

**Livestock data:** Season of use; breed development and improvement; attrition rates and reasons; seasonality of breeding; genetic improvement (selection/crossbreeding) of lamb production; disease control management.

**Predators:** Non-lethal coyote control; guard dog development.

**Research thrusts:** Alternative range sheep production systems; optimization of lamb production; improvement of range production and utilization.

# MONTANA

## Fort Keogh Livestock and Range Research Laboratory USDA-Agricultural Research Service

Route 1, Box 2021, Miles City, Montana 59301  
Telephone: 406-232-4970

**Location:** 3 miles west of Miles City, Montana.

**Facilities and accommodations:** Office with library, computer room, meeting rooms. Three houses and three mobile homes for staff and graduate students; laboratory (radioisotope); corrals, horse barn.

**Size:** 55,767 acres.

**Establishment:** In 1924, the U.S. Range Livestock Experiment Station was founded on the former site of the Fort Keogh Military Reservation. The name was changed to the Livestock and Range Research Station in March 1977 and to Fort Keogh Livestock and Range Laboratory in 1983. Legal source of establishment and current legal ownership: The approximately 55,767.44-acre tract was acquired by withdrawal from the Public Domain for the purpose of conducting livestock and range research. It is presently under jurisdiction of the Agricultural Research Service USDA. Withdrawal of the public lands for the Department of Agriculture was made by Act of Congress dated April 15, 1924, (43 Stat. 99). This Act provided that, if the lands were not used for research purposes, or having been used for such purposes are subsequently abandoned as being no longer needed, then said lands shall revert to, and become subject to the control and jurisdiction of the Department of Interior.

### Description

**Climate:** Long-term annual precipitation averages 13.2 inches with about 60 percent of this amount received in the April through August growing season. The climate can be both extreme and harsh. Drought is not uncommon. Temperatures often exceed 100°F in summer and drop to -40°F or lower during winter. Monthly extremes have varied from -65°F in 1888 to 111°F in 1901 for a total range of 176°F.

**Physical features:** About 2,000 acres of land are irrigated along the Yellowstone River Valley. The remainder of the station consists of rolling topography to broken badlands typical of range cattle producing areas of the Northern Great Plains. Elevation ranges from 2,350 to 2,800 feet and soils are variable in texture and salinity.

**Vegetation:** Vegetation is composed primarily of the grama-needlegrass-wheatgrass (*Bouteloua Stipa-*



Figure 11. Line 1 Hereford cattle on Fort Keogh Livestock and Range Research Station range. Vegetation is western wheatgrass/blue grama. Shrubs in background are silver sagebrush and/or Wyoming big sagebrush with some greasewood. Rough breaks in extreme background are characteristic of the Northern Great Plains.

*Agropyron*) phytocenoses or communities described by Kuchler in 1964. The needle-and-thread/blue grama (*Stipa comata/Bouteloua gracilis*) type occurs on medium and coarse textured soils and sandy loam soils that are solonetzic. Needle-and-thread/blue grama/western wheatgrass (*Stipa comata/Bouteloua gracilis/Agropyron smithii*) is a more productive vegetation type. It occurs on moister medium textured to more clayey type soils. The western wheatgrass type occurs on heavier clay soils. When soils are alkaline, western wheatgrass alone may dominate. It, along with blue grama and cactus, is found on clay or clay loam solonetzic soils. Silver sagebrush (*Artemisia cana*) associated with any or all of these species frequently occupies the better, deeper soils along dissected drainage ways leading to the main river or stream channels.

**Livestock management:** The breeding herd consists of 1,100 to 1,650 cows, maintained in 30 to 50 breeding herds. Replacement heifers, young bulls and steers, herd bulls, and cattle on reproduction and range nutrition experiments make up the remainder of the inventory. Livestock management is based on research needs.

**Research emphasis:** Livestock agriculture is the primary industry of the area and research has focused on use of the total resource. Both current and past research has included range management and improvement, livestock genetics, reproductive physiology, and range and animal nutrition research.

**Importance of site:** Long-term data bases on climate, vegetation, and livestock.

**Climatic data:** Measurements at the Miles City Airport, Miles City, and Fort Keogh all contribute to nearly a 100-year record for the United States Weather Bureau, NOAA: Precipitation—almost daily records. Temperatures—almost continuous daily records, maximum, minimum, and mean. Other climatic variables—irregular or intermittent. Soil moisture—intermittent variable by study at research station.

**Plant data:** Collected for a variety of studies, sites, and purposes since 1932 with a brief period of interruption in the late 1960 - early 1970 period. Plant data include 1932 to 1956 pantograph charts, reanalyzed with computer techniques in 1983. Forage yield—1932 stock rate data to present. Water spreading systems were developed and tested and other range improvement methods, such as chemical control, fire, furrowing, pitting, and fertilizing have also been investigated. These studies have measured yield, cover change, frequency, species composition, and other analytical descriptors. Studies have also been made to determine the most effective methods of increasing forage production. Early studies included adaptability studies which tested more than 100 plant species under various range conditions. Recent research emphasizes plant genetics and development research including hybrid grasses.

**Livestock data:** 2,000 to 2,500 animals. Beginning in 1930, the station pioneered in developing methods to evaluate performance in beef cattle. All beef performance testing programs now active in the United States and much of the remainder of the world can be traced to these pioneering activities. Perhaps the most important contribution of these experiments was the determination of heritability estimates for economically important traits in beef cattle. This gave knowledge of the comparative influences of heredity and environment in performance and has greatly improved selection techniques.

The first large-scale linebreeding studies in beef cattle in the United States were initiated at the station. A number of lines of purebred Hereford cattle have been developed and have been or are being tested for

production potential. These studies have resulted in the development of highly productive lines of cattle, Line 1 being the most famous. The objective of these experiments is to determine the improvement that can be made in a closed population of beef cattle starting from a superior genetic base. The oldest line (Line 1) has not had an introduction of either bulls or cows since 1934. Animals from the line are now widely used in purebred and commercial beef herds throughout the United States. Also studied are other genetic environmental interactions, selection criteria, genetic progress, and other related research. Records for some herds such as Line 1 are continuous from 1934. Depending on the studies, the data bases include genetic coefficients, fertility, animal weight gains, carcass data, and other research descriptors.

The objective of research in reproductive physiology is to increase reproductive efficiency of range cattle. Areas of work are directed toward increasing the percent calf crop to optimum levels and increasing the pounds of calf produced per cow exposed to breeding. Evaluations are directed toward determining the effects of dystocia on range beef cattle and measuring hormonal or endocrine function on reproduction and relating reproduction to animal health, range nutrition, and the range forage base. This work was initiated in 1962. It has been found that the largest single reason that cows do not wean calves is because they fail to become pregnant during the breeding season. The largest loss occurs because cows lose calves at or shortly after birth. These areas are receiving major emphasis in reproduction research studies.

Nutrition studies were initiated at LARRS in 1971 and have shown the importance of proper winter supplementation as measured by improved conception rates, calf survival, and cow and calf growth. Studies on protein, energy, vitamin A, and phosphorus supplementation have been important to producers of yearling and cow-calf producers. Data include forage digestibilities, intake, rate of passage, animal behavior, livestock performance, and condition in relation to winter grazing.

**Research thrusts:** Range management and improvement, livestock genetics, reproductive physiology, range and animal nutrition.



# NEVADA

## Gund Ranch Research Station University of Nevada, Reno

Range, Wildlife, and Forestry Department  
Beowawe, Nevada 89821  
Telephone: (702) 784-4671

**Location:** East side of Grass Valley, about 50 miles north northeast of Austin, Nevada.

**Facilities and accommodations:** Facilities for station personnel include two houses, three double and two single wide trailers, and a summer dining facility for large groups. Facilities to operate a cattle ranch are also present.

**Size:** 10,592 acres University owned plus an additional Bureau of Land Management allotment of nearly 67,000 acres.

**Establishment:** Initially established in December 1973, and expanded to its permanent size in May 1978. Legal source of establishment and current legal ownership: 2,800 acres were given to the University by George Gund and an additional 7,792 acres transferred from the Bureau of Land Management under the Recreation and Public Purpose Act.

### Description

**Climate:** The climate is characterized by cold winters and hot, dry summers. Annual precipitation on the ranch varies with location. Precipitation on the northwest playa area averages 8 to 10 inches and increases with elevation to the east, and on the allotment in the Simpson Park Range ranges from 14 to 20 inches. Yearly snowfall averages 10 to 60 inches, depending on location. Precipitation is highest in the spring. Annual pan evaporation is 48 to 50 inches per year. Mean annual temperatures range from 45 to 48°F. Mean winter temperatures are 12 to 16°F and below zero temperatures are common. Mean summer temperatures average around 88°F and occasionally exceed 100°F. The first frost is in late August or early September, and the frost-free season is generally about 90 days (averaging only 71 days the last 7 years).

**Physical features:** Elevations on the ranch average around 5,600 feet, and on the allotment range from 5,600 to more than 8,400 feet. Topography varies from level to rolling on the ranch and from level to steep mountains and canyons on the allotment.

**Vegetation:** Vegetation types found on the Ranch include salt desert shrub, primarily greasewood (*Sarcobatus vermiculatus*) communities, sagebrush-grass, and saline meadows. The allotment has sagebrush-grass, pinyon-juniper, and mountain brush communities.

**Livestock management:** The ranch is primarily a cow-calf operation with a base herd of 300 to 400



Figure 12. Gund Ranch.

cross-bred cows. The Bureau of Land Management allotments permit 4,400 AUMs of grazing from about April 15 through September 15, with the remainder of the year spent on the ranch.

### Research emphasis:

**Climatic data**—Weather records have been kept since the acquisition of the research station. A network of 12 non-recording rain gauges was established on the ranch in 1977. The ranch reports daily maximum and minimum temperatures, total precipitation, and some snowfall data published under Beowawe University of Nevada Ranch by the National Weather Service.

**Plant and soil data**—Most of the vegetation and soils on the ranch have been surveyed and mapped in support of the research efforts.

**Livestock data**—The ranch livestock operations at the Gund Ranch Research Station are in a public land setting similar to that of many central Nevada ranches. As such, the ranch offers a unique opportunity for research in extensive range livestock production.

**Remote sensing data**—Aerial photography and other remote sensing information exist for much of the area.

**Wildlife data**—Wildlife research on the Gund Ranch includes studies of big and small game, non-game species, and raptors. Wildlife surveys have involved most areas of the ranch and many areas of the allotment.

**Archeological data**—The Gund Ranch Research Station and the entire Grass Valley area are important for archeological research. The past existence of pluvial Lake Gilbert in the valley and other features have resulted in records of human habitation possibly dating back 10,000 to 12,000 years.

**Research thrusts:** Recent management changes on the ranch have dictated a period of adjustment and therefore active ongoing research efforts are minimal. Data are being gathered on ranch activities in support of an effort to test the SPUR model on this central Nevada Ranch.

# NEW MEXICO

## Jornada Experimental Range USDA-Agricultural Research Service

P. O. Box 3JER  
Las Cruces, New Mexico 88003  
Telephone: 505-646-4842

**Location:** The Jornada Experimental Range is 23 miles north of Las Cruces, New Mexico.

**Facilities and accommodations:** Office, laboratory and housing facilities for support personnel are available on the ranch and campus of New Mexico State University. No accommodations for overnight visitors are available.

**Size:** 193,394 acres.

**Establishment:** 1912. Legal source of establishment and current legal ownership: By Presidential Executive order the Jornada Range Reserve, administered by the Bureau of Plant Industry in the USDA, was established in 1912. After a transfer to the U.S. Forest Service and a name change to Jornada Experimental Range, administration was again transferred in 1954 to the current responsible agency, the Agricultural Research Service. A joint agreement for management on 40,717 acres exists with the White Sands Missile Range and the U.S. Fish and Wildlife Service.

### Description

**Climate:** Rainfall records have been kept at the Jornada Experimental Range Headquarters since 1915 and at other locations on the Range for equal or shorter time spans. The average annual precipitation is 9.05 inches with 52 percent of the annual rainfall occurring between July 1 and September 30. Droughts, or periods of low rainfall that seriously injure vegetation, are a recurrent climatic phenomenon. Severe droughts occurred in 1916-18, 1921-26, 1934, and 1951-57. The 1951-57 drought is believed to be the most severe in the past 350 years. The average maximum temperature is highest in June when it averages 97°F; the temperature is lowest in January when the average maximum is 56°F. The effective growing season, when both precipitation and temperature are favorable, is normally July through September.

**Physical features:** Elevations range from 4,200 feet on the plains to 8,500 feet in the mountains. The San Andres Mountains, formed from a west-dipping fault block, have moderate to steep slopes on the west and precipitous slopes on the east. Rocks in the mountains are derived from marine sediments deposited in Paleozoic time. Materials carried in by the ancestral Rio Grande and washed from the surrounding mountains have formed



Figure 13. The Jornada Experimental Range and the New Mexico State University Ranch are immediately adjacent to each other and are located within the semidesert grassland region of southern New Mexico.

the Jornada Plain, which occupies the level-to-gently-undulating floor of the intermountain basin. The basin is closed, with no external drainage, and water occasionally collects in the scattered low spots or playas. Coarser sediments are found near the foothills, and finer soil particles, the silts and clays, are found in the lowest areas. Both water and wind erosion processes are still active and micro relief changes are continuous. Some 22 soil types have been described on the Jornada Plain. The soils have almost no humus or organic matter, and there is little change in texture between surface soil and subsoil. The lime content is high in all of the soil types. Through time, lime from the soil and from calcareous dust has been leached downward and deposited at the depth to which rainfall normally penetrates, from a few inches to several feet. This zone of lime accumulation, or caliche layer, is often so thick and dense that neither water nor roots can penetrate it.

**Vegetation:** The Jornada Experimental Range is usually classified as semidesert grassland, which covers about 26 million acres in southeastern Arizona, southern New Mexico, western Texas, and northern Mexico. Research results are applicable to much larger areas. Although called "grassland" the region contains a complex of vegetation types ranging from pure stands of grass, through savanna types with grass interspersed by shrubs or trees, to nearly pure stands of shrubs. The mountains, plains, and drainageways provide a great variety of habitats for plants, and the flora is rich in species. On the Jornada Range, some 545 species of higher plants have been collected. On the Jornada Plain, the major grass species on sandy soils are black grama (*Boutelous eriopoda*), mesa dropseed (*Sporobolus flexuosus*), and red threeawn (*Aristida longiseta*). Shrubs or shrublike plants on sandy soils include honey mesquite (*Prosopis juliflora*), fourwing saltbush (*Atriplex canescens*),



soaptree yucca (*Yucca elata*), and broom snakeweed (*Gutierrezia sarothrae*). Extensive dunes have developed where mesquite has invaded sandy soils. Low-lying areas with heavier soils, and which receive water from surface runoff, are dominated by tobosa grass (*Hilaria mutica*) and burrograss (*Scleropogon brevifolius*). Tarbush (*Flourensia cernua*) is a frequent invader on heavy soils. The slopes with gravelly soils leading up to the mountains are dominated by creosotebush (*Larrea tridentata*).

**Livestock management:** Grazing management follows "Best Pasture System" which, as the name implies, means that if animals are moved, they go to the pasture with the best forage at that time. Under this system, cattle normally use tobosa and burrograss areas during the growing season; black grama range in winter; and mesquite sanddunes in late winter and spring, provided there is enough moisture for the growth of annuals. Flexibility in both time of grazing and number of animals is essential if arid ranges are to be maintained in good condition. Water development and salt placement are used to obtain uniform grazing within pastures. Station cattle are owned by New Mexico State University and grazed under a cooperative agreement. Purebred and crosses of Herefords, Santa Gertrudis, and Brangus, have been evaluated as breeding cows. Santa Gertrudis, Brangus and crossbred cows have consistently produced larger calves at weaning than have Herefords. The herd has an increasing proportion of Brangus cows.

**Station emphasis:** Range and livestock research.

**Importance of site:** Long-term data bases on climate, vegetation, and livestock.

**Climatic data (1914 to present):** Precipitation, temperature, wind, radiation, soil moisture.

**Plant data (1914 to present):** Utilization, yield, cover of herbaceous and brush species.

**Livestock data:** 500 head of cows and 800 head of ewes. Stocking rate by pasture. Livestock production, including conception rate and weights of mother animals, and birth date and weights of offspring.

#### **Research thrusts:**

Define the structure and function of range ecosystems, and determine the morphological, physiological, and abiotic factors that govern establishment, growth, reproduction, and persistence of range plants.

Develop range improvement practices for deteriorated rangelands by stabilizing soils, improving water management, and controlling pests to increase productivity of range ecosystems.

Develop improved grazing strategies to convert range forage to animal products consistent with conservation and multiple use of range ecosystems. Both sheep and cattle are used.

Determine the genetics of major range plants.

Determine the physiology of sheep grazing arid range.

## **New Mexico State University College Ranch**

Box 3-I, Department of Animal and Range Sciences  
New Mexico State University  
Las Cruces, New Mexico 88003  
Telephone: 505-646-1227

**Location:** 20 miles north of Las Cruces on Highway 25.

**Facilities and accommodations:** Barns, working corrals, and housing for personnel are the only permanent building structures on the ranch. Support office and laboratory facilities are on the university campus in Las Cruces. Mobile laboratories in trailers are used to support field work.

**Size:** 63,702 acres.

**Established:** 1927. Legal source of establishment and current legal ownership: An act granting acreage of the College Ranch to the State of New Mexico for use benefiting New Mexico State University, to conduct educational, demonstrative, and experimental development with livestock, grazing methods, and range forage plants, was passed into public law by the 69th Congress in 1927. Subsurface rights were retained and are managed by the Bureau of Land Management. Lands are withdrawn from mineral exploration, but not from oil, gas, or geothermal.

### **Description**

**Climate:** The Chihuahuan Desert receives an abundance of sunshine, a wide range between day and night temperatures, low relative humidity, an evaporation rate averaging 90 inches per year, and extremely variable precipitation. Average annual precipitation is 9 inches with 52 percent received between July 1 and September 30. Average maximum temperature for June is 97°F, and average maximum for January is 56°F. Average minimums for June and January are 62° and 23°F, respectively. Extremes of -20° and 109°F have been recorded. Winter precipitation is derived from frontal storms of Pacific origin and generally provide low-intensity rainfall covering wide areas. Summer precipitation is derived from air masses moving up from the Gulf of Mexico, occurring as intense, convective thunderstorms that are highly localized and of short duration.

**Physical features:** Geologically, the College Ranch has a representative cross section of basin and range topography typical of southwestern United States. Topography varies from the Rio Grande flood plains at 3,888 feet to the crest of the igneous rock extrusions of the Dona Ana Mountains at 5,776 feet. Unconsolidated aeolian and alluvial sediments to depths of 35 feet comprise the surface of the nearly level Jornada Plain. Most of the basin is closed with no exterior drainage, and water occasionally collects in scattered playas. Soils of the basin area are loamy sands and sandy loams underlain by a calcium carbonate hardpan at depths varying from a few inches to three feet or more. Deeper

sandy soils with high infiltration characteristics, low wilting percentages and high storage volume offer partial compensation for the limitation imposed by low rainfall.

**Vegetation:** Collections from the Jornada plain and surrounding mountains include 555 plant species. Major grass species on sandy soils are black grama (*Bouteloua eriopoda*), mesa dropseed (*Sporobolus flexuosus*), and red threeawn (*Artistida longiseta*). Shrubs on sandy soils include honey mesquite (*Prosopis glandulosa*), fourwing saltbush (*Atriplex canescens*), soap tree yucca (*Yucca elata*), and broom snakeweed (*Gutierrezia sarothrae*). Extensive dunes have developed where mesquite has invaded sandy soils. Mesquite control with ground and aerially applied herbicides has been conducted periodically since the mid 1950s on about one-fourth of the ranch. Playas and low-lying areas with soils higher in silt and clays are dominated by tobosa (*Hilaria mutica*) and burrograss (*Scleropogon brevifolius*). A few of the wetter playas are covered with vine mesquite (*Panicum obtusum*). Heavy soil along the Rio Grande floodplain supports stands of saltgrass (*Distichlis spicata*) and alkali sacaton (*Sporobolus airoides*). Tarbush (*Flourensia cernua*) is frequent on heavy basin soils. Creosotebush (*Larrea tridentata*) dominates on gravelly soils on gently sloping bajadas leading up to the mountains. Within the Dona Ana Mountains a wide variety of shrub types occur dominated by honey mesquite, creosotebush, sotol (*Dasylyrion wheeleri*), ocotillo (*Fouquieria splendens*), and mesquit acacia (*Acacia constricta*). Mountain grasslands are usually dominated by *Bouteloua* or *Aristida* species and are intermixed with widely scattered oneseed juniper (*Juniperus monosperma*).

**Livestock management:** Station cattle are owned by New Mexico State University. Cattle graze nearly all pastures on the ranch during the year. Grazing system research includes a separate herd of Brangus and is restricted to four pastures comprising 11 percent of the ranch.

**Station emphasis:** Teaching and research.

**Teaching importance:** The College Ranch since its initiation has served as a field laboratory for students attending New Mexico State University. The wide variety of plant and animal life is representative of that found throughout the Chihuahuan Desert. In one-half or one-day field trips, students can view different grazing management techniques, protection from grazing, seeding trials, and brush and weed control methods. Students can also observe applied ranch management techniques. Students participating in educational experiences on the College Ranch come from majors in range science, animal science, wildlife science, biology, agronomy, entomology, geology, and archeology. Because of the ranch's proximity to Las Cruces and New Mexico State University, various organizations and individuals from other countries and parts of the United States frequently include a tour of the College Ranch as part of their itinerary.

**Research importance:**

Livestock management—Livestock research is concerned with learning about the adaptability of crossbred cattle

to a desert environment. Brangus, Hereford, Charolais, and Simmental breeds are being studied in two-way, three-way and reciprocal crosses. Breeding yearling heifers to have their first calf at 2 years of age is included in the study.

Grazing management—directed towards monitoring response of plant communities and animal performance in continuous (pasture 15) and seasonal suitability grazing system (pastures 3W, 3N, 3S). Data collected annually from this project begun in 1967 include:

Precipitation—Measured after each rain event with standard rain gauges. Yield—Measured along permanent transects, clipping by species. Utilization—Estimate of end of growing season use from height-weight charts. Brush cover and density—Brush within belt transect determined in 1982. Livestock data—45- to 60-head cow herd weaning weights and weaning percentages used to measure pasture effect on cattle performance.

Brush management—Various herbicides and rates have been tested for more than 30 years. Older treatments are periodically reevaluated to determine longevity of original treatment.

Seeding—Trials to establish more palatable forages have been attempted since the 1930s. Long-term seedling establishment has not been successful.

Wildlife Science—Various short-term studies on rodents, rabbits, small birds, and pronghorn antelope are conducted.

Biology—In 1982, the College Ranch was selected as a study site in the National Science Foundation Long-Term Ecological Research Program. Purpose is to determine long-term changes in plant communities, animal populations, microorganism populations, soil water, microclimate, and macroclimate.

Other research—More than 20 enclosures established on the ranch since its initiation provide base line information for comparison with various ranch management and research practices. Two long-term, USDA-sponsored, antidesertification programs monitoring livestock diets and creosotebush control areas were conducted.

**Research thrusts:** Animal breeding, animal nutrition, grazing management, range plant ecophysiology, brush management, ecological studies, wildlife science.

## **New Mexico State University Fort Stanton Experimental Ranch**

Box 3-I, Department of Animal and Range Sciences  
New Mexico State University  
Las Cruces, New Mexico 88003  
Telephone: 505-646-1227

**Location:** Four miles east of Capitan, New Mexico, on Highway 380.

**Facilities and accommodations:** Housing for support personnel and graduate students was built in 1978. Facility is often used to house agency training sessions and includes laboratory, drying room, office, and





Figure 14. Pinyon-juniper and blue grama grasslands are the common vegetation types on the Fort Stanton Experimental Range in central New Mexico.

kitchen space. Working corrals, chutes, scales, wind-mills, etc., are available at three locations.

**Size:** 26,381 acres.

**Establishment:** 1963. Legal source of establishment and current legal ownership: Fort Stanton was established as a military fort in 1855 and later was a federal sanatorium for tuberculosis patients. When the hospital area became a state sanatorium in 1952, the remaining 26,000 acres were placed under jurisdiction of the General Services Administration, with the Bureau of Land Management having custodial care. In 1963, the BLM signed an agreement with New Mexico State University for use of the area. This was a yearly agreement until 1970, when a 20-year lease was signed.

## Description

**Climate:** Average annual precipitation recorded at the hospital headquarters is just over 15 inches. More than 60 percent of the total precipitation falls during June, July, August, and September, when most of the vegetational growth occurs. The spring season is usually dry, with unfavorable conditions for cool-season grasses. Temperatures are fairly mild, with a mean annual temperature of 52°F. January is the coldest month with a mean minimum temperature of 20°F; July is the warmest, with a mean maximum of 84°F. Spring months are often windy, but the rest of the year is comparatively calm.

**Physical features:** The area is underlain by the San Andres Formation, which is composed of limestone and dolomite of Permian age. The San Andres Formation is exposed on the east side of the ranch. A strip through the center of the ranch is composed of undifferentiated rock of dolomite, sandstone, siltstone, and shale of the Guadalupe age. On the northwest portion, the San Andres Formation is overlaid by undifferentiated Triassic rocks of sandstone and shale. The topography is characterized by fairly level mesas dissected by steep canyons. Soils are characterized by clay loam surface

textures. Relatively deep soils support grassland vegetation, although often there is a restrictive caliche layer about 25 inches under the surface. Pinyon-juniper vegetation grows on shallow, rocky soils.

**Vegetation:** Open grassland vegetation occurring on mesa tops includes blue grama (*Bouteloua gracilis*), sideoats grama (*Bouteloua curtipendula*), wolftail (*Lycurus phleoides*), sand dropseed (*Sporobolus cryptandrus*), ring muhly (*Muhlenbergia torreyi*), and carruth sagewort (*Artemisia carruthii*). Important species growing on shallow rocky soils include blue grama, sideoats grama, hairy grama (*Bouteloua hirsuta*), and threeawns (*Aristida* spp.). Pinyon pine (*Pinus edulis*), one-seed juniper (*Juniperus monosperma*), and alligator juniper (*Juniperus deppeana*) dominate on hillsides with an understory of skunkbrush (*Rhus trilobata*), wavyleaf oak (*Quercus undulata*), blue grama, New Mexico muhly (*Muhlenbergia pauciflora*), and New Mexico feathergrass (*Stipa neomexicana*).

**Wildlife:** Mule deer (*Odocoileus hemionus*) and pronghorn antelope (*Antilocapra americana*) are the two most important game species found at the Fort Stanton ranch. Other game species found in either lesser abundance or only occasionally include mourning dove (*Zenaidura macroura*), Montezuma quail (*Cyrtonyx montezumae*), Merriam's turkey (*Meleagris gallopavo*), and black bear (*Ursus americana*). Mallards (*Anas platyrhynchos*), are often present during periods of waterfowl migrations. Major carnivores include coyotes (*Canis latrans*), bobcats (*Felis rufus*), badgers (*Toxidea taxus*), skunks (*Mephitis mephitis*), and gray foxes (*Urocyon cinereo argenteus*). Many species of small mammals and songbirds indigenous to the pinyon-juniper type can be found throughout the area.

**Livestock management:** The cow herd is chiefly composed of grade Herefords which originated either from the New Mexico State University herd at the College Ranch near Las Cruces or from heifer calves purchased from the Bell Ranch in eastern San Miguel County. A small number of Brangus cows, also purchased from two New Mexico ranches, make up the balance of the herd at Fort Stanton. Cows are bred in early summer and calve in late winter and spring. All calves are tagged shortly after birth, branded (for ownership) when about 2 months old, and weaned in the fall, when they are about 7 months old. All calves are routinely vaccinated for blackleg, malignant edema, and hemorrhagic septicemia at branding time. Bull calves are also castrated at this time. All cattle are weighed at weaning, and most are also weighed at periodic intervals during the entire year. Supplemental feeding is generally carried out from about a month before calving until new grass is available. Phosphorus supplement and salt are provided on a year-around basis. All cows are pregnancy-tested at weaning time each fall. Results of this test, along with other production criteria, are used in culling the herd each year. The bulls used are fertility-tested before the breeding season each year.

**Station emphasis:** Research with beef cattle, range science, and wildlife science.



**Importance of site:** The research program at Fort Stanton is designed to provide useful information for range livestock producers and land management agencies. New Mexico contains almost 78 million acres, with 90 percent grazed by domestic livestock and wildlife. There are more than 1,600,000 cattle and 700,000 sheep in the state. The livestock industry accounts for more than 75 percent of New Mexico's agricultural income. Research work at Fort Stanton complements that carried out under desert range conditions at the College Ranch in the southern part of the state. Research results from Fort Stanton are widely applicable to central and northern portions of New Mexico.

**Research with beef cattle:** Supplemental feeding research at Fort Stanton deals with various classes and ages of cattle and with various types of feed. The basic aim behind these studies is to improve reproductive performance and to increase calf weaning weights. Management research at Fort Stanton has been concerned with age at first calving (two years old versus three years old) and early (January-February) versus late (March-April) calving. Detailed analysis of intake, digestibility, and passage rate with cattle are being conducted as influenced by management practices such as fertilization, grazing systems, etc. Research in range science: Range research includes practical studies on grazing systems, range fertilization, control of undesirable species, and basic studies on ecology and

physiology of major species. Dietary patterns of cattle have been made using esophageal fistulae and indirect methods. Grazing system research providing annual yield and utilization data is taken from four pasture rotation, continuous and short duration, grazing pastures.

**Research in wildlife science:** Game population trends are determined annually by recording live history characteristics of mule deer and pronghorn herds including numbers, sex and age ratios, natality and mortality.

**Educational functions:** Although the overall objective of the Fort Stanton Experimental Ranch is to study methods for improving production of livestock and game along with other multiple-use objectives, the ranch also has an important educational role. Training young scientists for advanced degrees is of major importance. Field trips provide an outdoor laboratory for undergraduate classes. At other times, the Fort Stanton ranch has been used for youth camps and 4-H training sessions. Research results are also of interest to livestock producers and land managers. Consequently, tours for interested ranchers, members of the Society for Range Management, livestock groups, breed associations, county agents, federal agency personnel, foreign visitors, etc., are often held.

**Research thrusts:** Range plant ecophysiology, range improvements, grazing management, animal nutrition, animal reproduction, game animal population trends.

# OREGON

**Squaw Butte Experiment Station**  
**USDA-Agricultural Research Service**  
**and**  
**Section 5**  
**Eastern Oregon**  
**Agricultural Experiment Station**

Star Rt. 1 - 4.51 Highway 205  
Burns, Oregon 97720  
Telephone: 503-573-2064

**Location:** Squaw Butte, range unit—42 miles west of Burns on Highway 20; Eastern Oregon Agricultural Research Center, Section 5, native meadow unit—4.5 miles south of Burns on Highway 205.

**Facilities and accommodations:** Both locations have housing for support personnel and graduate students. An office building, including a library and computer room and a laboratory equipped for forage and soil analysis are located at Section 5. Working corrals are at each location.

**Size:** Squaw Butte—16,000 acres. Section 5—660 acres.

**Establishment:** Squaw Butte—established in 1934 by the Taylor Grazing Service. Buildings, fences, and facilities were constructed by the Civilian Conservation Corps during 1936, 1937, and 1938. Section 5—acquired by the Oregon Agricultural Experiment Station in 1941. Legal source of establishment and current legal ownership: Squaw Butte—14,171 acres Federally owned withdrawn from public domain for research purposes, 1,289 acres leased from Harney County, Oregon, by Oregon State University Agricultural Experiment Station, and 640 acres are leased from the State of Oregon by USDA-Agricultural Research Service. Section 5—660 acres purchased by state.

## Description

**Climate:** The high desert receives about 12 inches of precipitation annually. Approximately 60 percent of the total precipitation is received during the fall and winter months, often as snow. Almost 25 percent falls as rain during May and June. Summer months (July, August, and September) are dry. Annual precipitation extremes have been 6 and 17 inches over a 34-year recording period. Recorded mean monthly temperature extremes recorded have been -24° and 104°F with frost free-periods of 60-140 days. The native meadows at Section 5 usually receive an abundance of water in the spring from snow which has accumulated at higher elevations. Water is directed across the meadows with a wild-flooding system of irrigation for 8-12 weeks. With termination of overflow and lowering of the water table, soils gradually



Figure 15. Squaw Butte in the background, crested wheatgrass planting on right, sagebrush on left in foreground.



Figure 16. Cattle are wintered at the Section 5 unit of the station.

dry until little or no available moisture remains in the soil by late July.

### Squaw Butte:

**Physical features**—(Taken from R.D. Lentz and G.H. Simonson, 1986. A detailed soils inventory and associated vegetation of Squaw Butte Range Experiment Station. Oregon Agricultural Experiment Station Special Report 760). The experimental range is located in the High Lava Plains physiographic province of Oregon. Local physiography is dominated by a sequence of several gently to moderately sloping lava plateau steps which ascend from a basalt plain at 4,500 feet in the

south portion to a dissected olivine andesite plateau and to a fault riddled and deeply dissected rhyolite and phylodacite plateau remnant at 5,200-foot elevation. Soils of plateau uplands formed in cobbly residual or colluvial material feature strongly developed argillic horizons, and commonly are shallow to bedrock or duripan. Dominant soil subgroups on low elevation lava plains include shallow Xerollic Durargids and Lithic Xerollic Haplargids. Soils on uplands at mid- and higher elevations include Lithic Argixerolls and Aridic Argixerolls. The namesake, Squaw Butte, is an early Pleistocene volcanic cone composed of basalt and andesite scoria, cinders and agglomerate. The summit rises to 5,500 feet, the highest point on the station.

**Vegetation**—This unit is in the Intermountain sagebrush and sagebrush-wheatgrass ecoregions; sagebrush ecosystem; and Kuchler's sagebrush steppe. Major shrubs include three big sagebrush subspecies (*Artemisia tridentata* subsp. *tridentata*, *vaseyana*, and *wyomingensis*), low sagebrush (*Artemisia arbuscula*), and rabbitbrush species (*Chrysothamnus nauseosus* subsp. *albicaulis* and *C. viscidiflorus* subsp. *viscidiflorus*). Western Juniper (*Juniperus occidentalis*) is an important component of the vegetation on escarpments, rocky crests and stringers, and steep north hillslopes at higher elevations. Major grasses include bluebunch wheatgrass (*Agropyron spicatum*), Idaho fescue (*Festuca idahoensis*), Sandberg bluegrass (*Poa sandbergii*), bottle brush squirreltail (*Sitanion hystrix*), and Thurber's needlegrass (*Stipa thurberiana*). Major forbs include Phlox (*Pblox boodii*), buckwheat (*Eriogonun* sp.), hawkbeard (*Crepis occidentalis*), and Lupine (*Lupinus caudatus*). About 1,000 acres have been plowed and seeded with crested wheatgrass (*Agropyron desertorum*), and 6,000 acres have been sprayed with 2,4-D.

### Section 5:

**Physical Features**—Native meadows are level and are at 4,100 feet elevation. Soils, generally unclassified, are mainly Fluventic and Cumulic Haplaquolls. Profiles have low chromas, mottling, and dark surface horizons high in organic matter. Texture is silt loam and reaction basic with pH 7.5 to 8.5.

**Vegetation**—Meadows are dominated by rushes and sedges with minor amounts of grasses and forbs. Principal species include baltic rush (*Juncus balticus*), rusty sedge (*Carex subjunca*), Nevada bluegrass (*Poa nevadensis*), meadow barley (*Hordeum brachyantherum*), beardless wildrye (*Elymus triticoides*), meadow foxtail (*Alopecurus pratensis*), and white-tip clover (*Trifolium variegatum*).

**Livestock management:** Station cattle are owned by the State of Oregon. Cattle are generally transferred from the meadows to the range unit in March, graze on rangeland and seeded pastures from March through October, and then are transferred back to meadows to

graze regrowth and rakebunched hay or be fed hay until spring.

**Research emphasis:** Range and livestock.

**Importance of site:** Provides long-term data bases on climate, vegetation, and livestock.

**Climatic data (1934 to present)—Range unit:** Precipitation—Daily with standard gauge. Temperature—Daily minimum and maximum. Wind—Totalizing anemometer at 4 feet height. Radiation—Total and direct, 1979 to present at Section 5. Soil moisture—Once annually in spring from 1965 to present, depths—0-10 and 10-20 inches, on sagebrush-bunchgrass range.

### Plant data:

Collected for a variety of sites and studies since 1930s. Long-term plant studies include the following: Sagebrush-bunchgrass type monitored from 1950 to present.

Species composition—*Artemisia tridentata* subsp. *vaseyana*; *Festuca idahoensis*; *Agropyron spicatum*, *Koeleria cristata*; *Sitanion hystrix*; *Stipa thurberiana*. Oven-dry yields were measured by clipping plants to ground level.

Cover—Brush canopy cover determined by line intercept was monitored from 1967 to present.

Seasonal nutritive quality—No or only as reflected by animal gains (1952-1975).

Brush density was determined 1967 to present.

Plots of crested wheatgrass located in the nursery area at the range unit were monitored from 1950 to 1984.

Oven-dried yields were measured by clipping to ground level during boot and maturity stages.

Seven exclosures were established in major pastures at Squaw Butte in 1936-37; base inventories using density and frequency measurements were conducted in 1930s; reinventoried in 1960 and 1974 when density was determined in the field and frequency was determined from density measurements.

### Livestock data:

A 300-head cow herd has been utilized in many studies from which long term-data bases exist on the following characteristics: Daily gains, fertility, meat/area, 1937 to present. Suckling calves and cows weighed at weaning, 1937 to present. Most animals weighed monthly, 1950 to present. Fertility, disease, and production of a closed herd, 1937 to 1970. Attrition rates and reasons, 1937 to present. Fall versus spring calving, 1967 to 1980. Fall versus spring calving, 1967 to 1980. Stocking rates, early 1940s to present. Season of use, early 1940s to present.

**Predators, insects, wildlife data:** Initial base inventories were established in late 1930s.

**Research thrusts:** Range plant ecophysiology, range improvements, grazing management, animal behavior, animal nutrition.



## Eastern Oregon Agricultural Research Center Union Station

PO Box E, Union, Oregon 97883

Telephone: 503-562-5129

**Location:** Base property—Union, Oregon. Hall Ranch—12 miles southeast of Union, Oregon on State Highway 203.

**Facilities and accommodations:** Office and laboratory facilities; barns, buildings, and equipment necessary to run an agricultural experiment station. Laboratory equipped to run basic nutritional analyses and micro-histological analysis. Areas are available for field trip camping and limited housing is available for graduate students.

**Size:** Base property—600 acres (farm ground). Hall Ranch—2,000 acres (forested land).

**Establishment:** Base property—1901. Hall Ranch—1939. Legal source of establishment and current ownership: Oregon State University, Corvallis.

### Description

**Climate:** *Base property*—Annual precipitation averages 14 inches. Snowfall is possible from November through April, and averages 26 inches annually. Mean temperatures range from 24°F (January) to 84°F (July), but temperatures below 0°F or exceeding 100°F are possible. *Hall ranch*—Fall and spring are cool and moist, while summers are hot and dry. Precipitation averages 26 inches. Snow is common and may be continuous in winter months. Accumulations in excess of 28 inches are possible. Temperatures range from 0°F (January) to 100° (July).

**Physical features:** Elevation of the base property is 2,769 feet. Elevations of the Hall Ranch range from 3,937 to 5,905 feet. Soils originate from two dominant parent materials: (1) silt-sized volcanic ash originating from Mount Mazama eruptions; and (2) basalt. Four soil series are found on the Hall Ranch, the Tolo, Klicker, Hall Ranch, and Chop silt loams. Pumicite is found in varying amounts in all soils.

**Vegetation:** The station base property is farm ground comprised of cropland for alfalfa and grain production. Additionally, non-tillable acres are seeded to pasture grasses, primarily tall fescue (*Festuca arundinacea*). The Hall Ranch is primarily forest land suitable for livestock grazing. Vegetation groups on the Hall Ranch are grand fir (*Abies grandis*) forest on the north slopes, mixed conifer forest, wet meadow, and riparian. Dominant plant species are grand fir, Douglas-fir (*Pseudotsuga menziesii*), ponderosa pine (*Pinus ponderosa*), ninebark (*Physocarpus malvaceus*), ocean spray (*Holodiscus discolor*), snowberry (*Symphoricarpos albus*), pine grass (*Calamagrostis rubescens*), elk sedge (*Carex geyeri*), and Kentucky bluegrass (*Poa pratensis*). Portions of the Hall



Figure 17. Mixed coniferous forest and Catherine Creek drainage on the Hall Ranch, with clearcut in foreground.

Ranch have been clearcut and seeded to orchardgrass (*Dactylis glomerata*), timothy (*Phleum pratense*), blue wildrye (*Elymus glaucus*), smooth brome (*Bromus inermis*), and white dutch clover (*Trifolium repens*).

**Livestock management:** Cattle are owned by Oregon State University. The cattle herd has 200 cows, 20-50 replacement heifers, and 80 steers kept to long yearlings. Cattle are maintained on the base property from mid-October to mid-June. Hay is fed from December 15 to May 15. Cattle are grazed on the Hall ranch the remainder of the year.

**Research emphasis:** Range, wildlife, timber, and livestock and interactions.

**Importance of site:** Long-term data base on climate, vegetation, timber, and livestock.

#### Climatic data:

Union—1901 to present

Temperature—daily maximum, minimum

Precipitation—daily (24-hour totals), 1973 to present.

Growing season evaporation.

Precipitation—continuous recording.

Wind—totalizing anemometer by direction on 60-foot tower.

Relative humidity and temperature—hygrothermograph.

Soil temperature—24-hour maximum, minimum at 12-inch depth.

Hall Ranch—1956 to present.

Monthly maximum and minimum temperature and precipitation.

**Plant data:** *Base property*—Historic data (before 1970) on crop varieties and yields. *Hall Ranch*—1) Two exclosures were established on the Hall Ranch in 1958 in Ponderosa Pine/ninebark and grand fir/myrtle pachistime habitat types. Measurements taken every 10 years both

inside and outside the exclosures are frequency and production of the herbaceous vegetation, frequency, and canopy cover of the shrubs and canopy cover of the trees. 2) Three exclosures were established the year after logging on the 1963 clearcut. Forage production, frequency of both herbaceous plants and shrubs, and tree height and diameter have been measured since 1964. 3) Four exclosures were established in 1972 in three different habitat types on a 1969 clearcut. Herbaceous biomass and frequency, and shrub canopy cover and density have been measured at 10-year intervals both inside and outside the exclosures. The above exclosures help describe successional trends in vegetation exposed to logging and grazing by large ungulates. 4) A long-term study initiated in 1978 is evaluating frequency, canopy cover, and production of several communities within a riparian zone. 5) Data are also being collected to evaluate the influence of grazing treatments on vegetation composition, small birds, and mammals.

**Livestock data:** Daily gain, fertility on sheep and cattle 1901-1981; cattle from 1981-present. Seasons of use, stocking rates, 1956-present.

**Research thrusts:** Range plant ecophysiology, plant understory and overstory relationships, range animal nutrition, livestock management, timber harvest procedures, grazing management, wildlife, livestock relations, ungulate food habits.

## Department of Animal Science Oregon State University\*

Corvallis, Oregon 97331  
Telephone: 503-754-3431

**Location:** Benton County, Oregon.

**Size:** Approximately 4,000 acres, in various parcels—  
Central farm area (340 acres), bounded by 35th,  
Harrison, 53rd Streets and the Southern Pacific Railway,  
Corvallis, Oregon

South farm (40 acres), irrigated pasture, south of main  
campus, off Brook Lane, Corvallis, Oregon

Hill pasture/Wilson farm (770 acres), west of Corvallis,  
stretching from Walnut Drive to Oak Creek Road

Soap Creek Ranch (1,880 acres), approximately 10 miles  
north of Corvallis, on Sulphur Springs Road in Camp  
Adair area

Berry Creek Ranch (850 acres), approximately 12 miles  
northwest of Corvallis, on Tampico Road in Camp Adair  
area

Total—approximately 3,880 acres.

**Facilities and accommodations:** Each location has  
barns and livestock working facilities. The main sheep

\*Supports research efforts of both the Department of Animal Science and the Department of Rangeland Resources at Oregon State University.



Figure 18. Hill pastures are maintained in a mixture of seeded grasses and legumes to facilitate studies of intensive grazing management practices.

and beef barns and a feed mill are adjacent to campus in the central farm area. Computer and laboratory facilities are in Withycombe Hall on the west edge of campus. Laboratory capabilities include common forage analyses, as well as gas chromatography and atomic absorption analysis.

**Establishment:** Variable. The central units were established before the turn of the century and represent some of the original land grant to what was then Oregon Agricultural College. The Soap and Berry Creek ranches were obtained from the federal government after World War II. The Hill pasture and Wilson farm units were added in the 1940s and 1950s through private purchase. Legal source of establishment and current legal ownership: Oregon State System of Higher Education, Oregon Agricultural Experiment Station. Mineral rights: Public ownership.

## Description

**Climate:** Weather data have been collected near Corvallis, Oregon, since 1889. The climate is maritime with cool, rainy winters and warm, dry summers. Average annual precipitation is 42 inches; approximately 80 percent falls as rain during October through March each year. Temperatures are relatively mild with average daily maximum/minimum temperatures ranging between 45/33 °F in January and 81/51 °F in July. Incoming solar radiation typically ranges from a low of 70 langley per day in December to a high of 540 langley per day in July. Potential open surface evaporation rates during the summer average approximately 0.2 inches of water per day. Average annual frost-free period is 189 days. It has historically ranged between 152 and 236 days during the 1949-1983 period.

**Physical features:** The land units managed by the Department of Animal Science predominately lie on gently rolling foothills which form the eastern edge of

the Coast Range. Elevation is less than 800 feet above sea level. Slope ranges from 0 to 50 percent, with most acreage having less than 20 percent slope. Soils are mainly mollisols on well-drained areas with some vertisols on low-lying areas.

**Vegetation:** Vegetation is primarily oak-conifer forest on unimproved hillsides and grass-clover improved pastures. Principal plant species on unimproved areas: white oak (*Quercus garryana*), Douglas-fir (*Pseudotsuga menziesii*), poison oak (*Rhus diversiloba*), sweetbriar (*Rosa eglantheria*), dogtail (*Cynosurus echinatus*), and blue wildrye (*Elymus glaucus*). Improved pastures are dominated by bentgrass (*Agrostis* spp.), tall fescue (*Festuca arundinacea*), perennial ryegrass (*Lolium perenne*), subclover (*Trifolium subterraneum*), and white clover (*Trifolium repens*).

**Livestock management:** Beef cattle, dairy cattle, and sheep are owned by the State of Oregon. Animals are moved short distances from pasture to pasture during the year, with dairy cattle and some meat animals spending the summer on irrigated pasture. Most livestock graze non-irrigated, improved pastures year-round.

**Research emphasis:** Pasture and livestock production and management.

**Importance of site:** Extensive climatic data base including measurements of maximum/minimum air temperature, precipitation, evaporation, 6-inch soil temperature, wind, relative humidity, total incoming solar and photosynthetically active radiation. Long-term data base of animal production, including fecundity, animal liveweight changes, health requirements, and milk production (dairy cattle only).

**Research thrusts:** Animal breeding, animal nutrition, pasture improvement and management, plant ecology, grazing management.

## **Starkey Experimental Forest and Range USDA Forest Service Pacific Northwest Forest and Range Experiment Station**

Route 2, Box 2315, La Grande, Oregon 97850  
Telephone: (503) 963-7122

**Location:** Headquarters are 30 miles southwest of La Grande on Highway 244. However, it is managed out of the Range and Wildlife Habitat Laboratory in La Grande.

**Facilities and accommodations:** Headquarters are only accessible about 8 months each year. Housing is available for staff personnel, temporary employees, and graduate students. When employees are not in residence, the facilities are available for touring groups.

**Size:** 27,517 acres.

**Establishment:** 1940. Legal source of establishment and ownership—USDA Forest Service.

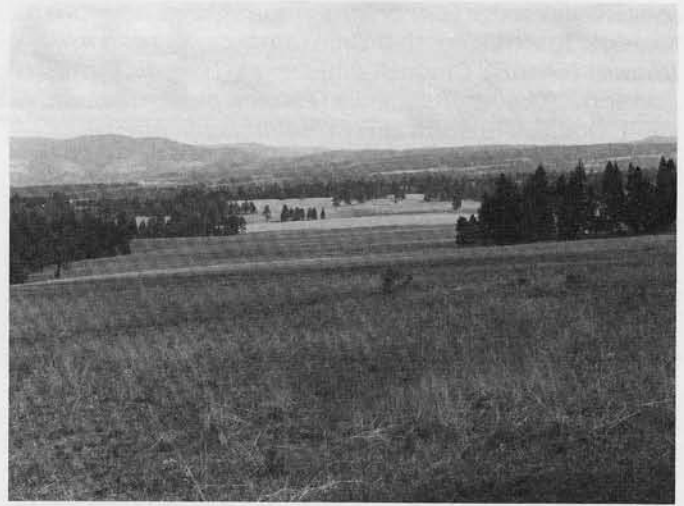


Figure 19. An overview of the Starkey Experimental Forest and Range which typifies the grassland-forest types throughout the Blue Mountains of Oregon. Photo by Scott Feltis, U.S. Forest Service.

## **Description**

**Climate:** The climate is continental with cold winters and warm summers. The average temperature for July is 64.4°F and for January is 24.8°F. Annual precipitation averages 20 inches. Winter snowfall accounts for 66 percent of the total precipitation, and spring and fall rains contribute the remainder. The growing season is about 120 days, but frost may occur in any month.

**Physical features:** The Experimental Forest and Range lies within the Blue Mountains of northeastern Oregon and southeastern Washington. Topography consists of moderate deep canyon drainages separating broad rolling uplands. Elevations range from 3,508 to 4,951 feet. Soils are mainly silt loams derived from basic basalt, pumicite, and basaltic alluvium and lacustrine materials. Depths range from 4 inches in basalt soils of grassland ridges to more than 4 feet in pumicite soils under forests on north slopes.

**Vegetation:** The Experimental Forest and Range is a mosaic of habitat types, characterized by ponderosa pine (*Pinus ponderosa*), Douglas-fir (*Pseudotsuga menziesii*) forest intermingled with bunch grass openings. Major upland habitat types include the following: Grand fir/Pachistima (*Abies grandis*/*Pachistima myrsinites*), Douglas-fir/snowberry (*Pseudotsuga menziesii*/*Symphoricarpos albus*), Douglas-fir/mallow ninebark (*Pseudotsuga menziesii*/*Physocarpus malvaceus*), Ponderosa pine/snowberry (*Pinus ponderosa*/*Symphoricarpos albus*), Ponderosa pine/Idaho fescue (*Pinus ponderosa*/*Festuca idahoensis*), Ponderosa pine/bluebunch wheatgrass (*Pinus ponderosa*/*Agropyron spicatum*), Idaho fescue/buckwheat (*Festuca idahoensis*/*Eriogonum heracleoides*), Bluebunch wheatgrass/Sandberg bluegrass (*Agropyron spicatum*/*Poa sandbergii*), Stiff sagebrush/Sandberg bluegrass (*Artemisia rigida*/*Poa sandbergii*), Sandberg bluegrass/onespike danthonia (*Poa sandbergii*/*Danthonia unispicata*). Major riparian plant communities include the following: Woolly



sedge/water sedge (*Carex lanuginosa/Carex aquatilis*), Meadow foxtail/smooth brome (*Alopecurus pratensis/Bromus inermis*), Cinquefoil/bluegrass (*Potentilla gracilis/Poa* spp.), Timothy/bluegrass (*Phleum pratense/Poa* spp.), Douglas-fir/snowberry (*Pseudotsuga menziesii/Symphoricarpos albus*).

**Livestock management:** The area is also a standard Forest Service cattle allotment that is grazed from mid-June to mid-October by 800 animal units that are provided by five permittees. Depending on research projects, different systems of grazing are employed. However, the major herd is being managed in a modified four pasture, rest rotation grazing system.

**Research emphasis:** Range, livestock, fish, wildlife, and silviculture research programs.

**Importance of the site:** The Experimental Forest and Range is managed to create the best possible conditions for planning and conducting a research program.

**Climatic data:** Incomplete but what has been collected is available. Usually these data are only collected on specific research locations. However, starting in November 1983, the U.S. Geological Survey started monitoring an acid rain station located at headquarters. This program is expected to continue through 1988.

**Plant data:** Fairly complete in publication form and available upon request. A handbook on the flora of Starkey is being updated.

**Livestock data:** Stocking is approximately 8 acres/AUM. Gains and responses, recorded as part of specific studies, are available upon request.

**Predators data:** Bobcat (*Felis rufus*), black bear (*Ursus americanus*), and coyote (*Canis latrans*).

**Hydrology data:** Data are incomplete and minimal. However, some information from specific studies are available.

**Soils data:** Several soil surveys have been conducted throughout the years; data are now being compiled and condensed into a soil survey report.

**Data storage:** Most of the information is stored at the Range and Wildlife Habitat Laboratory in La Grande, Oregon. Most of the information can be obtained by contacting the project leader.

**Research thrusts:** Riparian, livestock and fish interactions; animal behavior; cavity nesting birds and mammals; livestock production; grazing system studies; cattle, deer, and elk interaction studies; forest and grassland ecology; entomological studies; silviculture treatments.

# UTAH

## Brigham Young University Sam and Aline Skaggs Research Ranch Malta, Idaho 83342

c/o BYU Agriculture Station  
301 WIDB, BYU  
Provo, Utah 84602

**Location:** 8 miles north of Malta, Idaho, on Highway 81, in T11S R26E of Boise Meridian in Cassia County.

**Facilities:** Located at the ranch headquarters are 1 home occupied by the ranch foreman and his family, 3 trailer houses (1 for office and mess facilities and 2 for dormitories), water, electrical, and septic facilities for the area, and a temporary livestock maternity barn and associated corrals. Other improvements include 3 warm-water wells, 7 center-pivot sprinkler irrigation systems, partial boundary fencing, and a drift fence between croplands and the major block of rangeland, a few older cold-water springs and wells, and 1 small corral facility. An all-weather road, 2 ¼ miles, connects headquarters and Highway 81. Additional facilities are projected as funds become available.

**Size:** The ranch includes 7,129 acres of land divided by ownership and land uses as follows:

By ownership	By land use
Deeded—5,480 acres	Native range—3,955 acres
BLM—1,009 acres	Crested wheatgrass—1,675 acres
State—640 acres	Irrigated cropland (center pivots) —882 acres
	Irrigated cropland (other) —252 acres
	Dryland cropland—365 acres

An additional 320 acres have been made available for research purposes by the J.R. Simplot Co.

**Establishment:** January 1, 1985, by gift from Sam and Aline Skaggs of Salt Lake City, Utah, to Brigham Young University. Administration of the ranch is under the Brigham Young University Agriculture Station, College of Biology & Agriculture. The operations committee consists of the station director, a chairman, representatives of animal science, agricultural economics, agronomy, and range sciences at Brigham Young University, and a representative from the U.S. Forest Service Shrub Sciences Laboratory, Provo.

### Description

**Climate:** Average annual precipitation varies from an estimated 9 inches on the east side, the croplands area, to 13 inches on the west rim. Limited information, pertaining to the lower croplands area, indicates an

average frost-free period of about 120 days, 1-in-10-year killing frost as late as June 10 and as early as September 3, and average winter snowfall of about 18 inches.

**Physical features:** The elevation at the research ranch ranges from 4,400 feet at the valley floor on the east side to 6,000 feet on the west side or east rim of the Cotterel Mountain. Soils in the cropland area are mostly silt loams and silty clay loams with a pH of 7.0 to 7.5; high salinity problems are minimal. Gravelly silt loams predominate on the lower benches and base of the foothills, and small amounts occur in the cropland area. Soils in the foothill area of the ranch, with mostly native range, are complexes of silt loams, gravelly silt loams, cobbly silt loams, and exposed bedrock. Range sites over the ranch are principally semidesert loam and upland loam with gravelly, stony, and shallow soil modifications on steep slopes and ridges.

**Vegetation:** The principal original vegetation on the ranch was bunchgrasses and varieties of big sagebrush; much of the benchlands and lower slopes have been seeded to crested wheatgrass (*Agropyron cristatum*). A scattering of greasewood (*Sarcobatus vermiculatus*) was originally present along the east boundaries, and minimal amounts of mountain shrubs including skunkbush (*Rhus trilobata*), serviceberry (*Amelanchier alnifolia*), and chokecherry (*Prunus virginiana*) are found on the steep slopes and ridges under the west rim. Utah juniper (*Juniperus osteosperma*) is limited to a few steep south slopes in the foothills.

**Research emphasis:** Develop integrated systems of beef cattle ranching emphasizing high yields, high efficiency, profitability, and the maximum use of native range, dryland and irrigated pasture, and home-grown feedstuffs. In addition to emphasizing research in beef cattle, range, pasture, crops, soils, and water management, programs are directed toward teaching activities for undergraduate students, graduate students, and ranch-farm producers.

**Research thrusts:** In line with the central objective of developing integrated beef cattle ranching systems, the following areas are being emphasized, in addition to economic analyses and practical application. *Range and pasture*—Establishing and managing forage shrubs in crested wheatgrass seedings (cooperatively with the U.S. Forest Service), seasonal grazing of shrub-grasslands, utilizing grass and grass-legume mixtures for spring breeding pastures, evaluating new range plant cultivars on selected range sites, evaluating systems for grazing native sagebrush-grass range including winter grazing versus drylot, and evaluating systems for grazing irrigated pastures. *Beef cattle*—Seasons of calving, reduced calving intervals, early weaning, twinning and

embryo transplants, calve-once-and-slaughter system, rapid steer finishing, crossbreeding, and carcass evaluation. *Field crops*—Evaluating alfalfa cultivars for hay and grazing, wheat and barley cultivars, new alternative crops, fertigation, and soil and water management under sprinkle irrigation.

**Desert Experimental Range  
USDA-Forest Service  
Intermountain Forest and Range  
Experiment Station**

Milford, Utah 84751  
c/o Shrub Sciences Laboratory  
735 North 500 East  
Provo, Utah 84601  
Telephone: 801-377-5717

**Location:** N 38° 40' latitude; W 113° 45' longitude. On Highway U21, between Milford and Garrison, Utah.

**Facilities and accommodations:** Housing may be arranged (at cost) for scientists, support personnel, and graduate students. There are three dwellings, an office, and several garage-storage buildings. Water is supplied from a deep well and storage tank. No electricity.

**Size:** 55,680 acres.

**Establishment:** 1933. Legal source of establishment and current legal ownership: Established by Executive Order of President Hoover, February 1, 1933. Federal lands were withdrawn from the Public Domain for range research. Under the jurisdiction of the USDA-Forest Service, Intermountain Forest, and Range Experiment Station, Ogden, Utah.

### Description

**Climate:** Summers are warm and winters are cold. During the 50 years from 1934-1984, temperature extremes varied from +104°F to -40°F. Typical July maximums are 92°F and typical January minimums are 12°F. The mean daily range in temperature is 32°F and the average frost-free period is about 125 days—mid-May into September. Average annual precipitation is 6.2 inches at the Desert Experimental Range headquarters. Roughly half of the precipitation falls during the frost-free period when the moisture is being actively used by the plants. The remaining half typically falls during October to April when temperatures are low and evapotranspiration is minimal, resulting in an accumulation of soil moisture.

**Physical features:** The soils are Aridisols (calciorthids, camborthids) and Entisols (torrifluvents, torripsamments). They are loams, sandy loams, or loamy sands; most are skeletal. Clay content is low except on the barren playa in the bottom of the valley. The soils have a pH of about 8.0; and the electrical conductivity (saturative extract) ranges from less than 1 mmho/cm in the upper 12 to 16 inches of the profile to 10 to 25 mmho/cm at greater depths.



Figure 20. Desert Experimental Range headquarters complex with low-shrub cold desert vegetation in foreground.

**Vegetation:** The vegetation is a mosaic of low (ca 10 inches) shrub and shrubgrass types; the different types reflect soil differences between sites. The dominant shrub species are winterfat (*Ceratoides lanata*), bud sagebrush (*Artemisia spinescens*), black sagebrush (*Artemisia nova*), shadscale (*Atriplex confertifolia*), and low rabbitbrush (*Chrysothamnus viscidiflorus*). Several perennial grass species are associated with the shrubs on most soils. The three most common are Indian ricegrass (*Oryzopsis hymenoides*), galleta (*Hilaria jamesii*), and sand dropseed (*Sporobolus cryptandrus*). All three are good forage species, but Indian ricegrass is the most desirable because it is more dependably palatable in winter. The vegetation of the steeper, mountainous part of the range is similar to that of the valleys, but richer in species. Several other shrubs, grasses, and perennial forbs are of importance in the cover.

**Livestock management:** Fences necessary for conducting grazing experiments and headquarters facilities at the experimental range were constructed in 1933 and 1934. Grazing studies began the winter of 1934-1935. Twenty large (320 acre) range pastures were each assigned a season or combination of seasons to be grazed by sheep at one of three stocking intensities. The assignment has remained unchanged. The rest of the range was divided into 14 units: 11 of them have been grazed by sheep at particular seasons every year, in different seasons in alternate years, or grazed and not grazed in alternate years; two of them have been grazed by cattle in midwinter; and one has not been grazed. Ungrazed exclosures were constructed in the pastures and on large units, and permanent sampling points were established. This long-term study was closed in 1985.

**Research emphasis:** Range, livestock, and wildlife.

**Importance of site:** Has been protected and utilized in experimental grazing for 50 years. Meets the criteria for an Experimental Ecological Reserve. Long-term records of range use, vegetation change, and climate are



available. The area has been covered by a soils survey. Has considerable potential for ecological research and development of an understanding of how the ecosystem functions.

**Climatic data (1934 to 1986):** Precipitation—daily with standard range gauge. Temperature—daily minimum-maximum. Wind—totalizing anemometer at 6 feet height (15 years of monthly air movement in winter; 20 years for summer to present). Soil temperature—daily at several depths (2 years at one site, 3 at another).

#### **Plant data:**

Plant community map, 1:10,000 as of 1933, 109 square miles (includes 22 square miles outside boundary of Reserve), partially remapped in 1974, both unpublished. A baseline sample (1933) of plant cover on 10,900 plots on 109 square miles (87 on the Reserve, 22 on adjoining lands). Fifty-five square miles resampled in 1978.

Record of plant compositional change (retrogression or secondary succession) as a consequence of several patterns of livestock winter and spring use, each applied for 50 years on an assigned grazing area and similar records on nongrazed areas.

Plant growth and development records, seven perennial species, 7 years.

Quadrat charts of perennial plants on about 240 plots (100 square feet) mapped 3 to 5 times between 1935 and 1975.

Annual herbage cover and yield (by species) of the pastures for 17 of the last 49 years. Less frequent productivity records for 39 nongrazed small (1- to 4-acres) livestock enclosures and their paired grazed plots.

Records of livestock forage preference and utilization winter and early spring, 26 years; and pronghorn antelope (*Antilocapra americana*) forage preference year around, about 10 years.

#### **Livestock data:**

Actual use records (cow- and sheep-days by period, by range unit and pasture for 48 years [winter or winter-spring use]) for the 13 grazing units and 20 large pastures.

Winter weight changes of sheep related to grazing treatment from 1937 to 1944.

Fleece weight (1936-1943), lamb crops (1936-1946), and death losses (1937-1944).

Water consumption on winter range, 40 years.

**Predators, insects, wildlife data:** Winter sheep loss records, all causes including predators, 48 years to present. Predator-prey relationships directed to the problem of pronghorn antelope fawn survival, 1975-1979. Small mammal population fluctuations, ca. 40,000 trap nights, 1975-1979.

**Research thrusts:** Grazing management, animal nutrition, climate-site-vegetation relationships, livestock-wildlife relationships, desert ecology.

## **Great Basin Experimental Range USDA Forest Service Intermountain Forest and Range Experiment Station**

c/o Shrub Sciences Laboratory  
735 North 500 East, Provo, Utah 84601  
Telephone: 801-377-5717

**Location:** Five miles east of Ephraim on Utah State Highway 29 (Manti-La Sal National Forest Highway 8).

**Facilities and accommodations:** The following administrative buildings are on the Great Basin Experimental Range: the headquarters group, five residences, and an office; Alpine Cabin and two settling basin buildings at the upper end of the Experimental Range; and a small complex of storage units. Other research facilities on the Experimental Range include enclosures and other fences, and stream gauging stations. Communication to headquarters is provided by a Forest Service telephone line. A Forest Service powerline serves the headquarters station.

**Size:** 4,608 acres.

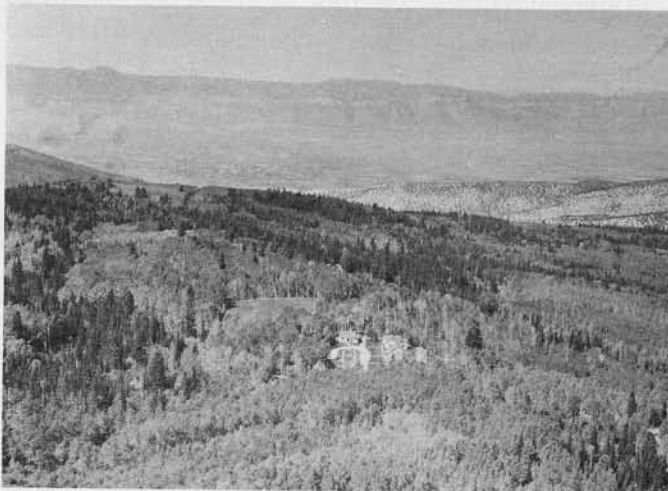


Figure 21. Lower portion of the Great Basin Experimental Range with headquarters facilities in mid-ground and San Pete Valley in background.

**Establishment:** Secretary of Agriculture Regulation U-4 gave the Great Basin Experimental Range experimental area status before 1920. It was created as the Utah Experiment Station, the predecessor of the present Intermountain Forest and Range Experiment Station, in 1912. The Great Basin Experimental Range was formally established April 28, 1970. Houses and other facilities were built during the decades of 1910-1920 and 1930-1940. Legal source of establishment and current legal ownership: The Great Basin Experimental Range is all within the Sanpete Ranger District of the Manti-La Sal National Forest, and is under the jurisdiction of the USDA Forest Service, Intermountain Forest and Range Experiment Station.

## Description

**Climate:** Precipitation is well distributed throughout the year and varies between 15 and 34 inches annually, depending upon the elevation. Temperatures have ranged from a minimum of -34°F in winter to 97°F in summer. Mean January temperature for all life zones is 19°F; mean July temperature, 61°F. The growing season averages 86 days.

**Physical features:** The Great Basin Experimental Range varies in elevation from about 6,800 feet at the National Forest boundary to about 10,300 feet along the Skyline Drive. Soils at the lower elevation of the Experimental Range are commonly derived from the North Horn formation and vary from silt loam and loam at the surface to clay loam in the subsoils. At the upper part of the Experimental Range, soils are derived mainly from Flagstaff limestone and are mostly clay loam in texture. In general, the soils are very productive, have good water-holding qualities, and are only moderately erodible.

**Vegetation:** The vegetation of the Great Basin Experimental Range includes the following major plant communities or vegetation types—

Vegetation types	Acres
Barren and waste	42
Herbland	1,775
Oakbrush and juniper ( <i>Quercus gambelii</i> and <i>Juniperus</i> spp.)	694
Aspen ( <i>Populus tremuloides</i> )	623
Engelmann spruce ( <i>Picea engelmannii</i> )	710
Subalpine fir ( <i>Abies lasiocarpa</i> )	252
White fir ( <i>Abies concolor</i> )	512
	<hr/>
	4,608

**Livestock management:** Except for exclosures, the entire area is used for sheep and cattle grazing under National Forest permits.

**Research emphasis:** Range, watershed, wildlife, livestock, silviculture, and ecology.

**Importance of site:** Because of its variety of plant communities, the Experimental Range provides examples of most of the ecological situations representative of the Central Utah-Wasatch Mountain area, and consequently, some excellent sites for range, wildlife habitat, watershed, and timber management research. This area is recognized as one of the two most important "cradles of range research." Pioneer range scientist, D. A. W. Sampson, was in charge of the early work here. Many of the prominent researchers through the West received their early training and experience here during the next 40 years.

**Long-term data bases:** There are numerous permanent plots and exclosures in the various vegetation communities. Records are available to follow plant growth and succession over long periods of time. Water yield from watersheds A & B—1913-1953; sediment yield—1913-present; vegetational composition about 1913 to 1923. Detailed vegetation data on 20 exclosures—1912 or 1914 to 1960. Additional exclosures built in 1940s.

**Research thrusts:** The Great Basin Experimental Range provides excellent opportunities for a variety of wild-land research. Studies of (1) ecology and management of pinyon-juniper, spruce-fir, mountain herb, oakbrush, aspen, and associated plant communities and their relationship to various environmental factors, particularly soils and weather; (2) improvement and management of big game habitat; (3) selection and breeding of improved shrubs, evaluation of promising selections, development of efficient seed-production technology, and development of effective procedures for shrub establishment in forest and range environments; (4) wildlife-livestock relations in multiple use management; (5) range-watershed rehabilitation; (6) water-yield improvement through vegetative manipulation and structural measures; (7) silviculture and management of aspen and associated conifers in relation to forage, water, and other multiple use values; and (8) forest recreation planning and management are all studies that have been, or are being conducted or are envisioned.

## Tintic Research Station

Eureka, Utah 84628  
Telephone: 801-433-6372 or 750-2471

**Location:** Six miles southwest of Eureka, Utah, on Highway 6.

**Facilities and accommodations:** Housing is available for technicians and graduate students. A 3,000 square foot storage/maintenance shop area is also available. Offices with a herbarium and microcomputer are also part of the station.

**Size:** 1,680 acres of seeded rangeland; 1,680 acres of native rangeland.

**Establishment:** Originally designated as a research area in 1949. Improvements such as seeding and fencing were conducted from 1949 to 1956. Legal source of establishment and current ownership: The land is administered by the Bureau of Land Management and managed by Utah State University under a cooperative agreement.

## Description

**Climate:** This semiarid site, typical of much of Utah's foothill range, receives an average of 14.3 inches of precipitation annually. Although the distribution of precipitation throughout the year is fairly uniform, the amount of precipitation is highly variable. During a 25-year recording period, annual precipitation ranged from 9.3 to 25 inches. Temperature extremes can range from 4 to 97°F. Soil moisture is abundant throughout the spring but rapidly depletes by mid-June.

**Physical features:** A comprehensive soil survey has been conducted on the entire station. The station is situated on 1-2% west and sloping alluvial and loessal

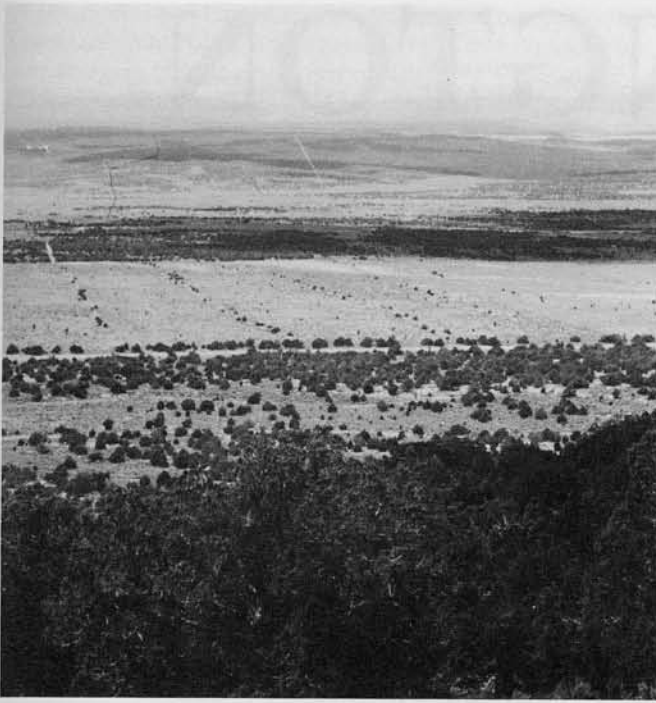


Figure 22. A view toward the west of improved pastures (beyond highway No. 6, running through the upper center of the photo) and unimproved native rangeland on both the east and west.

plains on the west flank of the East Tintic Mountains. The elevation varies from 5,200 to 6,000 feet above sea level.

**Vegetation:** One half of the area remains in native vegetation consisting of pinyon (*Pinus monophylla*), Utah juniper (*Juniperus osteosperma*), and basin big sagebrush (*Artemisia tridentata* ssp. *tridentata*). Perennial grass species are rare on this site, with the most common species being bottlebrush squirreltail (*Sitanion hystrix*), western wheatgrass (*Agropyron smithii*), and bluebunch wheatgrass (*A. spicatum*). Annual species, notably cheatgrass (*Bromus tectorum*), are much more conspicuous than perennial grasses. Native vegetation has been removed from the other half of the area. Beginning in 1949, 24 pastures of 69.1 acres each were treated by disc-plowing, roto-beating or chaining to remove juniper and sagebrush. Four seeding treatments were applied to form six replicates. The treatments were: Crested wheatgrass (*A. desertorum*), intermediate wheatgrass (*A. intermedium*), tall wheatgrass (*A. elongatum*), and a combination of the three species. The older pastures now consist of a mixture of re-invading sagebrush and perennial grass. New pastures with Hycrest crested wheatgrass and *Agropyron spicatum* x *A. repens* are being established.

**Livestock management:** The cattle on the research site belong to a local rancher. One-hundred and eighty replacement black Angus heifers graze on the area from early May to late October. More livestock is available from the livestock manager, upon request for use at this station.

**Research emphasis:** Range and animal ecology.

**Importance of site:** This site early demonstrated to ranchers and agency personnel the feasibility of vegetation conversions to enhance livestock production. High intensity, short-duration grazing has not proved as efficacious as season-long schemes.

**Data bases:** Variables, see West et al. 1984. *Journal of Range Management* 37:262-264.

**Climatic data:** Precipitation—Daily with computerized range gauge and monthly with total collection gauges. Temperature—Daily maximum, minimum, and average with computer recorder. Wind—Anemometer at 1-foot height. Radiation—Direct. Soil moisture—Blocks at 4 and 19.5 inches recorded daily and numerous neutron probe access tubes recorded weekly.

**Range data:** Newer research includes use of Tebuthiuron on grass-depleted sagebrush communities. Areas are reseeded with different techniques including drilling, broadcast, and broadcast with subsequent trampling to establish a grass stand. Another study is investigating the rate and degree of sagebrush invasion into grass stands. A third study is investigating different techniques and species mixtures for interseeding crested wheatgrass stands. The response of individual tillers to different levels of grazing is also being researched. This is also a site used by ARS scientists to check adaptability of exotic shrubs, forbs, and grasses as well as new genotypes of the grasses.

**Livestock data:** Research includes using sheep and goats to remove sagebrush from grass-depleted communities and grazing animal behavior in relation to the time spent in a pasture and in relation to the size of the pasture.

**Grazing data:** The major research thrust is to determine how and why animals select certain plants to be grazed in different grazing management schemes. Comparison of season-long (May-July) with short-duration grazing systems continues.

**Research thrusts:** Means of improving livestock production on foothill ranges traditionally grazed in spring and fall. Improvements via seeding of exotics, mechanical, chemical, and prescribed burning treatments of brush. Outplanting of new exotic and synthetic plant materials. Impacts of these conversions on wildlife, soil erosion, and the hydrologic cycle.



# WASHINGTON

## Colockum Multiple-Use Research Unit

8774 Colockum Road  
Malaga, Washington 98828  
509-663-6400

**Location:** Twenty miles southeast of Wenatchee, Washington.

**Facilities and accommodations:** Facilities available to support a limited number of personnel; no laboratory facilities; one large permanent livestock corral with portable animal facilities; permanent pens designed to contain big game at headquarters; six, 100-acre seeded, fenced pastures close to headquarters.

**Size:** 11,270 acres.

**Establishment:** 1961. Legal source of establishment and current legal ownership: The Colockum Multiple-Use Research Unit (CMURU) was established through a cooperative agreement between the Washington State Department of Natural Resources (DNR), Washington State Department of Game (WSGD), United States Forest Service (USFS), and Washington State University (WSU). The agreement provides for the establishment and maintenance of a research and teaching facility under the supervision of the Department of Forestry and Range Management, WSU. All participating organizations maintain legal jurisdiction over contributed lands. Acreage according to ownership—

Department of Natural Resources	6,640
Department of Game	3,412
U.S. Forest Service	1,218

## Description

**Climate:** The Cascade Mountain Range west of the unit causes the rain shadow effect that produces the prevailing semi-arid climate of the area. At lower elevations, the mean annual temperature is 48°F with mean monthly temperatures of 25°F in January and 75°F in July. At higher elevations, the mean annual temperature is 43°F and mean monthly temperatures of 22°F in January and 64°F in July. Mean annual precipitation ranges from 12-16 inches at lower elevations and 24-30 inches at higher elevations. Most of the precipitation occurs as snow between October and March.

**Physical features:** The unit is located on the eastern slopes of the Wenatchee Mountains between 1,800 and 5,200 feet. The terrain of the area is characterized by deep, steep-sided canyons separated by narrow, long ridges. Average slope is greater than 6 percent. Several perennial and annual streams transect the area, reaching a low gradient within 5-6 miles of their source. The

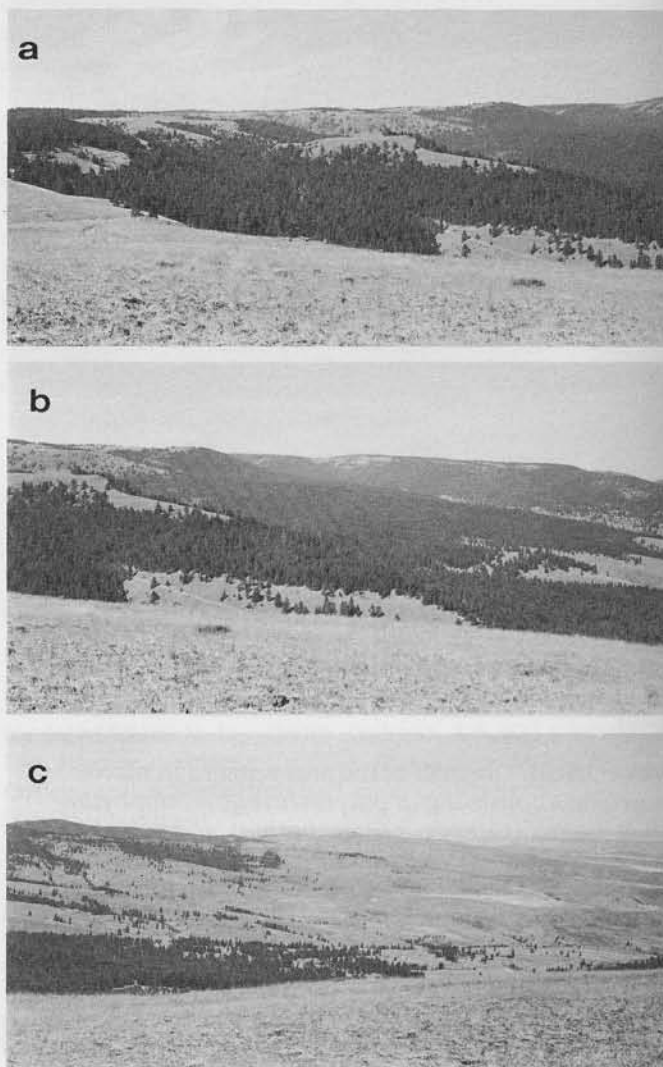


Figure 23. Panorama showing upper boundary of CMURU at crest of Colockum Ridge (extreme left in photo a) to lower boundary below tree line (extreme right in photo c).

watershed is as deeply dissected as the prevailing erosion cycle will permit. Rock outcropping and talus slopes of fractured basalt are common. Soils have developed from loess deposits overlying basalt, modified in some areas by volcanic ash deposits. Soil profile development is minimal. Thirteen soil series and 31 soil types have been identified on the unit. The principal differences in the soils are related to the presence of weathered basalt, weathered sandstone, and pockets of volcanic ash.

**Vegetation:** The lower, drier areas are dominated by bunchgrass and sagebrush/bunchgrass plant communities. Forest communities at higher elevations dominate and are interspersed with shrub and grass communities on ridges and shallow soil sites. The following

vegetation types have been identified on the unit—stiff sagebrush/Sandberg's bluegrass (*Artemisia rigida/Poa sandbergii*), thyme eriogonum/Sandberg's bluegrass (*Eriogonum thymoides/Poa sandbergii*), big sagebrush/bluebunch wheatgrass (*Artemisia tridentata/Agropyron spicatum*), big sagebrush/Idaho fescue (*Artemisia tridentata/Festuca idahoensis*), threetip sagebrush/bluebunch wheatgrass (*Artemisia tripartita/Agropyron spicatum*), threetip sagebrush/Idaho fescue (*Artemisia tripartita/Festuca idahoensis*), bluebunch wheatgrass/Idaho fescue (*Agropyron spicatum/Festuca idahoensis*), Idaho fescue/common snowberry (*Festuca idahoensis/Symphoricarpos albus*), ponderosa pine/bluebunch wheatgrass (*Pinus ponderosa/Agropyron spicatum*), ponderosa pine/Idaho fescue (*Pinus ponderosa/Festuca idahoensis*), ponderosa pine/bitterbrush (*Pinus ponderosa/Purshia tridentata*), ponderosa pine/common snowberry (*Pinus ponderosa/Symphoricarpos albus*), douglas-fir/common snowberry (*Pseudotsuga menziesii/Symphoricarpos albus*), douglas-fir/pinegrass (*Pseudotsuga menziesii/Calamagrostis rubescens*), douglas-fir/mallow ninebark (*Pseudotsuga menziesii/Physocarpus malvaceus*), grand fir/myrtle pachistima (*Abies grandis/Pachistima myrsinites*), subalpine fir/grouse whortleberry (*Abies lasiocarpa/Vaccinium scoparium*), quaking aspen/Rocky Mountain iris (*Populus tremuloides/Iris missouriensis*), riparian, rough fescue dry meadow (*Festuca scabrella*), sedge wet meadow (*Carex scopulorum*).

**Livestock management:** One-hundred-seventy-five cow-calf pairs plus additional replacement heifers are managed in a rotation system through 10 native forage and seeded units with one or more units rested each year.

**Research emphasis:** Range, livestock, silviculture.

**Importance of area as a research site:** The CMURU has topographic, climatic, and vegetation features similar to much of the DNR land, low elevation USFS land, several WSGD wildlife habitat management areas, and large acreages of private land on the east slope of the Cascade Mountains, lower slopes of the Blue Mountains, and low elevations in northeastern Washington. The area also provides about 30 percent of the critical spring-fall habitat for one of the three largest Rocky Mountain elk herds in the state and is immediately adjacent to the largest elk winter range under control of the WSGD in Washington.

**Climatic data:** Soil Conservation Service high elevation remote station (daily AM radio relay, installed 1979)—daily current air temperature, yearly precipitation, daily snow water equivalent. Washington State University low elevation station (installed 1971)—weekly precipitation amount with hourly occurrence record, hourly air temperature, weekly average wind speed, hourly solar radiation, hourly relative humidity.

**Plant data** (1972 to present): Forest understory composition and dominance in relation to overstory manipulation.

**Livestock data** (1961) to present: Detailed grazing management records.

**Research thrusts:** Understory-overstory relationships on forested range; big game habitat management; range livestock nutrition, grazing behavior, grazing management; elk/cattle interrelationships.

# WYOMING

## High Plains Grasslands Research Station

### USDA-Agricultural Research Service

8408 Hildreth Road, Cheyenne, Wyoming 82009  
Telephone: 307-772-2433 FTS 328-2433

**Location:** *Headquarters Unit*—4 miles west and 4 miles north of Cheyenne, via Happy Jack (Wyoming Highway 210) and Roundtop Roads. *East Unit*—6 miles north and 1 mile west of Cheyenne, via I-25 and Horse Creek Road.

**Facilities and accommodations:** Headquarters Unit has two office-laboratory buildings with library, computer room, soil and forage lab; a controlled-environment facility; four greenhouses; two lath houses; shop; barn; six permanently occupied residences; two working corrals; facilities for ditch or sprinkler irrigation for 72 acres; and livestock water from city system. East Unit has one set of corrals, and water is supplied from a well.

**Size:** Headquarters Unit—2,139 acres. East Unit—740 acres.

**Establishment:** Headquarters Unit established as Central Great Plains Field Station in 1928; name changed to Cheyenne Horticultural Field Station in 1929, and High Plains Grassland Research Station in 1974. East Unit acquired in 1979, formerly part of Frances E. Warren Air Force Base. Legal source of establishment and current ownership: Headquarters Unit land owned by City of Cheyenne, leased to USDA Agricultural Research Service along with 450 acre-feet irrigation water right on a 199-year lease, which expires June 2126. East Unit owned by USDA. All buildings are owned by USDA Agricultural Research Service.

## Description

**Climate:** The climate is semiarid-temperate, with wide variations and occasional abrupt changes in weather. Precipitation at the official weather station in Cheyenne averaged 14.63 inches per year, 1871-1982, with 10.69 inches or 73 percent falling April 1 - September 30. Snowfall averages 51 inches, with the majority in March and April. May is the wettest month (2.41 inches) and January the driest (0.42 inches). Annual precipitation at Cheyenne has ranged from 5.04 inches (1876) to 23.69 inches (1942). The Station recorded 24.13 inches in 1983, but Cheyenne Airport recorded only 20.69 inches. Monthly mean temperatures at Cheyenne range from 26.0°F in January to 67.5°F in July. Temperatures at the Research Station average about 2°F below those in Cheyenne. Wind direction has important effects on weather at the Station. Downslope winds from the



Figure 24. High Plains Grassland Research Station, looking west toward the Sherman mountains.

Laramie Mountains to the west produce a chinook or warming effect in winter, and upslope winds from the east or south produce clouds and precipitation.

**Headquarters Unit:** 1,240 acres native rangeland. *Physical features*—Elevational range is 6,260-6,460 feet. A detailed soil survey completed in 1983 identified mainly Aridic and Pachic Argiustolls of the Albinas, Altvan, and Ascalon series, with smaller areas of other series and of Calciorthids, Haplustolls, Haplargids, and Torriorthents. Surface textures include loams and sandy, silt, and gravelly loams, with pH of surface layers between 6.2 - 7.2. *Vegetation*—The station is in Kuchler's Grama-Buffalograss Grassland, but J.L. Dodd considers in the xeric phase of Mixed Grassland. The Station is probably in the transition zone between the shortgrass and the mixed grass. The vegetation is also influenced by the close proximity of the Rocky Mountain Forest Province. The vegetation consists of blue grama (*Bouteloua gracilis*), 43 percent; western wheatgrass (*Agropyron smithii*), 16 percent; sedges (*Carex eleocharis* and *C. filifolia*), 12 percent; other grasses 4 percent; and forbs 14 percent. Scarlet globemallow (*Sphaeralcea coccinea*) and fringed sagewort (*Artemisia frigida*) are the more frequent forbs. *Livestock use*—The native range was grazed by cattle at one head per 6-30 acres, 1914-1929; horses at one per 80-160 acres, 1930-1953; steers at one per 16 acres, 1954-1973; and by cattle at 0.1-0.7 AUM per acre, 1873-present. 550 acres levelled for irrigation. *Physical features*—These lands are on an old alluvial terrace of Crow Creek, at altitudes of 6,200-6,250 feet. Soils are Haplustolls and Argiustolls of the Ascalon, Brocksburg, Nucla, and Wheatridge series; surface horizons are loam, but Brocksburg and Wheatridge overlie sandy to gravelly subsoils and have reduced water-holding capacity. *Vegetation*—Much of this area has been



levelled for irrigation, with some disturbance and redistribution of the profile, and most has been seeded to introduced forage species such as crested wheatgrass (*Agropyron desertorum*), smooth and Regar brome (*Bromus inermis* and *B. biebersteinii*), alfalfa (*Medicago sativa*), creeping meadow foxtail (*Alopecurus arundinaceus*), and small plots of many other species. The Station also has several hundred ornamental shrub and tree species in an arboretum to maintain plant materials hardy to the Central Plains. Remaining land is roads, buildings, grounds, windbreaks, and recreational areas.

**East Unit:** This unit, with altitudes of 6,300-6,400 feet, is native rangeland with soils and vegetation very similar to those of the rangeland on the Headquarters Unit. Livestock grazing on 600 acres was light and sporadic before 1979. About 130 acres were used by the military as an ordnance disposal area. Approximately 15 acres were denuded of vegetation at different times, but the remainder was undisturbed by livestock grazing or human activity and is a natural reference area. This area was described by Beetle in 1952 *Journal Range Mangement* 5:141-143.

**Livestock management:** A cow-calf herd of about 75 pairs plus 20-25 replacement heifers, owned by the University of Wyoming, is on the Station all year. This herd is on improved dryland pasture plus supplement, December-April; improved dryland or irrigated pasture, May-June; and native range, July-November. Cattle are used to study grazing systems on rangeland or combinations of range and improved pasture, winter nutrition, and breeding systems. The University provides 60-80 steers each summer (June-October) for a study of grazing systems and stocking rates on range.

**Research emphasis:** Range and livestock, primarily grazing system and stocking rate studies; soil and water conservation; disturbed land reclamation; establishment of grasses, legumes, and shrubs; nutrient cycling; and soil erosion and productivity.

**Importance of site:** Transitional between short-grass and mixed-grass prairie, leaning toward latter. Very comprehensive research on grazing systems and stocking rates, and reclamation. Detailed soil survey and weather data allow interpretation of soil and weather effects on range and livestock.

#### **Climatic data:**

*Headquarters Unit* (1977-present)

Precipitation—daily from standard rain gauge (includes snow).

Air temperature—thermograph trace, in standard shelter.

Soil temperature—1.5 and 4 inches, thermograph trace.

Relative humidity—hygrograph trace.

Wind—totalizing anemometer at 2 feet above ground, daily totals through 1983, weekly thereafter.

Evaporation—standard pan, May 1-September 30, daily totals through 1983, weekly thereafter.

Solar radiation—total daily, from pyrliograph trace.

*Headquarters Unit* (1966-1976)

Air temperature—maximum and minimum on week days.

Precipitation—rain from standard gauge, snow depths.

#### **Plant data:**

*Native range*—Fertilized plots (20 or 30 pounds nitrogen per acre applied spring or fall yearly from seasons 1975-1981 and 1983 to present. Frequency of occurrence-1975 to present. Yield-clipped to ground level, oven-dried, at maturity; clipped only 1975-1981; visual double sampling, 1982 and 1983; herbage meter double sampling, 1984.

*Grazed rangeland on Headquarters Unit*—Peak standing crop, 1974-1984. Biweekly biomass, 1980-1981. Quality, 1975-1978.

*Disturbed rangeland* (last disturbance for different sites was 1926, 193?, 1966(?), and 1976)—Yield-clipped to ground level, oven-dried, at maturity, 1976 to present (not all sites in all years). Frequency of occurrence-1976 to present (not all sites each year, 1976-1981; all sites since 1982). Density-yearly for recently disturbed sites, 1978 to present; occasionally on oldest disturbed site.

#### *Grazing systems:*

*Headquarters Unit*—Cover, basal-all species plus litter and bare ground on light and heavy stocking rate pastures, 1982 to present.

*East Unit*—Biweekly biomass, 1982-1983. Peak standing crop., 1982-1984. Root biomass and total non-structural carbohydrates-western wheatgrass and blue grama, 1983-1984.

#### **Livestock data:**

*Cow-calf herd*—Weights of cows, calves, and heifers—every 2 weeks, May-November, every 4 weeks, December-April (some gaps in winter because of bad weather), 1974-1984. Stocking rates and seasons of use on improved pastures and range, 1974 to present. Conception rates and calf crops, 1974 to present. Botanical and chemical composition of diets, 1975-1977. Calving dates, times, birth weights, calving difficulty, 1974-1984 (some missing data).

*Steers*—Weights every 2 weeks on three grazing systems, three stocking rates, 1982 to present. Activity every 15 minutes, 6 days in 1983, 3 days in 1984. Location, 1984.

*Cattle on reclaimed land*—Weights every 20-30 days, June-October. Blood serum element contents every 28-30 days during grazing, 3-years.

**Soils data:** Water infiltration and bulk density, spring and fall 1983-1984, under two stocking rates and three grazing systems. Organic carbon, total nitrogen, mineral nitrogen, soluble cations, pH, electrical conductivity, water retention characteristics, microbial biomass, microbial nitrogen and carbon, and mineralizable nitrogen (on some soil types), 1979 to present.

**Research thrusts:** Evaluate role of soil erosion and deposition on productivity. Evaluate effect of natural and manmade soil disturbances on nutrient cycling and

its effect on forage quality. Understand physiology and ecology of establishment, competition, and succession of native and introduced plants on range lands. Evaluate grazing systems including native and improved pastures, cycles of rest and grazing, seasons of use, and stocking

rates. Determine impact of grazing and trampling on soil stability and fertility and plant responses. Develop simulation models from empirical data and theory to explain observed responses as a basis for decision making.