District Five

Vegetative Inventory Report

Prepared for:
Bureau of Indian Affairs
Western Navajo Agency

Prepared by:

Ecosphere Environmental Services

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TABLE OF CONTENTS

List of Figures and Appendices

Abstract

Ecosphere Environmental Services (Ecosphere) was contracted by the Bureau of Indian Affairs (BIA) to collect and compile vegetation data on 1,220 transects on Grazing District Five, Units One, Two and Three of the Western Navajo Agency. The BIA provided Ecosphere with pre-determined transect locations within 16 compartments located in District Five. Data were collected on all 1,220 transects in District Five during October and November of 2006. Data included measurements for biomass production, ground cover, and species frequency. Data were grouped by range sites within each of the 16 compartments and were analyzed to determine total annual production, total allowable production, and seral state as well as ground cover percentages and frequency of indicator species. The results of the survey will be used to monitor rangelands and adjust stocking rates.

Recommended stocking rates of the range sites within the 16 compartments ranged from 7 to 102 acres per sheep unit with an average of 41 acres per sheep unit. The recommended carrying capacity of the entire study area in District Five was 14, 727 sheep units year long. Overall, the District Five range resource varies in condition. The southwest quarter of the District is in the best condition, while the main drainages are exhibiting signs of deteriorating condition. The percentage of acreage in good condition has improved since 1971.

1.0 INTRODUCTION

Ecosphere Environmental Services (Ecosphere) was contracted by the Bureau of Indian Affairs (BIA) to conduct rangeland vegetation inventories on District Five of the Western Navajo Agency. Field crews collected species specific vegetation data including annual production, cover, and frequency. These data were also used to calculate carrying capacity and current range condition. Information derived from these calculations can be used to guide management decisions, including stocking rates. This report supplies the results of the inventory as well as the background, methodology, and discussion necessary for management planning.

1.1 Purpose and Need

The purpose of this inventory is to provide comparison information about the existing range resource to enable resource managers and permittees to improve and/or maintain the condition of the range resource. The last comprehensive vegetation inventory in District Five was conducted over 30 years ago. The results of this inventory will enable recommendations for updated stocking rates as well as more comprehensive range management plans which are crucial for future rangeland health and productivity.

1.2 Affected Regulatory Entities

Livestock grazing permits are administered by the BIA Natural Resources Program in accordance to the Navajo Grazing Regulations (25 CFR §167). The BIA is required by this regulation "to adjust livestock numbers to the carrying capacity of the range…that the livestock economy of the Navajo Tribe will be preserved." The Navajo Nation Department of Agriculture (NNDOA) assists with management of livestock grazing activities on the Navajo Nation primarily through District Grazing Committees. All three parties, BIA, NNDOA and the Grazing Committees, coordinate their activities in an effort to utilize and manage the range resources.

1.2.1 BIA Agency Natural Resources Program

All livestock grazing permits are issued by BIA Natural Resources. Master livestock grazing records are also maintained by the BIA Natural Resources. The BIA is responsible for complying with all federal statutes, orders and regulations. According to the BIA, their obligation "is to protect and preserve the resources on the land, including the land itself, on behalf of the Indian landowners. Protection and preservation includes conservation, highest and best use, and protection against misuse of the property for illegal purposes. BIA will use the best scientific information available, and reasonable and prudent conservation practices, to manage trust and restricted Indian lands. Conservation practices must reflect local land management goals and objectives. Tribes, individual landowners, and BIA will manage Indian agricultural lands." A summary of the BIA Range Policy as stated in the Agricultural and Range Management Handbook (2003) is outlined in Figure 1.1.

Figure 1.1 BIA Range Policy Summary

- Comply with the American Indian Agricultural Resources Management Act of December 3, 1993, as amended.
- Comply with applicable environmental and cultural resources laws.
- Comply with applicable sections of the Indian Land Consolidation Act, as amended.
- Unless prohibited by federal law, recognize and comply with tribal laws regulating activities on Indian agricultural land, including tribal laws relating to land use, environmental protection, and historic and/or cultural preservation.
- Manage Indian agricultural lands either directly or through contracts, compacts, cooperative agreements, or grants under the Indian Self-Determination and Education Assistance Act, as amended
- Administer land use as set forth by 25 CFR 162 – Leases and Permits and 25 CFR 167-Navajo Grazing Regulations.
- Seek tribal participation in BIA agriculture and rangeland management decision-making.
- Integrate environmental considerations into the initial stage of planning for all activities with potential impact on the quality of the land, air, water, or biological resources.
- Investigate accidental, willful, and/or incidental trespass on Indian agricultural land.
- Provide leadership, training, and technical assistance to Indian landowners and land users.
- Keep records that document the organization, functions, conduct of business, decisions, procedures, operations, and other activities undertaken in the performance of federal trust functions.
- Restrict the number of livestock grazed on Indian range units to the estimated grazing capacity of such ranges, and promulgate such other rules and regulations as may be necessary to protect the range from deterioration, prevent soil erosion, assure full utilization of the range, and like purposes.
- Ensure farming and grazing operations be conducted in accordance with recognized principles of sustained yield management, integrated resource management planning, and sound conservation practices.

1.2.2 District Grazing Committees

Districts, which are formally called Land Management Districts, were established in 1936 by the Soil Conservation Service (SCS) and adopted by the BIA. There are 23 districts on the Navajo Nation. The periodic sampling of rangelands allows district grazing committees to evaluate the carrying capacity and resulting stocking rates of rangelands (Goodman 1982).

The Navajo Nation is organized into 110 Chapters. Chapters are locally organized entities similar to Counties. District Grazing Committees consist of elected representatives from each Chapter who are responsible for monitoring livestock grazing within their respective chapters. The District Five study area includes three Chapters: Leupp, Tolani Lake and Bird Springs.

1.2.3 Navajo Nation Department of Agriculture (NNDOA)

Individual Grazing District Committee members are elected officials who are directly accountable to their local chapters and administratively accountable to the Director of the NNDOA. The NNDOA is also responsible for annual livestock tallies to determine if permittees are in compliance with their permit. In addition, the NNDOA is responsible for resolving grazing disputes.

1.2.4. Navajo Nation Department of Justice

Many legal issues are attached to the use, transfer, and legality of grazing permits. The Navajo Nation Department of Justice may be called upon from time to time to determine if actions are in the best interests of the Navajo Nation. The Navajo Nation Department of Justice may also be called upon to determine if any actions infringe on the rights of individuals.

2.0 RESOURCE DESCRIPTIONS

In order to best utilize existing rangelands, they will need to be monitored and improved through careful management. Knowledge of the resource issues which affect rangeland health and productivity is essential to any management plan. In addition to stocking rates, the season of use, annual precipitation, soil types, location of water sources, and topography strongly influence the variety and quality of forage on rangelands.

2.1 History

The Colorado Plateau has always been a marginal resource for livestock production. "Many of the ranchers who have struggled with the semi-arid conditions of the area consider much of the Plateau to be a '60-40 range.' This is a range where a cow must have a mouth sixty feet wide and move at forty miles–per-hour to be able to find enough to eat. The Navajo Reservation is no exception to this rule and, if anything, conditions there are worse than in other locations on the Plateau (Grahame and Sisk 2002)."

During the last century livestock numbers on the Navajo Nation fluctuated greatly in cycles of overstocking followed by reactionary reduction programs. In 1936 the entire Navajo Nation was stocked well beyond the grazing capacity of the ranges, and grazing districts were established as a means to reduce the overgrazing. Later, these districts were further subdivided into units. District Five contains 16 units, or Compartments. Individuals were issued permits to graze their animals in specific grazing districts and range units (BIA 1971).

Since the last comprehensive rangeland inventory of District Five was conducted in 1971, the demographics of the district have shifted. The 2000 census population of the three Chapters in District Five (Leupp, Birdsprings, and Tolani Lake) totaled 3,290. The population of the district has since increased more than 25% (Navajo Nation, 2004). This pressure, in combination with the effects of historic overgrazing, as well as an extended drought, has eroded the condition of soil and vegetative resources in areas of District Five.

According to William Abruzzi, author of the paper, *The Social and Ecological Consequences of Early Cattle Ranching in the Little Colorado River Basin*, "overgrazing has also had a detrimental effect on surface water in the basin and, therefore, on those who depend on this resource. The high sediment content of the Little Colorado and its more northerly tributaries clearly predated the arrival of cattle ranching and the Aztec Land and Cattle Company. However, since grasses provide a dense root system which counteracts erosion during periods of high runoff, the decrease in effective floral cover caused by excessive overgrazing quickly resulted in increased soil erosion and the deposition of substantially greater amounts of silt into the Little Colorado at lower elevations…Numerous local indices of overexploited grasslands persist throughout the region even to this day, including the predominance of bare soil, the low percentage of herbaceous vegetation among the vegetation that remains, the widespread invasion of juniper trees into the grassland community, and the overall reduction in range productivity (1995)."

The natural aridity of the Navajo Nation on the Colorado Plateau, concurrent with a regional warming trend, has been enhanced by a noticeable reduction of precipitation since 1966. “In recent years, the Navajo Nation has been experiencing drought conditions that may surpass the severity of all previous droughts in the 20th century (USGS 2005).” This drought, as well as the documented overgrazing which occurred on Navajo Nation rangelands, undoubtedly contributed to a shift from grass dominated landscapes to shrub dominated ones. This, in turn, reduced vegetative cover which decreased soil stability and is currently contributing to further erosion (USGS 2005).

The results of this vegetative inventory quantify the current conditions of the rangelands on District Five. This information can be used to document future changes on the rangelands and assist with the management decisions.

2.2 Geographic Setting

District Five is located in the southwest corner of the Navajo Nation in Arizona (Appendix A). The town of Leupp is located roughly in the center of the project area; approximately 25 miles northwest of the city of Winslow on Interstate 40 and approximately 40 miles east of Flagstaff. It surrounds the southwest corner of the Hopi Reservation. District Five contains 16 grazing Compartments (Figure 2.1). The District increases in elevation from east to west from roughly 4500 to 5500 feet.

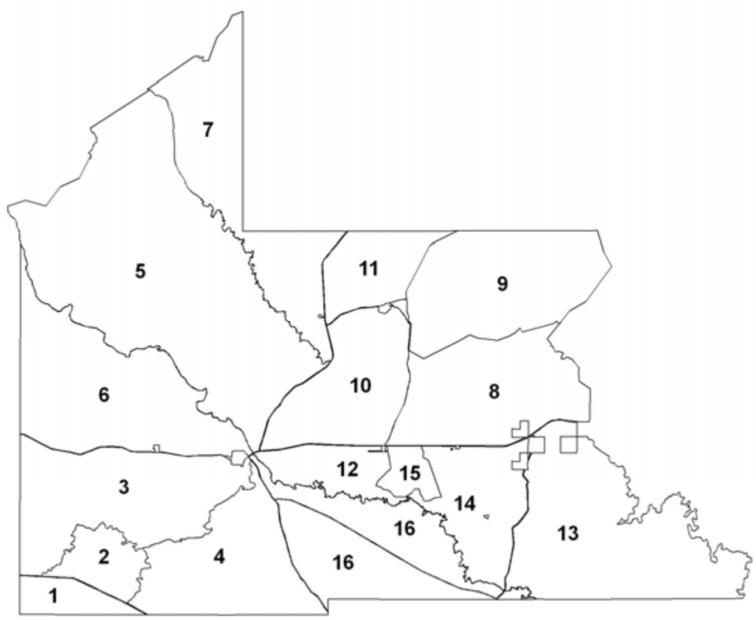


Figure 2.1 Grazing Compartments in District Five.

The project area is located within the Colorado Plateau (35) Major Land Resource Area (MLRA) and within the 35-2AZ Colorado Plateau Cold Desert Shrub sub-resource area, or Common Resource Area (CRA), previously known as a Land Resource Unit. A small portion in the southwest corner of the project area is located in a different CRA, the 35-1AZ Colorado Plateau Mixed Grass Plains.

Elevations on the Colorado Plateau Mixed Grass Plains range from 5100 to 6000 feet. Precipitation averages 10 to 14 inches per year. The soil temperature regime is mesic. The soil moisture regime is ustic aridic. Colorado Plateau Cold Desert Shrub elevations range from 3500 to 5500 feet. Precipitation averages 6 to 10 inches per year. The soil temperature regime is mesic and the soil moisture regime is typic aridic.

2.3 Geology

The Navajo Nation is located on the Colorado Plateau, a distinct geologic land form which has been uplifted from its surroundings. During the uplift the rivers flowing across the plateau cut into the bedrock, forming impressive geologic features and scenery such as extensive rock outcrops, canyons, cliffs, as well as volcanic remnants.

The District Five area can be divided into three distinct land forms: the San Francisco Plateau in the southwest, the Navajo Uplands in the northern and northeast portion, and the Painted Desert extending from the southeast through the center of District Five to the northwest. The San Francisco Plateau was formed during the volcanism and uplift of the San Francisco Peaks and consists of cinders and volcanic rock. The Navajo Uplands consist of degraded mesas and cuestas. The Painted Desert was formed by uplifting and severe erosion (BIA 1971).

The Little Colorado River transects the district from southeast to northwest on its way to the Colorado River. Most of its course lies in a broad river valley except for the nonconformity of Grand Falls. Canyon Diablo Wash and its tributaries in the southwest corner of the district create deep canyons, while Jeddito, Coyote, Polacca, Oraibi and Dennehotso washes all enter the district from the northeast and dissect the cuestas and mesas north of the Little Colorado.

Grand Falls is a fascinating geologic site. “Skirting the lava flow that dammed it, the Little Colorado’s muddy stream cascades over its own former canyon wall” (Chronic 1983). The basalt lava which dammed the river flowed 10 km from its vent area to the Little Colorado River, where it cascaded into and filled a 65 meter deep canyon to form the Grand Falls lava dam. Lava continued to flow about 25 km downstream and about one km onto the far rim beyond where the canyon was filled. Eventually the river established a channel along the east and north margins of the lava flow to the site where water falls back into the original canyon (Duffield 2006).

2.4 Soils

Knowledge of the soil properties in a particular area is essential for predicting potential forage production. The application of soil survey information is what enables rangeland managers to provide estimates of forage production in a given area. Soils in the District Five study area are primarily mesic semiarid and mesic arid soils.

The inventory area is located within the boundaries soil survey AZ 707, Little Colorado River Area, AZ, Parts of Coconino and Navajo Counties. This soil survey project is currently in progress; the soil mapping is not yet complete. Therefore no descriptive data was available at the time of this inventory. In lieu of the updated AZ707 soil survey, soils data from the 1971 Soil and Range Inventory was utilized.

2.5 Climate

The Colorado Plateau is quite arid. Most of the area follows a bi-seasonal weather regime characterized by summer and winter precipitation and fall and spring droughts. April, May and June tend to be the driest months. Precipitation occurs in the summer months in the form of heavy rain storms with limited infiltration. Less intense storms bring significant precipitation in the winter months and contribute to groundwater recharge. The region is dominated by drying southwesterly winds. The Colorado Plateau Cold Desert Shrub CRA is the driest CRA on the Colorado Plateau. Precipitation averages from five to nine inches annually. The mean annual temperature is around 50 to 55° Fahrenheit (F).

2.6 Precipitation

An accurate precipitation monitoring system is essential to range management programs. Production estimates are directly affected by precipitation measurements when reconstructing the plant community to an average precipitation year. If precipitation is over estimated in the reconstruction factor, the total annual production estimate decreases. If precipitation is under estimated in the reconstruction factor, the total annual production estimate increases.

Data from three precipitation stations in District Five were provided from the Navajo Nation Department of Water Resources. The three stations have complete data for the past six years, but beyond six years the data is inconsistent or unavailable. We therefore used five years of historical data as a comparison and the most recent water year for deviation from normal. The three stations are not evenly located throughout the District Five area. We did not assign each transect to the closest precipitation station because of the clustered locations of the stations, but instead averaged the three stations to produce an average precipitation percentage throughout the District. From discussions with rangeland managers in Western Navajo Agency, and with residents of District Five during the course of data collection, it was clear that rainfall in the area is not consistent. The sporadic rainfall could only be precisely measured with dozens more precipitation stations. Some Compartments may have received more rainfall than the District average, others less, but without more precise data the average of the three precipitation stations is currently the best measure of precipitation District wide. The percent of normal precipitation for the 2006 water year in District Five, based on the five year average, was 81.66%. Precipitation data is included as Appendix B.

2.7 Plant Communities

The Colorado Plateau Cold Desert Shrub CRA (35-2AZ) is primarily rangeland on the Navajo Reservation. The general topography is rolling, and supports a fair amount of forage species. The Southwest Regional Gap Analysis Project (SWReGAP) has mapped vegetative landcover over the entire southwest area (http://ftp.nr.usu.edu/swgap/index.html). The primary landcovers in the study area include Inter-Mountain Basins Semi-Desert Shrub Steppe, Inter-Mountain Basins Mixed Salt Desert Scrub, Inter-Mountain Basins Semi-Desert Grassland, and Southern Colorado Plateau Sand Shrubland. Several other less dominant landcovers are also present in the study area, including Inter-Mountain Basins Greasewood Flat, Inter-Mountain Basins Volcanic Rock and Cinder Land, Inter-Mountain Basins Playa, Inter-Mountain Basins Shale Badland, and Colorado Plateau Mixed Bedrock Canyon and Tableland. The following descriptions of the primary landcovers are provided from the landcover legend for the SWReGAP.

Inter-Mountain Basins Semi-Desert Shrub Steppe typically occurs at lower elevations on alluvial fans and flats with moderate to deep soils. This semi-arid shrub-steppe is typically dominated by graminoids (>25% cover) with an open shrub layer. Characteristic grasses include *Achnatherum hymenoides, Bouteloua gracilis, Distichlis spicata, Stipa comata, Pleuraphis jamesii, Poa secunda, and Sporobolus airoides*. The woody layer is often a mixture of shrubs and dwarf-shrubs. *Artemisia tridentata* may be present, but does not dominate. The general aspect of occurrences may be either open shrubland with patchy grasses or patchy open herbaceous layer. Disturbance may be important in maintaining the woody component. Microphytic crust is very important in some stands.

Inter-Mountain Basins Mixed Salt Desert Scrub includes open-canopied shrublands of typically saline basins, alluvial slopes and plains across the Intermountain west. Substrates are often saline and calcareous, medium- to fine-textured, alkaline soils, but include some coarser-textured soils. The vegetation is characterized by a typically open to moderately dense shrubland composed of one or more *Atriplex* species. The herbaceous layer varies from sparse to moderately dense and is dominated by perennial graminoids. Various forbs are also present.

Inter-Mountain Basins Semi-Desert Grassland occurs on dry plains and mesas, at approximately 4750-7610 feet elevation. These grasslands occur in lowland and upland areas and may occupy swales, playas, mesa tops, plateau parks, alluvial flats, and plains, but sites are typically xeric. Substrates are often well-drained sandy or loamy-textured soils derived from sedimentary parent materials, but are quite variable and may include fine-textured soils derived from igneous and metamorphic rocks. The dominant perennial bunch grasses and shrubs within this system are all very drought-resistant plants.

Southern Colorado Plateau Sand Shrubland is a large-patch ecological system. It occurs on windswept mesas, broad basins and plains at low to moderate elevations (4,200-6,000 feet). Substrates are stabilized sand sheets or shallow to moderately deep sandy soils that may form small hummocks or small coppice dunes. This semi-arid, open shrubland is typically dominated by short shrubs (10-30% cover) with a sparse graminoid layer. The woody layer is often a mixture of shrubs and dwarf-shrubs. Characteristic species include *Ephedra* species, and *Artemisia filifolia*. *Coleogyne ramosissima* is typically not present. Characteristic grasses include *Achnatherum hymenoides, Bouteloua gracilis, Hesperostipa comata, and Pleuraphis jamesii.* Occasionally grasses may be moderately abundant locally and form a distinct layer. Disturbance may be important in maintaining the woody component. Eolian processes are evident, such as pediceled plants, occasional blowouts or small dunes, but the generally higher vegetative cover and less prominent geomorphic features distinguish this system from Inter-Mountain Basins Active and Stabilized Dune.

Photographic representation of these primary landcovers is included as Appendix C. A complete list of understory plant species found during the Vegetation Inventory is attached as Appendix D.

3.0 METHODOLOGY

An inventory is the collection, assemblage, interpretation, and analysis of natural resource data for planning or other purposes. Inventories should be regularly completed to determine the present condition of variables important to resource decision makers. To satisfy the specific objectives for this inventory the BIA requested data collection for cover, frequency, and production.

3.1 Pre-Field Methodology

Before the field work began for the inventory, preparations were made to establish a technically sound protocol for field data collection. To initiate this process the Statement of Work (SOW) was provided to Ecosphere by the BIA and was reviewed as were the technical references cited in the SOW.

3.1.1 Document Review

The SOW outlined specific methodologies for data collection. The SOW cites the following four technical references which were reviewed by the Ecosphere team prior to the pre-work conference:

U.S. Department of Interior, Bureau of Land Management (USDI BLM) 1999. Sampling Vegetation Attributes, Interagency Technical Reference 1734-4. Denver, Colorado.

Habich, E. F. 2001. Ecological Site Inventory, Technical Reference 1734-7. Bureau of Land Management, Denver, Colorado.

U.S. Department of Agriculture, Natural Resources Conservation Service (USDA NRCS). 2003. National Range and Pasture Handbook.

3.1.2 Pre-Work Conference

A pre-work conference was held on July 11, 2006 in Tuba City, Arizona to discuss contract specifics, questions and concerns, make resolutions and clarifications, and discuss timelines of the project. BIA employees present at the conference included Mr. Jim Dee, Regional Rangeland Specialist, Mr. Tony Robbins, Natural Resources Manager for Western Navajo Agency, Mr. Casey Francisco, Rangeland Management Specialist and Project Manager, Mr. Ned Lane and Mr. Kent Graymountain, both Rangeland Technicians, Mr. Lawrence Yazzie, Biological Technician, Ms. Raye Benally, Natural Resources Specialist in noxious weeds, and Ms. Deanna Benally, Natural Resources Specialist in mapping. Members of the Ecosphere team present at the conference included Ms. Alexis Watts, Project Manager; and Mr. Ike Wennihan, South Wind Conservation Inc., Natural Resource Specialist.

3.1.3 Electronic Data Collection Protocol

Ecosphere decided that the use of electronic data recorders would contribute to a higher quality product and more accurate data collection than paper data sheets with manual transfer to a digital database. Ecosphere chose Palm Zire 21 units for their black and white screens which are readable in outdoor daylight conditions. Ecosphere created a Pendragon software program specifically for the data parameters of this inventory based on data sheets and information provided in the SOW. Pendragon software was used to create a specific program to enter the vegetative data required for this project. The coupling of the Palm units with a custom Pendragon program ensured quality data collection with minimal errors. The Pendragon software allows data to be transferred directly into an MS Access database and MS Excel worksheets for consolidation, analysis, and calculations.

A data management protocol was created to ensure all data was securely entered, downloaded, and stored. Each field biologist's electronic data recorder was downloaded into a notebook computer at the end of each work day. Each field biologist submitted transect data daily to the Project Manager or Field Leader. The Project Manager or Field Leader reviewed the data for errors or discrepancies. The risk of data loss was eliminated by daily backup of data to both the notebook hard drive as well as an external storage device.

3.2 Field Methodology

Sample design, including number and location of transects, transect length, and plot size, was provided by the BIA and outlined in the SOW. Standard methodologies originated from the technical references listed in section 3.1.1.

3.2.1 Transect Establishment

Data collection in the field occurred between 27 September and 12 November, 2006. The BIA provided Ecosphere with predetermined locations for all 1,220 transects (Figure 3.1). This sample set of locations was created by evenly distributing the transects throughout the study area. The Universal Transverse Mercator (UTM) coordinates of these transect locations were downloaded into hand held Global Positioning System (GPS) units. The GPS units were used in combination with topographic maps to navigate by vehicle and foot to the transect locations. Transects were established within ten meters of the GPS coordinates, and usually within one or two meters. Some transects were located in inaccessible canyons, or adjacent to private residences. These transects were moved to suitable locations as close to the original location as possible. The UTM coordinates of the new locations were recorded. A total of 66 transects were moved in District Five, representing 5.4% of the total number of transects.

Transects consisted of a paced, linear study design. An attempt was made to keep each transect within its Range Site. The transect bearing was randomly determined by selecting a prominent distant landmark such as a mesa or lone tree. The transect bearing was read with a compass and recorded. Transects were then paced along the transect bearing. Vegetation attribute readings were taken from ten plots at approximately ten meter intervals along the transect bearing. Each plot was established at the toe of the final pace. The plots were measured with a $9.6ft^2$ quadrant frame. The 9.6 ft^2 plot is generally used in areas where vegetation density and production are relatively light (USDA NRCS 2003). Care was taken to avoid bias by establishing each plot using a consistent method, in this case always laying the frame to the right side. While pacing the transects, obstructions such as trees were avoided by sidestepping at 90° from the transect bearing and continuing to pace parallel to the transect. The original transect line was regained by sidestepping 90° in the opposite direction as soon as possible. The vegetative attributes measured at each transect were production, cover, and frequency. Aspect, slope, soil surface texture and voluntary noxious weed data were collected in addition to the vegetative attributes.

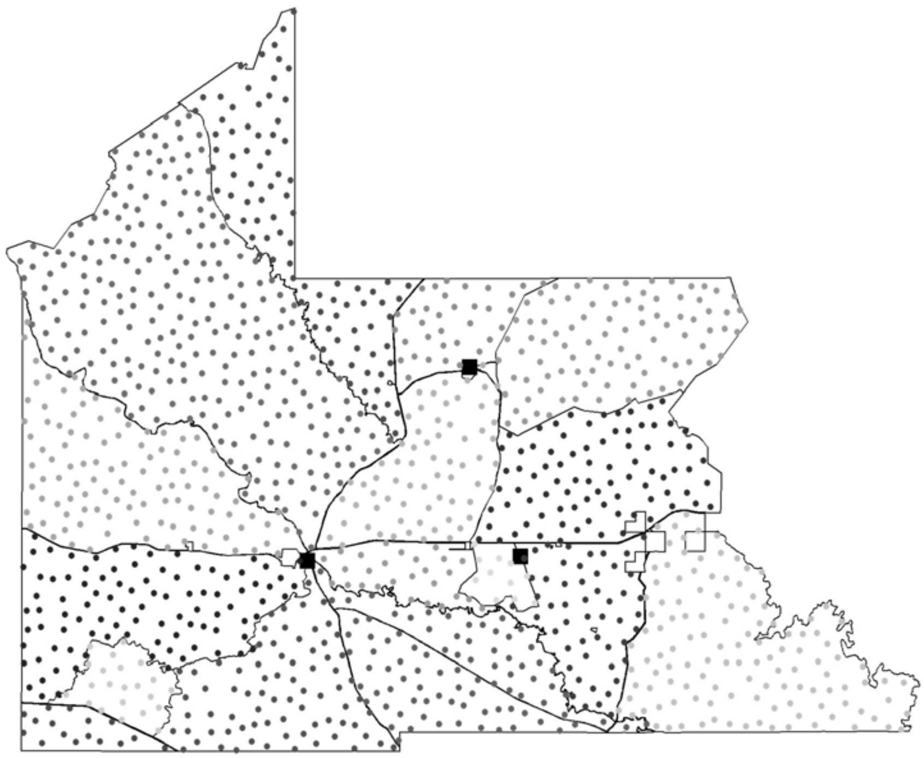


Figure 3.1 Location of Inventory Transects in District Five

3.2.2 Production Data Collection

For the purposes of this study, production was measured as standing forage crop and reconstructed to peak standing crop. Standing forage crop is the total herbaceous and woody plant biomass present above ground and available to herbivores, while peak standing crop is the greatest amount of plant biomass above ground present during a given year (Coulloudon et al., 1999).

Production and composition of the plant communities were determined by a combination of estimating and harvesting (double sampling). Ecosphere followed the Double Sampling methodology of the United States Department of Agriculture – Natural Resources Conservation Service (NRCS), modified to standards outlined in the SOW and resolutions generated from the pre-work conference.

3.2.2.1 Establishing a weight unit

A weight unit is a part of a plant, an entire plant, or a group of plants of the same species used for estimation purposes. The weight unit method is an efficient means of estimating production. After weight units are established biologists can be very accurate in production estimation. The field team adhered to the following procedure for establishing weight units on individual species: decide on a weight unit (in grams), visually select part of a plant, an entire plant, or a group of plants that will most likely equal this weight, harvest and weigh the plant material with a hand scale to determine actual weight, and repeat this process until the desired weight unit can be estimated with reasonable accuracy. The field team maintained proficiency in estimating by periodically harvesting and weighing to check estimates of production.

3.2.2.2 Double Sampling Methodology (Estimating and Harvesting)

Production (in grams) was estimated by counting the weight units of each species in each plot. All plants and parts of plants inside an imaginary box outlined by the 9.6ft^2 frame up to a height of four feet were estimated. Excluded were any plants and parts of plants outside of the imaginary box (Figure 3.2). After estimates of species in all ten plots were completed, two “representative” plots were designated as clip plots and all species inside those plots were clipped, or harvested, to ground level. The selection of clipped plots was enabled by the custom Pendragon program which calculated frequency of estimates greater than one gram, and summed the total estimated weights of each species. Preference was given to forage species and to species which occurred often. Clipped biomass was weighed with a hand scale, and both estimated and harvested weights were recorded. All harvested materials were collected and stored in paper bags labeled with tracking information including Transect, Date, Species, and Plot number. All of the harvested material was allow to air-dry for ten days or more before re-weighing to convert from field (green) weight to air-dry weight (ADW). The purpose of the double sampling is to correct any variability in the estimation of production (Estimation Correction Factor).

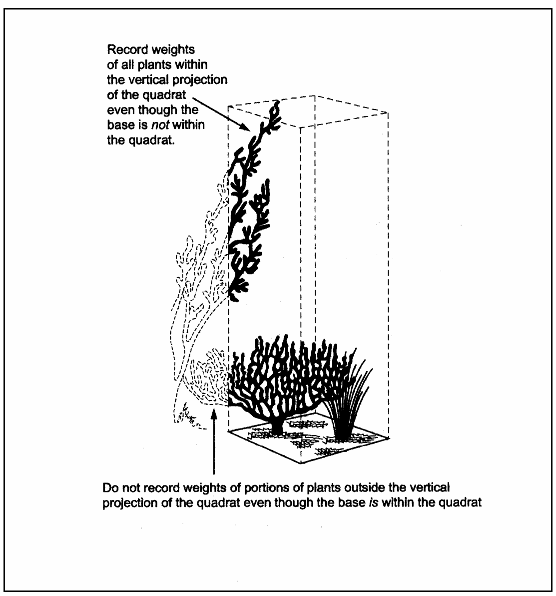


Figure 3.2 Weight Estimate Box
(Source: USDA NRCS 2003)

3.2.2.3 Ocular Estimates of Utilization

Utilization, or use, is the proportion of annual growth that has been consumed by grazing animals. The purpose of estimating utilization is to assist in the reconstruction of vegetation measurements by accounting for vegetation consumed prior to the inventory. With the Ocular Estimation Method, utilization is determined by visual inspection of forage species. This method is reasonably accurate, commonly applied, and suited for use with both grasses and forbs. Field biologists were thoroughly trained and practiced in making ocular estimates of utilization of plants. Data on the percentage of un-grazed plant remaining was recorded for each species on each transect. An attempt was made to locate un-grazed plants near the transect. These un-grazed plants were assumed to approximately represent the species before grazing occurred. Ungrazed plants were used as a comparison to estimate grazed plants. Some re-growth may have occurred before the inventory period. However, if grazing patterns are undetectable on the plant, it is nearly impossible to determine what re-growth, if any, may have occurred.

3.2.2.4 Sensitive Plants Protocol

Threatened, endangered, culturally important, or otherwise sensitive plants were never intentionally harvested for the purposes of this inventory. The weight of such plants was estimated but the plants were not clipped.

3.2.2.5 No Clip List

The BIA approved a "No-Clip List" for the field methodology. This list included non-forage, toxic, and undesirable species. The No-Clip species were *Astragalus* spp*., Hordeum* spp*., Lupine* spp*., Senecio* spp*., Euphorbia* spp*., Gutierrezia sarothrae, Muhlenbergia torreyi, Erodium cicutarium and Leucelene ericoides.* These species were exempt from harvesting in the double sampling procedure. The No Clip list species were estimated only. The weight that was estimated for these species was carried over to the assumed clipped weight for calculation purposes. At regular intervals field biologists clipped these species and measured green weights to calibrate their estimated weights.

3.2.3 Frequency Data Collection

Frequency describes the abundance and distribution of species. Frequency measurements are an easy and efficient method for monitoring changes in a plant community over time. Frequency is the number of times a species is present in a given number of sampling units, usually expressed as a percentage. Electronic data collection allowed for easy and accurate collection of frequency data. The number of plots on which a species occurred in a transect was automatically entered by the custom software program when weights were estimated for the species.

3.2.4 Cover Data Collection

Cover in this study refers to ground cover and describes the percentage of ground which is covered by vegetation, organic litter, bare ground, rock and biological crust. The Point-Intercept method employed on this study consisted of a modified pin/point frame used at each plot along a transect using a sighting device (pin flag) in the four corners of our 9.6 ft^2 quadrant frame. Pin/point frames determine hits by recording the cover category intercepted by each of the pin points. A total of 40 hits was recorded from ten frame placements. Only the point of the pin flag was used to record a hit. Emphasis was placed on lowering the pin directly over (perpendicular to the ground) in the corners of the quadrant frame as specified in Technical Reference 1734-4 Sampling Vegetation Attributes. Cover hits fell into the following categories: Basal Vegetation, Canopy Vegetation, Litter, Bare Ground, Gravel/Stone, and Biological Crust. A Basal Vegetation cover hit was recorded when the pin flag struck the ground surface occupied by the basal portion of the plants. Canopy Vegetation hits were recorded when the pin flag struck an area of ground covered by the vertical projection of the outermost perimeter of the natural spread of foliage of plants (Figure 3.3). Litter hits were recorded when the pin flag intercepted herbaceous or woody plant litter. Bare Ground was recorded when the pin flag struck bare ground free of litter, vegetation, gravel or stone, or any biological crusts. Gravel/Stone was recorded when the pin flag intercepted gravel or stone free of vegetation. Measuring cover by points is considered one of the least biased and most objective cover measures (Bonham1989).

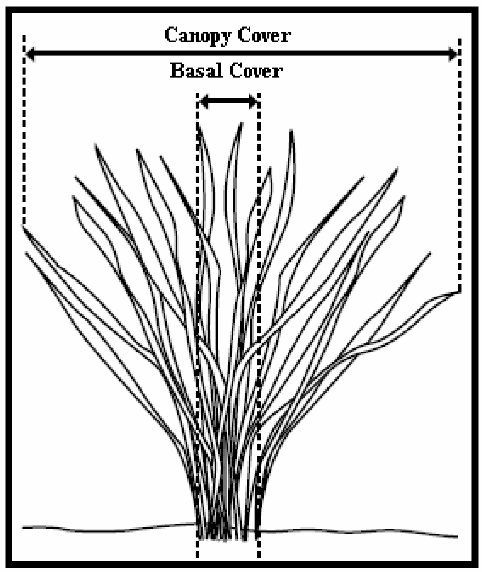


Figure 3.3. Vegetative Cover
(Source: Elzinga, Salzer and Willoughby 1998)

3.2.5 Soil Surface Texture Test

At each transect the A Horizon (top 0”-6”) of the soil surface was sampled. The surface was cleared of debris to bare mineral soil. A small sample was analyzed using the USDA Soil Texturing Field Flow Chart. The Flow Chart uses a step by step procedure for estimating sand, silt, and clay content. The test also uses the ribbon method to determine the fraction of fine-grained particles within the sample. Team members then assigned a texture class to the sample based on its tested content and ribbon characteristics. The USDA Soil Texturing Field Flow Chart is attached as Appendix E.

3.3 Post-Field Methodology

3.3.1 Calculating Production

The translation of a plot full of plants to a measure of pounds per acre is achieved through simple calculations. The formula, derived primarily from Technical Reference 1734-7 Ecological Site Inventory, is the estimated green weight of a species multiplied by a correction factor and then by the percent air dry weight (%ADW) of the species. This number is divided by the result of the utilization of the species multiplied by its growth curve for that time of year. This may be more easily understood with the equation below:

$$\textbf{Total Weight} = \frac{\textbf{(estimated green weight(g) x correction factor) x \% ADW}}{\textbf{(un-utilized percentage x growth curve percentage)}}$$

The result is also reconstructed to account for the percentage of normal precipitation that fell prior to data collection. The details of each of the elements in this equation are explained in the following sections.

3.3.2 Estimation Correction Factor

The harvested or clipped plots provide the data for correction factors of estimated weights. Measured (clipped) weights of species were divided by the estimated weights of the same species in the same plots to establish a correction factor. This correction factor was then applied to all estimations of that species for the entire transect. For example, if *Sporobolus airoides* was estimated on plot 3 to weigh 50 grams (g), but the clipped weight was actually 45g, then all estimates of *Sporobolus airoides* for that transect would be multiplied by 0.90. If *Sporobolus airoides* was also estimated and clipped on plot 7 then the correction factor would be calculated by first summing the estimated weights in plots 3 and 7 and then summing the clipped weights in plots 3 and 7 before applying the same calculation. For example, if the estimated weight in plot 7 was 10g, and the clipped weight was 11g, then the sum of the estimated weights (60g) and the sum of the clipped weights (56g) would be calculated into a correction factor of 0.93. If the total estimated weight for estimates of *Sporobolus airoides* on all plots in this transect was 80g, the resulting corrected weight would be 74.4g.

$$\text{Correction Factor} = \frac{\text{Sum of Measured Weights on Clipped Plots}}{\text{Sum of Estimated Weights on Clipped Plots}} = \frac{60}{56} = 0.93$$

$$\text{(estimated green weight(g) x correction factor)} = \text{80g x 0.93} = \text{74.4g}$$

3.3.3 Biomass ADW Conversion

All biomass from clipped plots was collected in paper bags with tracking information recorded on the bags (date, transect, plot, and species). Clipped, or green, weights were immediately weighed with a hand scale, which was adjusted for the weight of the bag, and recorded. The paper bags were collected and air-dried for a minimum of ten days. All bags were then weighed again and dry weights were recorded into a MS Excel Spreadsheet. The weights after drying were divided by the green weights to give a percent air dry weight (%ADW) in grams to be used in the total annual production calculations. In the example above, the total green weight for *Sporobolus airoides* was 74.4g. If the dry weight was 50g, then the %ADW would be 0.67. For species in the transect which were not clipped (non-palatable/less palatable species) the %ADW defaulted to one.

$$\%ADW = \frac{\text{Dry Weight}}{\text{Corrected Green Weight}} = \frac{50}{74.4} = 0.67$$

At this point, continuing with the same example, all of the elements for the numerator of the equation are present: the estimated weight, the correction factor, and the %ADW. The estimated weight multiplied by the correction factor was 74.4g. Multiplied by the %ADW, the result would be 49.85.

$$(\text{estimated green weight(g)} \times \text{correction factor}) \times \%\ ADW = (80 \times 0.93) \times 0.67 = 49.85$$

3.3.4 Utilization

The utilization estimate is applied to adjust for portions of plants which were not measured due to grazing of the plant prior to the survey. The default was 100 percent ungrazed. Grazed, or utilized species were measured according to the average amount of plants which remained ungrazed in the vicinity of the transect. For example, *Sporobolus airoides* was recorded at a utilization factor of 90% ungrazed. Therefore, the amount of *Sporobolus airoides* estimated represents only 90% of the total amount of *Sporobolus airoides.*

3.3.5 Growth Curves

Growth curves are used to reconstruct the above-ground portion of a plant that has not yet reached its full growth potential for the season. The application of a growth curve accounts for the amount of forage which has not yet grown, and thus was not measured during the vegetation inventory. For instance, a measurement taken in June will be much less than a measurement of the same plant taken in September when the plant is nearing full growth. A growth curve calculates the average growth, by month, of plant species throughout the year within a specific region. Growth curves for the 35-2AZ CRA were constructed by Karlynn Huling, former Rangeland Conservationist for the Flagstaff Area NRCS office. During September growth averages 97% complete. By October, growth is 100% complete. For example, if *Sporobolus airoides* was measured in a transect during September, that measurement represents only 97% of the full growth of that species. Another 3% would be added to account for potential growth.

At this point the two elements in the denominator of the sample equation are present. The utilization multiplied by a growth curve, 90% multiplied by 97%, or 0.873.

$$\%\text{Utilization} \times \%\text{Growth Curve} = 0.90 \times 0.97 = 0.873$$

The full total annual production equation would now look like this:

$$\frac{(80 \times 0.93) \times 0.43}{0.90 \times 0.97} = \frac{49.85}{0.873} = 57.10$$

The total weight of Sporobolus airoides for this transect is 57.10 grams per plot.

3.3.6 Conversion from Grams to Pounds per Acre

The conversion from the working unit of grams into the application of pounds per acre is factored into the formula. However, in this case the conversion factor equals one and therefore is not explicitly written into the equation. The plot size, 9.6 ft^2, was repeated ten times in each transect, thereby creating 96 ft^2 of sampling area, which calculates into a 1:1 conversion (Coulloudon et al.1999). Hence, in the example, there were 57.10 pounds per acre of *Sporobolos airoides*. The figure 57.10 represents the annual production of the species, or the total weight.

3.3.7 Precipitation Deviation

Precipitation has a direct effect on annual production; therefore comparisons of production levels from year to year are not accurate without accounting for precipitation influences. Precipitation is factored into production by multiplying the total weight by the current water years' deviation from average precipitation. The result is called the reconstructed weight.

Pounds per acre * precipitation deviation = Reconstructed Weight

57.10 = 81.66% of normal, therefore the Reconstructed Weight would be 69.92 pounds per acre.

3.3.8 Calculating Cover

Cover was calculated by dividing the number of hits of a category (basal vegetation, canopy vegetation, gravel/rock, bare ground, litter, biological crust) by the total hits for the transect (40 hits). For example, if there were 20 hits of basal vegetation and 40 total hits, the percent cover for basal vegetation was 50% for that transect. Cover data was grouped and averaged by Compartment.

$$\frac{20 \text{ “basal” hits/transect}}{40 \text{ total hits/transect}} = 50\% \text{ Cover}$$

3.3.9 Calculating Frequency

Electronic data collection allowed for simple and accurate collection of frequency data. Species frequency was automatically calculated when weights were estimated for the species in each transect. For example, if *Sporobolus airoides* occurred in six of the plots in a given transect, the frequency would be 60%. Frequencies were averaged by compartment. Indicator species, as listed in the Range Site descriptions, were singled out for frequency analysis. Decreasers are those species that will tend to decrease with grazing pressure, while increasers will tend to increase with grazing pressure. Invader species will invade under disturbance or continued overuse. The indicator species used for the frequency analysis were the most common species that did not occur in another category. For example, in some Range Sites *Pleuraphis jamesii* will occur as a decreaser and in other range sites as a decreaser. We chose only those species unique to the category. This is not a site specific list. Each Range Site Description contains a comprehensive list of increaser, decreaser and invader species appropriate to the individual Range Site. This frequency analysis is not site specific because it is intended to serve as a baseline for the entire District Five area.

3.3.10 Assigning Range Sites

Range Sites are defined areas of land having a combination of specific characteristics including edaphic, climatic, topographic, soil and natural biotic factors that are significantly different from adjacent areas and which dictate potential quantity and variety of vegetation. Three Range Sites have no vegetative reference community due to a lack of practical utility for livestock or range management. These Range Sites are Rough Broken, Badlands and Non-Usable. The other Range Sites in District Five are Cinders, Clayey, Limestone, Loamy, Sands, Sandy, Saline Upland, Saline Lowland, Shallow, Very Shallow and Thin Breaks. Representative photographs of each Range Site are included as Appendix F.

Range Sites were previously delineated in the 1971 Map Atlas which is a product of the Soil and Range Inventory completed for District Five. Range Sites were digitized by Deanna Bennally of the Western Navajo Agency, Branch of Natural Resources. Transect locations were overlayed onto the digital Range Site layer so that each transect was located within and assigned to a particular Range Site. Unfortunately, the edges of the Map Atlas do not line up well with the current boundaries of the District, leaving a handful of transects (seven) located beyond the delineations of the Range Sites. Along the border with District 7, some of the transects could be located on Range Sites by using the District 7 Map Atlas. Using this method, six transects were assigned Range Sites. The last transect (671) was located in area for which no adjacent Range Site Map Atlas was available for comparison. This transect was removed from the final calculations.

It should be noted that Range Sites were used because Ecological Sites have not yet been developed for the study area. Ecological Sites are similar to Range Sites but have been updated and expanded and are the most current site-specific descriptions developed by the NRCS. Ecological Sites may also have State and Transition Models that describe the potential dynamic changes in plant communities whereas Range Sites describe only one potential vegetation community. States are generally composed of one or more plant communities and are differentiated by thresholds of stability that are not reversible without significant input such as brush management or controlled burning. A transition is the changing between states triggered by natural events or management actions.

3.3.11 Seral State

Understanding the origin of seral states is important when interpreting the recommendations put forth in Range Site descriptions. These documents use somewhat antiquated terminology, but they are essentially based upon succession. Succession is defined as the directional replacement of species. There are two types of succession, primary and secondary. Primary succession takes place on soils essentially devoid of vegetation and complex structure. These conditions often arise from extreme disturbances such as, intense wildfires, volcanic eruption and severe overgrazing. Small, annual plants are usually the first to colonize these sites, followed by biennials and short-duration perennials. The structure and diversity of plant communities continues to develop as conditions begin to favor longer-lived perennial grasses and forbs. In the absence of major disturbance, communities eventually become more static and reach a state where little observable change occurs (Heady & Child 1994). Secondary succession refers to the smaller movements of vegetation communities along the gradient of seral states.

A seral state is simply a vegetation type that exists at a given point in time. In other words, the seral state is a place along the continuum of succession that a plant community currently occupies. Seral states are organized into the broad categories of early, mid, late and potential natural community (PNC). Early seral states represent the initial colonization of a soil and establishment of quick-maturing plants. Mid seral states encompass the displacement of these species by longer-duration plants and are often characterized by increased species diversity. Late seral states represent established plant communities in which species displacement has begun to dissipate. The final state, PNC, indicates that forward succession has essentially halted and the community has become stable.

Range Site descriptions use condition classes (poor, fair, good and excellent). These classes, in current vernacular, are similar to the four seral state categories and, like seral states, indicate the present vegetation type as compared to the potential climax vegetation community. The climax community in a Range Site is referred to as a Historic Climax Plant Community (HCPC) in Ecological Site descriptions.

Each seral state is correlated with the following percentages that indicate how close the vegetation of a certain area is to the climax community described in the Range Site description: early 0-25, mid 26-50, late 51-75, and PNC 76-100. A seral state comparison was completed for each transect on the District Five project For example, the vegetation component of a transect may be analyzed as 20, which would indicate that the plant community is 20% similar to what would be expected at the climax community described for the Range Site. A community that is 20% similar would fall within the range of an early seral state (0-25).

Each Range Site description has a table showing pounds per acre of annual, useable air dry forage in both favorable and unfavorable years. The table is further subdivided into the condition classes of poor, fair, good and excellent. These numbers represent the amount of forage per acre that a Range Site would produce in a given condition. As each transect has been compared against its potential, the Plant Community Production was selected from the excellent (PNC) category. To illustrate, a Loamy Range Site within the PNC range (76-100%) of similarity to the climax vegetation community should produce 280 pounds of forage in a favorable year and 140 pounds in an unfavorable year. Averaged together, production becomes 210 pounds per acre. The favorable and unfavorable figures were averaged to represent an average year. We referred to this average production as the “Plant Community Production”. The “Allowable Percent” represents the percent composition of each plant that would be expected within PNC. For example, if on a Loamy Range Site the reconstructed weight of *Pleuraphis jamesii* was 200 pounds, it would comprise 95 % of the plant community (200 divided by 210). However, within PNC, *Pleuraphis jamesii* should not exceed 35% of the total or 73.5 pounds per acre (210 multiplied by 35%). The resulting 73.5 pounds per acre was called "Pounds Allowable". The sum of the pounds allowable divided by the plant community production resulted in a similarity comparison rating. This procedure was verified by Karlynn Huling and Arizona State Range Conservationist Steve Cassady.

3.3.12 Assessing Apparent Trend

Trend is a rating of the direction of change that may be occurring on a site. The plant community and the associated components of the ecosystem may be either moving toward or away from the climax vegetation community or some other desired plant community or vegetation state. Alternately, the trend may not be perceptible. There are two common types of trend determination: Apparent Trend and Measured Trend. In order to determine a measured trend baseline data needs to be established for the area of assessment. Apparent trend is just a snapshot of what is apparently occurring on the site at the present time. For monitoring purposes it is necessary to develop a measured trend over time. Attributes for evaluating trend include composition changes, recruitment of young plants, plant vigor, and condition of soil surface. The most comprehensive and accurate way to measure trend is to evaluate all of these attributes. Apparent Trend for this inventory was determined primarily by the frequency and composition of PNC plants. This was measured indirectly by comparison of the described climax community in the Range Site to the current plant community and directly by species frequency data. If the current plant community is changing due to prolonged over-grazing, the perennial species that are most sensitive to damage by grazing will decrease (decreaser species). Increaser species and invader species will replace the decreaser species as disturbance increases. This will lead to a change in species composition in a direction away from the climax community.

3.3.13 Carrying Capacity and Stocking Rates

Stocking rate is the maximum number of kinds and classes of animals grazing a specific area of land for a specific period of time. Carrying capacity for rangeland management purposes defines the number of grazing animals (maximum stocking rate) that a specified area is able to support without depleting the forage resources of that area. Carrying capacity may incorporate both domestic and wild grazing animals, and the capacity may vary annually in response to forage production.

The stocking rate recommendations for the District Five project area are based on the Range Sites established in the 1971 Navajo Area Tuba City Agency District Five Soil and Range Inventory Technical Report. The stocking rates in the Range Site descriptions are based upon total allowable production in a normal year. Each Condition Class lists a range of allowable production associated with a range of stocking rates. The range of allowable production was averaged for each condition class. The range of allowable production was then correlated with the range of stocking rates. To produce a single stocking rate, rather than a range of possible stocking rates, the range of allowable production was divided by the range of stocking rates to produce single rate of allowable pounds of production per sheep unit.

As an example, the Thin Breaks Range Site has an expected allowable production value of 120 pounds for an “Excellent” condition class in an average year. The highest expected value for a “Good” condition class in an average year is 97.5. This is a range of 22.5 pounds of allowable production for the excellent condition class. The stocking rate for the excellent condition class has a range of 19-23 acres per sheep unit. This is a range of 5 sheep units. 22.5 pounds of allowable production divided by 5 sheep units equals a rate of 4.5 pounds of allowable production per sheep unit. So for every 4.5 pounds of allowable production the sheep units will change by a factor of 1 when the measured transect in the Thin Break site falls into the “Excellent” condition class.

A stocking rate was assigned to each Range Site within each Compartment based upon the above methodology. The average pounds of allowable production was used to determine the stocking rate for each Range Site within each Compartment. That rate was then applied to the total number of acres for that Range Site. To estimate the sheep units for the Range Site within that Compartment the total acres were divided by the stocking rates to provide a number of sheep units. The sheep units were then totaled for all of the Range Sites within a Compartment, resulting in a total number of sheep units for the entire Compartment.

4.0 RESULTS

A total of 1,220 transects were located on District Five. The attributes analyzed from the data were total forage production, similarity comparison to potential natural community, ground cover, and species frequency as well as overall trend. Each Compartment was analyzed by the Range Sites present within it. A Range Site within a Compartment is referred to herein as a Unit. There are a total of 76 Units on District Five, not including those Range Sites with no production criteria (Non-Usable, Badlands and Rough Breaks). The data were aggregated by Compartment to provide useful management applications of the results. The table in Appendix G combines results for all Compartments.

The total recommended carrying capacity of District 5 is 14, 741 sheep units year long, however this includes acreage that may be inaccessible to livestock and should be excluded from the carrying capacity. The average permitted sheep units for the last ten years was 11, 261 sheep units. Several Units were not sampled. In general, these were areas of very small acreage, and range condition could be extrapolated from a contiguous Range Site located in an adjacent Compartment. In three cases, the range condition could not be extrapolated by this method due to an absence of adjacent, sampled Range Sites. These locations are in Compartment 12 (0.008 acres), the Clayey Range Site and in Compartment 14, the Shallow (373.5 acres) and Very Shallow (424.1 acres) Range Sites. The former site was excluded from calculations due to its insignificant size. The two latter sites were calculated using the average stocking rate for Shallow and Very Shallow Range Sites, respectively.

In general, Compartments in the best condition were 2, 3, 4, 5 and 6. These Compartments each received an average Condition Class rating of Excellent and a Seral State at PNC. The Units adjacent to the major drainages appear to be suffering. The Compartments in the worst condition were 11, 12 and 15. The maps in Appendix H illustrate seral states across the District.

By far the largest category of ground cover throughout the District was Bare Ground. Compartment 3 had the highest percentage of Bare Ground with 70%. Litter was the next most frequent ground cover overall. The percentage of Litter for each Compartment was between 17% and 20%. In descending order, Canopy, Rock/Gravel, Basal and Biocrust followed Bare Ground and Litter in frequency. In all compartments, Bio Crust was less than 1%. Basal cover ranged between 0.63% and 0.65% for all Compartments.

Frequency of indicator species was averaged by Unit and is presented by Compartment. All Range Sites were included in the analysis. The results across the District by Range Site indicated that there were no decreaser species found in any of the Loamy sites or Saline Upland sites. Decreaser frequency was highest in the Cinders sites, followed by the Limestone sites. Black grama (*Bouteloua eriopoda*) was the most common decreaser species in the District, while snake weed (*Gutierrezia sarothrae*) was the most frequent increaser species. Analysis by compartment demonstrated an inverse proportion between decreaser species and increaser and invader species. Figures 4.1 and 4.2 show the average frequency of indicator species by Compartment and Range Site.

Figure 4.1 Average Percent Frequency of Indicator Species by Compartment

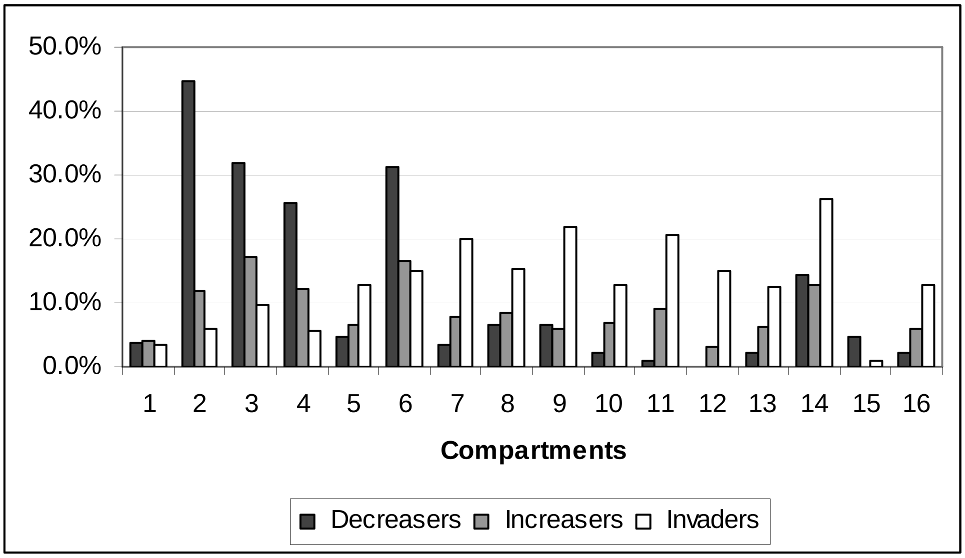
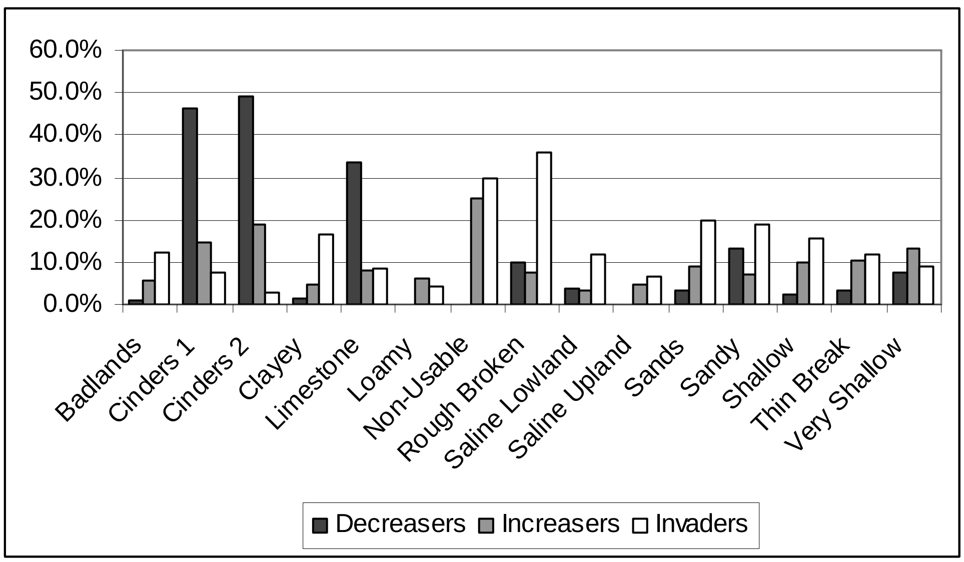


Figure 4.2 Average Percent Frequency of Indicator Species by Range Site



The abundance of increaser and invader species relative to the frequency of decreaser species is one indication of the trend of the rangeland resource. The frequency of increaser and invader species outnumbered the frequency of decreaser species throughout the project area. In addition, there was more diversity of increaser species than decreaser species in each compartment or Range Site. This frequency comparison suggests that the composition of the rangelands in District Five are, in general, trending away from the potential natural community.

Invasive non-native plants occur throughout the District. The Arizona Wildlands Invasive Plant Working Group, a collaborative of various organizations federal agencies, published a pamphlet in August of 2005 titled "Invasive Non-Native Plants That Threaten Wildlands in Arizona."

Plants were ranked into High, Medium, and Low categories according to their ecological impacts. Russian knapweed (*Centaura* [*Acroptilon*] *repens*) and cheatgrass (*Bromus tectorum*) are two species which are ranked High and occur in District Five. Tamarisk (*Tamarix* sp.), a High category species, occurred along most of the Little Colorado River drainage, but was considered a tree for the purposes of this survey and was not recorded. Camelthorn (*Alhagi maurorum*) and Filaree (*Erodium circutarium*) are plants occurring in District Five which are ranked Medium. Russian thistle (*Salsola* spp.), another Medium ranked species, occurred on almost half of all transects (570 out of 1220 total transects). Figure 4.3 illustrates the distribution of invasive and non-native species in District Five by transect, with the exception of Russian thistle due to its ubiquity.

The comparison of condition class between the 1971 inventory, as illustrated in the District Five Soil and Range Inventory Technical Report, and the 2006 Inventory shows an increase in percentage of acreage in good condition and a decrease in percentage of acreage in poor and fair condition (Figure 4.4). The combination of "Good" and "Excellent" condition classes in 1971 was 9% of the total acreage, and had increased to 34% by 2006.

The current total recommended Stocking Rate for the District as a whole is 14,727.3 sheep units year round. This number includes the removal of 3,309.6 sheep units in Units determined to be in poor condition. However, this figure does not exclude acreage which may be unusable due to slope, homesites, or excessive distance from water.

Figure 4.3 Invasive Non-Native Plants

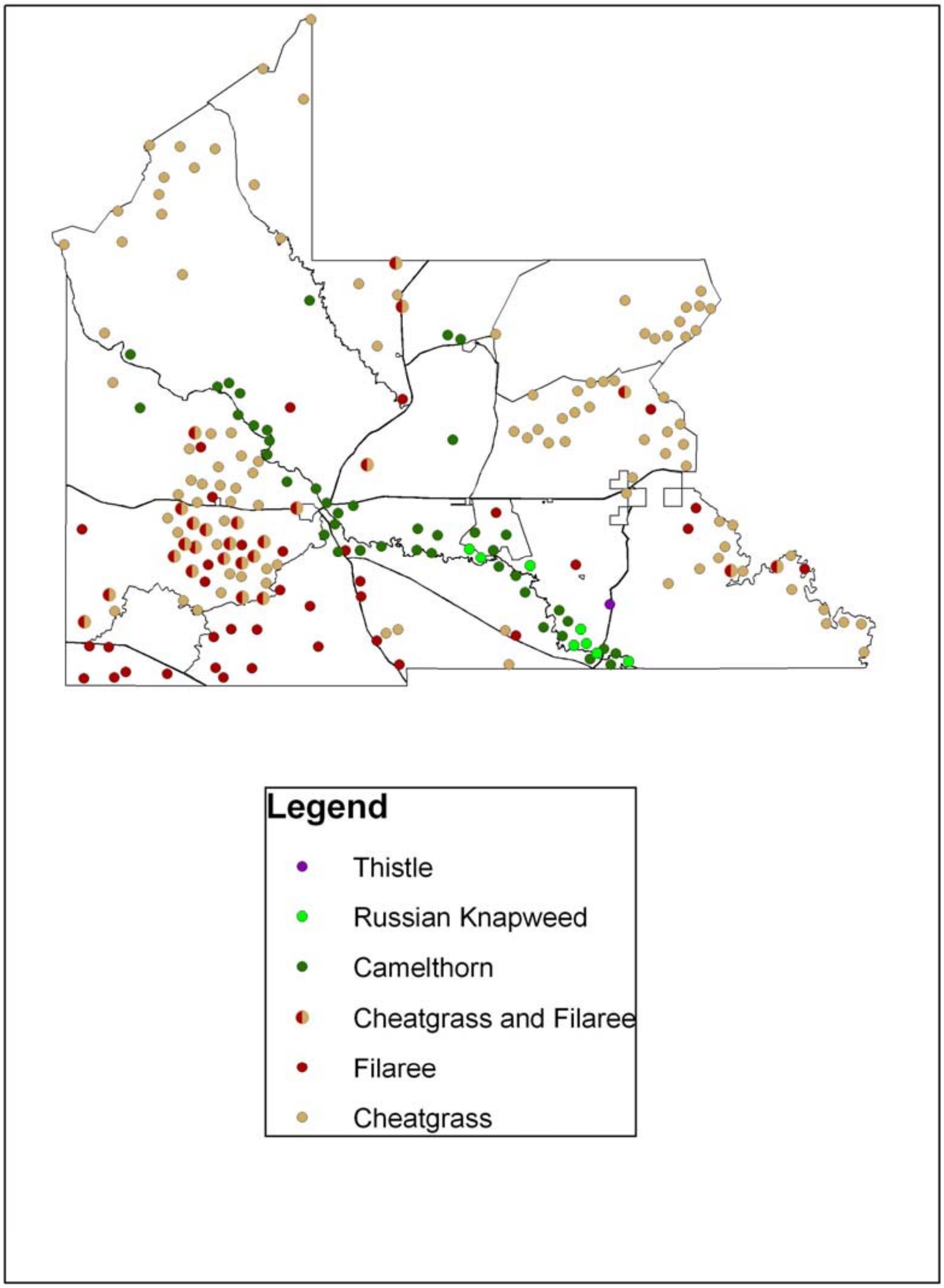
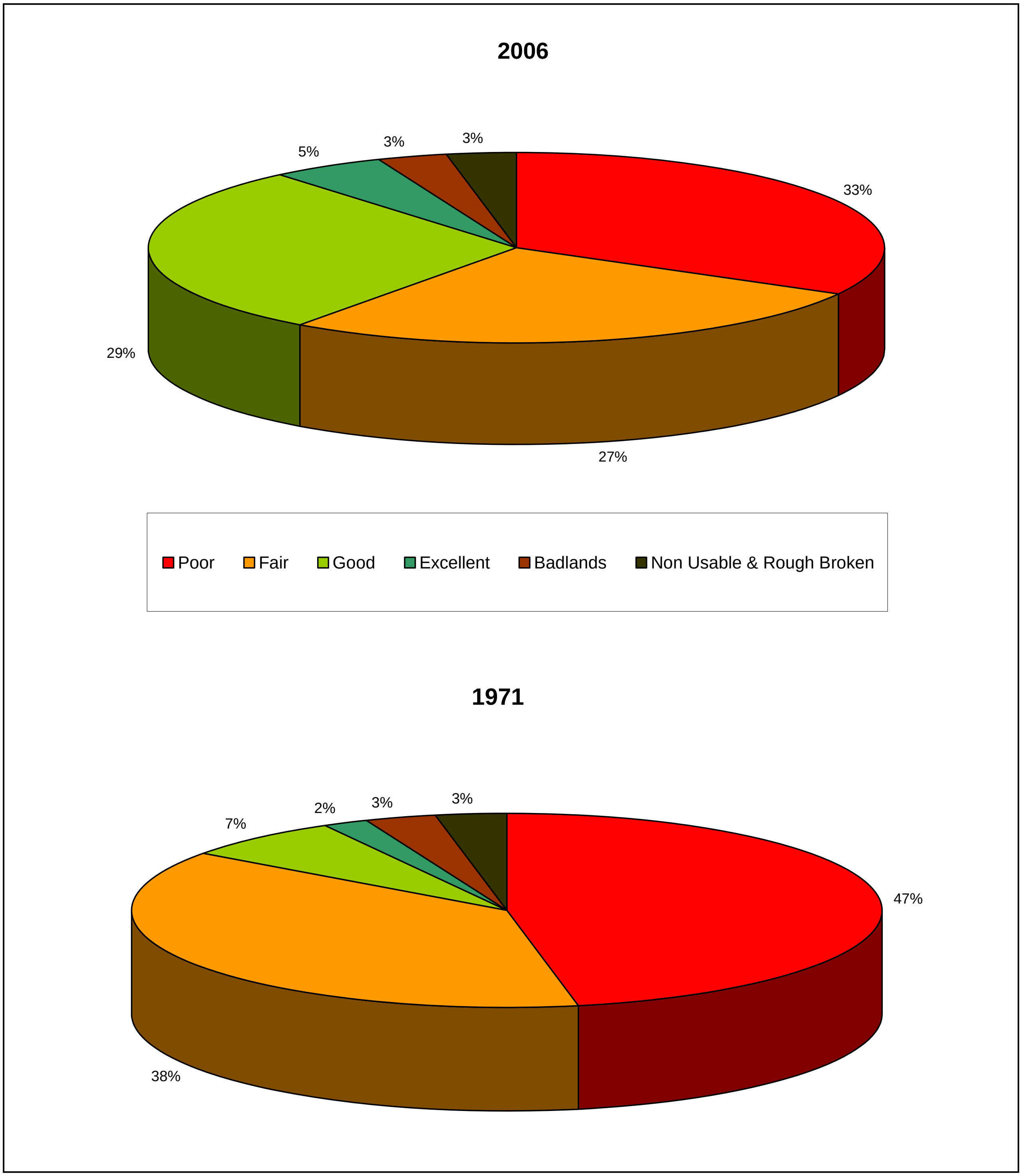


Figure 4.4 Comparison of Range Condition

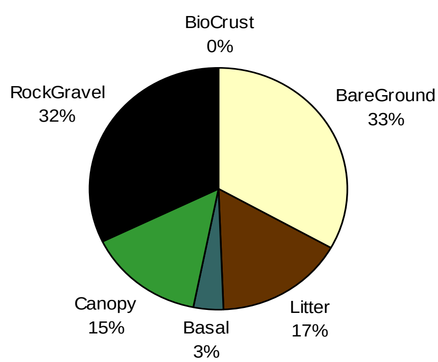


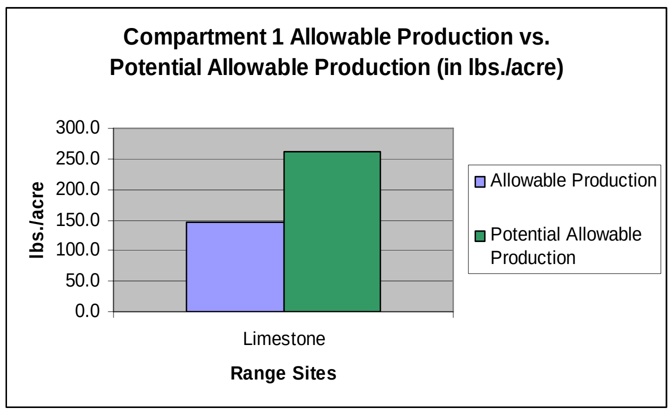
4.1 Compartment One

In Compartment 1 data were collected on 16 transects in the Limestone Range Site. The maximum stocking rate for this Range Site was 16 acres per sheep unit. The recommended carrying capacity is 514 sheep units year long for Compartment 1.

Transects	Range Site	Trend	Condition Class	Seral State	Stocking Rate (Acres/SU) Year Long	Acres	Carrying Capacity in Sheep Units Year Long	Sheep Units Recommended for Deferral	Recommended Carrying Capacity SU Year Long
16	Limestone	Towards	Good	Late	16	8,222	514		
16						**8,222**	**514**		**514**

The transects within the Limestone Range Site had an average similarity comparison of 56% to the climax community described in the Range Site, indicating a late seral state. Ground cover results indicate that Compartment 1 had the least amount of bare ground of any Compartment, with 33%, and also the highest percentage of basal cover at 3%. Compartment 1 had the highest frequency of needle and thread grass (*Stipa comata*) in the District.





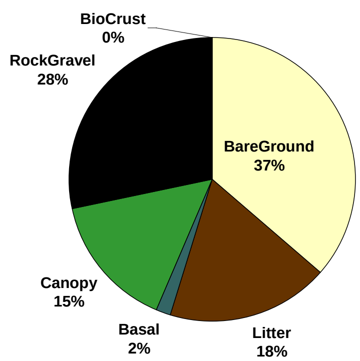
Compartment 1 Frequency of Indicator Species		Limestone
Decreasers	Agropyron smithii	
	Bouteloua eriopoda	1.3%
	Elymus elymoides	
	Stipa comata	6.3%
Increasers	Atriplex confertifolia	0.6%
	Chrysothamnus nauseosus	3.1%
	Gutierrezia sarothrae	8.8%
	Muhlenbergia pungens	
Invaders	Astragalus spp.	3.1%
	Salsola kali	3.8%

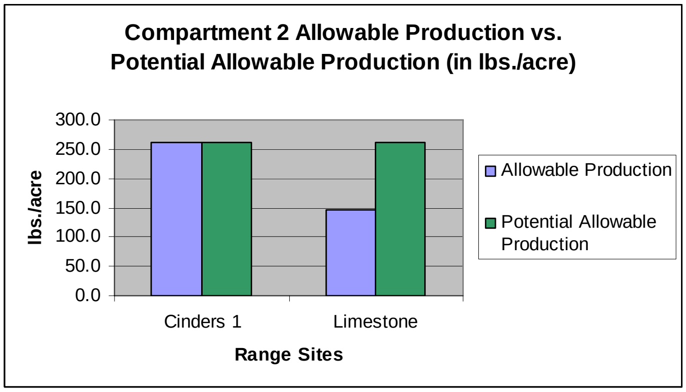
4.2 Compartment Two

In Compartment 2 data were collected on 22 transects. One transect was located in the Cinders 1 Range Site, and 21 transects were located in the Limestone Range Site. The maximum stocking rate for the Cinders 1 Range Site was 9 acres per sheep unit, and 17 acres per sheep unit for the Limestone Range Site. The recommended carrying capacity is 685 sheep units year long.

Transects	Range Site	Trend	Condition Class	Seral State	Stocking Rate (Acres/SU) Year Long	Acres	Carrying Capacity in Sheep Units Year Long	Sheep Units Recommended for Deferral	Recommended Carrying Capacity SU Year Long
1	Cinders 1	Towards	Excellent	PNC	9	591	66		
21	Limestone	Towards	Good	Late	17	10,534	620		
22						**11,124**	**685**		**685**

For the Limestone Range Site the 56% similarity comparison to the climax community described in the Range Site indicated a late seral state. In the Cinders 1 Range Site, the similarity comparison of 100% indicated these areas were within the PNC, although data is derived from a single transect. Ground cover results indicate a good percentage of vegetative cover. Compartment 2 had a very high percentage of black grama (*Bouteloua eriopoda*), a decreaser species.





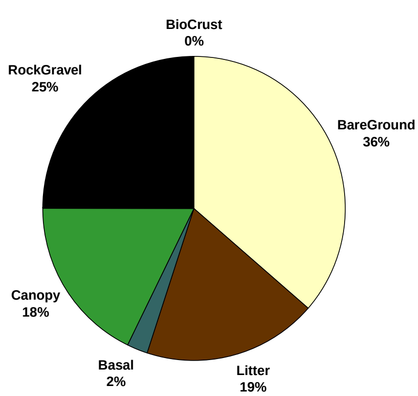
Compartment 2 Frequency of Indicator Species		Cinders 1	Limestone
Decreasers	Agropyron smithii		
	Bouteloua eriopoda	60.0%	29.5%
	Elymus elymoides		
	Stipa comata		
Increasers	Atriplex confertifolia		0.5%
	Chrysothamnus nauseosus	30.0%	1.0%
	Gutierrezia sarothrae		16.2%
	Muhlenbergia pungens		
Invaders	Astragalus spp.		2.4%
	Salsola kali		9.5%

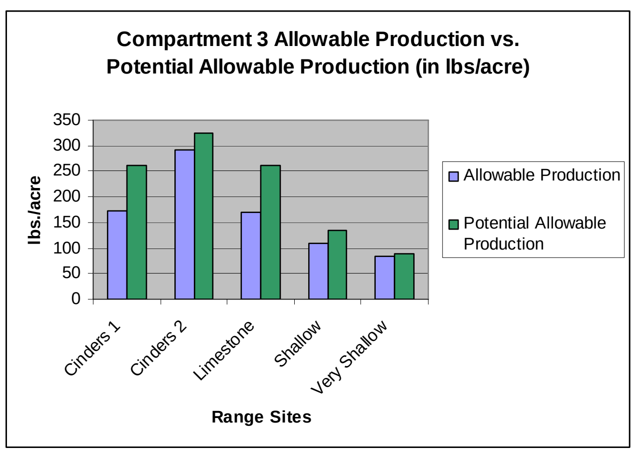
4.3 Compartment Three

In Compartment 3 data were collected on 95 transects. Twenty-two transects were located in the Cinders 1 Range Site, and 11 transects were located in the Cinders 2 Range Site, 47 transects were located in the Limestone Range Site, six transects in the Shallow Range Site, and nine in the Very Shallow Range Site. The maximum stocking rates were 14 acres per sheep unit for the Cinders 1 Range Site, seven for the Cinders 2 Range Site, 14 for the Limestone Range Site, 21 for the Shallow Range Site and 27 for the Very Shallow Range Site. The recommended carrying capacity is 3,499 sheep units year long for Compartment 3.

Transects	Range Site	Trend	Condition Class	Seral State	Stocking Rate (Acres/SU) Year Long	Acres	Carrying Capacity in Sheep Units Year Long	Sheep Units Recommended for Deferral	Recommended Carrying Capacity SU Year Long
22	Cinders 1	Towards	Good	Late	14	10,189	728		
11	Cinders 2	Towards	Excellent	PNC	7	5,180	740		
47	Limestone	Towards	Good	Late	14	23,917	1,708		
6	Shallow	Towards	Excellent	PNC	21	2,153	103		
9	Very Shallow	Towards	Excellent	PNC	27	5,955	221		
95						**47,394**	**3,499**		**3,499**

For the Cinders 1 Range Site, similarity to the climax community described in the Range Site was 66% indicating a late seral state. In the Cinders 2 Range Site similarity to the climax community was 90% indicating these areas were within the PNC. In the Limestone Range Site similarity to the climax community was 65% indicating a late seral state. The Shallow Range Site had a similarity comparison of 81% and the Very Shallow Range Site had a similarity comparison of 93%. Both Range Sites were within their PNC. Vegetative cover in Compartment 3 totaled 20% of the total ground cover, the most of any compartment. Frequency of decreaser species in Compartment 3 was generally higher in the Cinders and Limestone sites than in the Shallow and Very Shallow sites. Overall the frequency of decreasers and increasers in Compartment 3 was above average for the District.





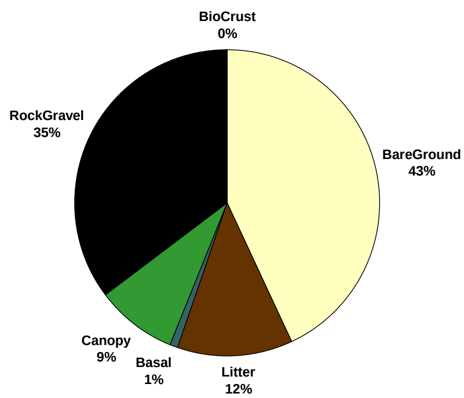
Compartment 3 Frequency of Indicator Species		Cinders 1	Cinders 2	Limestone	Shallow	Very Shallow
Decreasers	Agropyron smithii					
	Bouteloua eriopoda	52.7%	80.9%	42.1%	1.7%	13.3%
	Elymus elymoides		0.9%			
	Stipa comata					
Increasers	Atriplex confertifolia			16.4%	31.7%	43.3%
	Chrysothamnus nauseosus	15.0%	22.7%	2.6%	6.7%	
	Gutierrezia sarothrae	12.7%	13.6%	18.3%	5.0%	20.0%
	Muhlenbergia pungens					
Invaders	Astragalus spp.	0.5%		13.0%		4.4%
	Salsola kali	18.6%	3.6%	9.6%	18.3%	10.0%

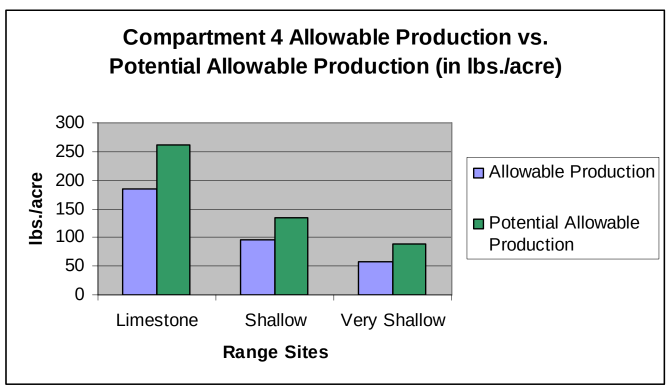
4.4 Compartment Four

In Compartment 4 data were collected on 75 transects. One transect in this compartment (#671) could not be assigned a Range Site due to its location outside of the delineated Range Site area for District Five. Twenty-four transects were located in the Limestone Range Site, 26 transects in the Shallow Range Site, and 24 in the Very Shallow Range Site. The maximum stocking rates were 12 acres per sheep unit for the Limestone Range Site, 25 for the Shallow Range Site and 24 for the Very Shallow Range Site. The recommended carrying capacity is 2,086 sheep units year long for Compartment 4.

Transects	Range Site	Trend	Condition Class	Seral State	Stocking Rate (Acres/SU) Year Long	Acres	Carrying Capacity in Sheep Units Year Long	Sheep Units Recommended for Deferral	Recommended Carrying Capacity SU Year Long
24	Limestone	Towards	Excellent	PNC	12	12,960	1,080		
26	Shallow	Towards	Good	Late	25	14,033	561		
24	Very Shallow	Towards	Good	Late	24	10,660	444		
74						**37,654**	**2,086**		**2,086**

In the Limestone Range Site the 70% similarity comparison indicated a state within the PNC. In the Shallow and Very Shallow Range Sites, both Range Sites were in a late seral state, the Shallow Range Site had a similarity of 83% to the climax vegetation community described in the Range Site, while the Very Shallow Range Site had a similarity of 74%. Vegetative cover in Compartment 4 was relatively low with only 10% combined canopy and basal cover. The rock and gravel content of Compartment 4 was extremely high at 35%. Frequency of decreaser species was highest on the Limestone Range Site, and low on the other sites.





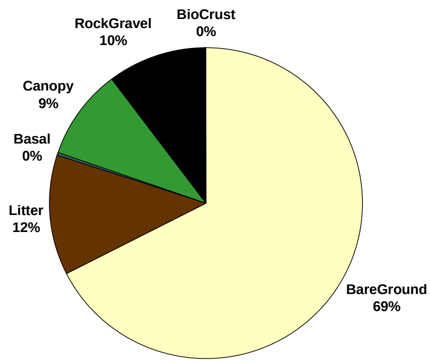
Compartment 4 Frequency of Indicator Species		Limestone	Shallow	Very Shallow
Decreasers	Agropyron smithii			
	Bouteloua eriopoda	62.9%	4.6%	9.6%
	Elymus elymoides			
	Stipa comata			
Increasers	Atriplex confertifolia	1.7%	20.0%	19.6%
	Chrysothamnus nauseosus	2.5%		0.8%
	Gutierrezia sarothrae	11.3%	2.3%	10.4%
	Muhlenbergia pungens			
Invaders	Astragalus spp.	7.1%	0.4%	2.5%
	Salsola kali		10.8%	7.1%

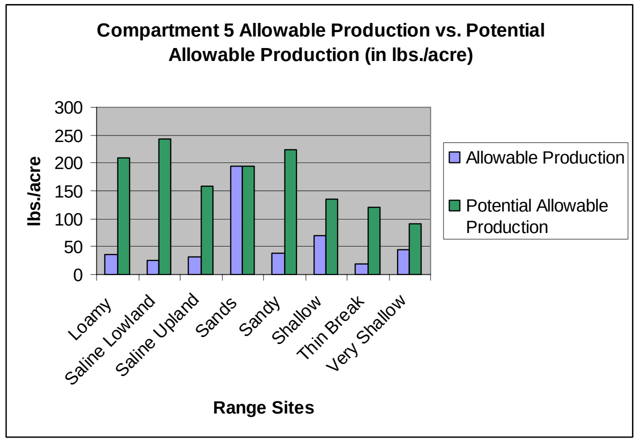
4.5 Compartment Five

In Compartment 5 data were collected on 241 transects. One transect fell in a Non-Usable area, 16 transects were in a Badlands Range Site, 31 transects in the Loamy range site, 27 transects in Saline Lowland, 46 transects in Saline Upland, one transect in the Sands Range Site, 85 transects in Sandy, eight transects in Shallow, three transects in Thin Break and 23 transects in the Very Shallow Range Site. The maximum stocking rates were zero in the Non-Usable and Badlands areas, 51 acres per sheep unit for Loamy Range Site, 62 in Saline Lowland, 58 in Saline Upland, 12 in Sands, 51 in Sandy, 33 in Shallow and 75 in Thin Break. The recommended carrying capacity is 402 sheep units year long for Compartment 5.

Transects	Range Site	Trend	Condition Class	Seral State	Stocking Rate (Acres/SU) Year Long	Acres	Carrying Capacity in Sheep Units Year Long	Sheep Units Recommended for Deferral	Recommended Carrying Capacity SU Year Long
1	Non Usable	N/A	N/A	N/A		789			
16	Badlands	N/A	N/A	N/A	0	6,542	0		
31	Loamy	Away	Poor	Early	51	15,706	308	**308**	
27	Saline Lowland	Away	Poor	Early	62	13,829	223	**223**	
46	Saline Upland	Away	Poor	Early	58	24,330	419	**419**	
1	Sands	Towards	Excellent	PNC	12	665	55		
85	Sandy	Away	Poor	Early	51	40,330	791	**791**	
8	Shallow	Towards	Good	Late	32	3,497	109		
3	Thin Break	Away	Poor	Early	75	1,210	16	**16**	
23	Very Shallow	Not Apparent	Fair	Mid	53	12,566	237		
241						**119,465**	**2,159**	**1,757**	**402**

The best Range Site in the Compartment was the Sands Range Site, with an average similarity to the climax comunity of 100%. (Unfortunately, this is also the Range Site with the least amount of acreage and the data is based on one transect.) The Shallow Range Site had a similarity to the climax community of 52% and indicated a late seral state. The Very Shallow Range Site had a similarity comparison of 49% which indicated a mid seral state. The remainder of the Range Sites were in poor condition and in early seral states with similarity comparisons of 2% for Loamy, 15% for Saline Lowland, 30% for Saline Upland, 23% for Sandy, and 25% for Thin Break. Vegetative cover in Compartment 5 was low with 9% canopy cover. The large majority of ground cover in Compartment 5 consisted of bare ground. Compartment 4 had a low frequency of decreaser species, consisting only of black grama (*Bouteloua eriopoda*) which was present in only three of the ten Range Sites in the Compartment. Compartment 5 also had a higher than average frequency of increaser species for the District.





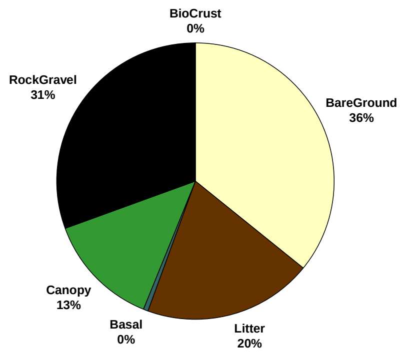
Compartment 5 Frequency of Indicator Species		Badlands	Loamy	Saline Lowland	Saline Upland	Sands	Sandy	Shallow	Thin Break	Very Shallow
Decreasers	Agropyron smithii									
	Bouteloua eriopoda	1.9%					4.1%			8.3%
	Elymus elymoides									
	Stipa comata									
Increasers	Atriplex confertifolia	13.1%	1.3%	4.1%	10.9%		6.1%	15.0%	30.0%	13.0%
	Chrysothamnus nauseosus			0.4%			2.0%			3.5%
	Gutierrezia sarothrae	0.6%	1.6%		0.2%	10.0%	5.1%			7.0%
	Muhlenbergia pungens		1.0%		2.8%		1.3%			
Invaders	Astragalus spp.	6.9%	5.8%	0.4%	1.7%		4.6%	13.8%	3.3%	7.4%
	Salsola kali	26.3%		11.5%	11.7%		22.9%	16.3%	3.3%	17.4%

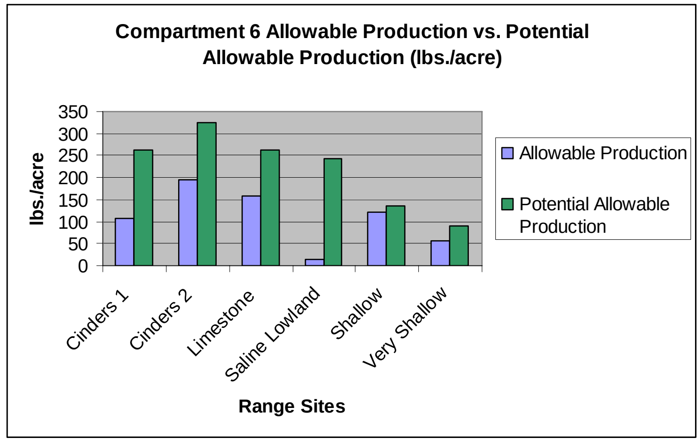
4.6 Compartment Six

In Compartment 6 data were collected on 107 transects. One transect fell in a Non-Usable area, 39 transects were in the Cinders 1 Range Site, 10 transects in the Cinders 2 range site, four transects were in the Limestone Range Site, four transects in Saline Lowland, one transect in Sandy, three transects in Shallow, and 45 transects in the Very Shallow Range Site. The maximum stocking rates were zero in the Non-Usable and Sandy areas, 22 acres per sheep unit in Cinders 1, 12 in Cinders 2, 15 in Limestone, 62 in Saline Lowland, 19 in Shallow and 41 in Very Shallow. The recommended carrying capacity is 1,987 year long sheep units for Compartment 6.

Transects	Range Site	Trend	Condition Class	Seral State	Stocking Rate (Acres/SU) Year Long	Acres	Carrying Capacity in Sheep Units Year Long	Sheep Units Recommended for Deferral	Recommended Carrying Capacity SU Year Long
1	Non Usable		N/A	N/A		918			
39	Cinders 1	Not Apparent	Fair	Mid	22	18,815	855		
10	Cinders 2	Towards	Fair	Late	14	4,305	308		
4	Limestone	Towards	Good	Late	15	2,729	182		
4	Saline Lowland	Away	Poor	Early	62	2,093	34	**34**	
1	Sandy	Away	Poor	Early	0	197	0	**0**	
3	Shallow	Towards	Excellent	PNC	19	1,803	95		
45	Very Shallow	Towards	Good	Late	41	22,469	548		
107						**53,327**	**2,021**	**34**	**1,987**

The best Range Site in the Compartment was the Shallow Range Site, with an average similarity to the climax community of 90%. The Very Shallow and Limestone Range Sites were in late seral states with average similarity comparisons of 64% and 61%. The Cinders 2 Range Site had a similarity of 60% indicating a late seral state. Cinders 1 was in a mid seral state with a 41% similarity, while Saline Lowland and Sandy were both in early seral states with similarities of 5% and 0%. The results for the Sandy Range Site are based on only one transect. Vegetative cover in Compartment 6 was moderate with 13% canopy cover and 29% litter. Frequency of all indicator species in Compartment 6 was above average for the District. Frequency of decreaser species was highest in the Cinders and Limestone sites due to the prevalence of black grama (*Bouteloua eriopoda*). The variability of results in some sites may be a factor of the small sample size.





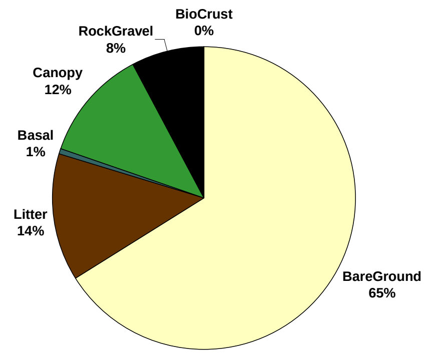
Compartment 6 Frequency of Indicator Species		Cinders 1	Cinders 2	Limestone	Saline Lowland	Sandy	Shallow	Very Shallow
Decreasers	Agropyron smithii							
	Bouteloua eriopoda	25.6%	66.0%	60.0%				2.4%
	Elymus elymoides				2.5%			
	Stipa comata							
Increasers	Atriplex confertifolia	6.7%		12.5%	20.0%		56.7%	21.6%
	Chrysothamnus nauseosus	12.1%	29.0%	5.0%	2.5%			1.8%
	Gutierrezia sarothrae	12.8%	10.0%	22.5%			6.7%	12.2%
	Muhlenbergia pungens							
Invaders	Astragalus spp.	4.1%		15.0%			3.3%	1.8%
	Salsola kali	6.7%	2.0%	15.0%		50.0%	33.3%	18.9%

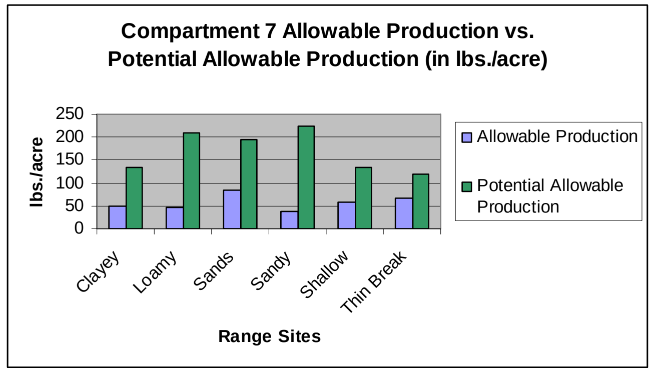
4.7 Compartment Seven

In Compartment 7 data were collected on 91 transects. One transect was located in a Non Usable area, 23 transects were located in Badlands, four transects were located in the Clayey Range Site, one transect was located in Loamy, one transect in Rough Broken, 39 transects in Sands, 15 transects in Sandy, four transects in Shallow and three transects in Thin Break. The maximum stocking rates were zero acres per sheep unit for the Non Usable and Badlands and Rough Broken areas, 52 acres per sheep unit in the Clayey Range Site, 50 in Loamy, 27 in Sands, 51 in Sandy, 46 in Shallow, and 33 acres per sheep unit in the Thin Break Range Site. The recommended carrying capacity is 1,020 year long sheep units for Compartment 7.

Transects	Range Site	Trend	Condition Class	Seral State	Stocking Rate (Acres/SU) Year Long	Acres	Carrying Capacity in Sheep Units Year Long	Sheep Units Recommended for Deferral	Recommended Carrying Capacity SU Year Long
1	Non Usable	N/A	N/A	N/A		246			
23	Badlands	N/A	N/A	N/A	0	8,828	0		
4	Clayey	Not Apparent	Fair	Mid	52	2,416	46		
1	Loamy	Away	Fair	Early	49	359	7		
1	Rough Broken	N/A	N/A	N/A	0	422	0		
39	Sands	Not Apparent	Good	Mid	27	23,857	884		
15	Sandy	Away	Poor	Early	51	6,000	118	118	
4	Shallow	Not Apparent	Fair	Mid	46	2,046	44		
3	Thin Break	Towards	Good	Late	33	1,243	38		
91						**45,417**	**1,137**	**118**	**1,020**

The Non Usable, Badlands, and Rough Broken areas have no criteria for similarity comparisons. The Clayey Range Site displayed a 36% similarity to the climax vegetation community indicating a mid seral state. The Loamy site had 23% similarity and was in an early seral state. The Sands similarity was 43%, in a mid seral state. Sandy areas were 17% similar and in an early seral state, as well as having a poor condition class. Shallow had a 42% similarity and a mid seral state while the Thin Break Range Site had an average 56% similarity indicating a late seral state. Vegetative cover for Compartment 7 was moderate with 13% combined canopy and basal. There was a very high quantity of bare ground at 65%. Frequency of decreaser species in Compartment 7 was low, while frequency of invader species in the Rough Broken sites was the highest in the District.





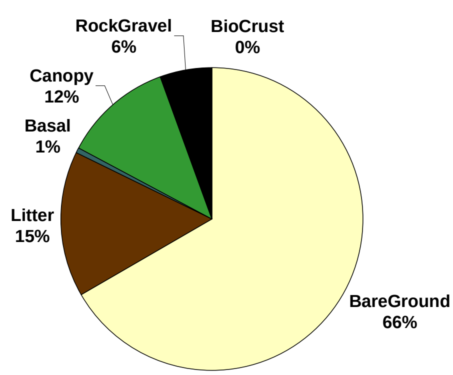
Compartment 7 Frequency of Indicator Species		Badlands	Clayey	Loamy	Rough Broken	Sands	Sandy	Shallow	Thin Break
Decreasers	Agropyron smithii								
	Bouteloua eriopoda	0.4%				1.0%		2.5%	6.7%
	Elymus elymoides								
	Stipa comata				10.0%	0.3%			
Increasers	Atriplex confertifolia	7.8%		20.0%		1.8%	1.3%	10.0%	20.0%
	Chrysothamnus nauseosus	1.3%	2.5%			1.8%		2.5%	
	Gutierrezia sarothrae	9.6%	2.5%			17.2%		2.5%	6.7%
	Muhlenbergia pungens	2.6%			10.0%	13.3%	19.3%	5.0%	
Invaders	Astragalus spp.	14.3%	5.0%		80.0%	22.3%	18.0%	15.0%	
	Salsola kali	15.7%	2.5%		60.0%	22.1%	4.0%	2.5%	6.7%

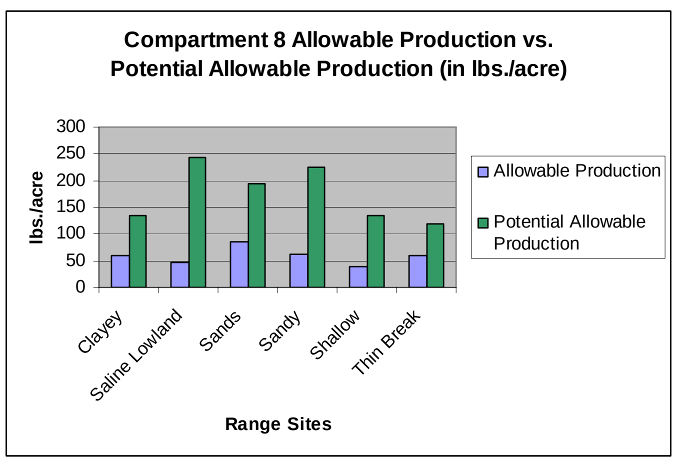
4.8 Compartment Eight

In Compartment 8 data were collected on 83 transects. One transect was located in the Clayey Range Site, 17 transects in Saline Lowland, 42 transects in Sands, five transects in Sandy, seven transects in Shallow and 11 transects in Thin Break. The maximum stocking rates were 41 acres per sheep unit in the Clayey Range Site, 56 in Saline Lowland, 27 in Sands, 43 in Sandy, 65 in Shallow, and 42 acres per sheep unit in the Thin Break Range Site. The recommended carrying capacity is 1,188 sheep units year long for Compartment 8.

Transects	Range Site	Trend	Condition Class	Seral State	Stocking Rate (Acres/SU) Year Long	Acres	Carrying Capacity in Sheep Units Year Long	Sheep Units Recommended for Deferral	Recommended Carrying Capacity SU Year Long
1	Clayey	Not Apparent	Good	Mid	40	1,146	29		
17	Saline Lowland	Away	Fair	Early	55	8,257	150		
42	Sands	Not Apparent	Good	Mid	26	21,565	829		
5	Sandy	Away	Fair	Mid	42	3,517	84		
7	Shallow	Away	Fair	Mid	64	2,317	36		
11	Thin Break	Not Apparent	Fair	Mid	42	4,060	97		
83						**40,862**	**1,225**		**1,188**

The Clayey Range Site and in the Sands Range site both had an average similarity to the climax vegetation community of 44% indicating mid seral states. Saline Lowland was 19% similar indicating an early seral state. The transects in the Sandy Range Site had an average similarity of 28% indicating a mid seral state. The Shallow Range Site had a similarity of 29%, in a mid seral state and Thin Break was 50% similar, also in a mid seral state. Ground cover results show 13% vegetative cover and a large percentage of bare ground at 66%. The measured frequency of biocrust in Compartment 8 was 0.09%, the highest in the District. Compartment 8 had an average frequency of all indicator species across the District.





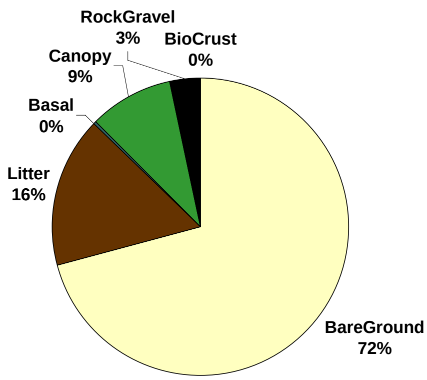
Compartment 8 Frequency of Indicator Species		Clayey	Saline Lowland	Sands	Sandy	Shallow	Thin Break
Decreasers	Agropyron smithii						
	Bouteloua eriopoda			5.0%	12.0%		2.7%
	Elymus elymoides						
	Stipa comata						
Increasers	Atriplex confertifolia			0.7%		7.1%	6.4%
	Chrysothamnus nauseosus	15.0%	0.6%	4.0%		1.4%	5.5%
	Gutierrezia sarothrae	7.5%	1.8%	20.2%	28.0%	5.7%	15.5%
	Muhlenbergia pungens			9.3%			4.5%
Invaders	Astragalus spp.			10.2%	10.0%	14.3%	11.8%
	Salsola kali	17.5%	24.7%	5.0%	10.0%	31.4%	17.3%

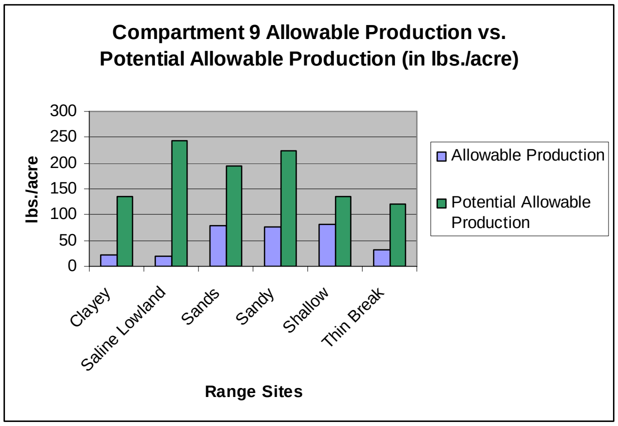
4.9 Compartment Nine

In Compartment 9 data were collected on 90 transects. Fifteen transects were located in the Clayey Range Site, nine transects in Saline Lowland, 46 transects in Sands, nine transects in Sandy, nine transects in Shallow and two transects in Thin Break. The maximum stocking rates were 102 acres per sheep unit in the Clayey Range Site, 62 in Saline Lowland, 31 in Sands, 37 in Sandy, 29 in Shallow, and 73 acres per sheep unit in the Thin Break Range Site. The recommended carrying capacity is 1,097 year long sheep units for Compartment 9.

Transects	Range Site	Trend	Condition Class	Seral State	Stocking Rate (Acres/SU) Year Long	Acres	Carrying Capacity in Sheep Units Year Long	Sheep Units Recommended for Deferral	Recommended Carrying Capacity SU Year Long
15	Clayey	Away	Poor	Early	102	7,118	70	**70**	
9	Saline Lowland	Away	Poor	Early	62	2,258	36	**36**	
46	Sands	Not Apparent	Fair	Mid	31	23,169	747		
9	Sandy	Away	Fair	Mid	37	2,701	73		
9	Shallow	Towards	Good	Late	28	7,170	256		
2	Thin Break	Away	Fair	Mid	73	1,513	21		
90						**43,930**	**1,203**	**106**	**1,097**

The best Range Site in Compartment 9 was the Shallow Range Site which had a similarity comparison of 61% and was in a late seral state. The Clayey and Saline Lowland Range Sites were in early seral states with average similarities of 16% and 9%, respectively. The remaining three Range Sites were in mid seral states with similarities of 40% in Sands, 34% in Sandy, and 27% in Thin Break. Ground cover in Compartment 9 was largely bare ground with only 9% vegetative cover. Frequencies of all indicator species in Compartment 9 were low, except for high frequencies in the Sandy Range Sites.





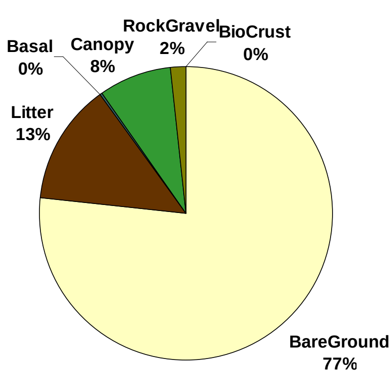
Compartment 9 Frequency of Indicator Species		Clayey	Saline Lowland	Sands	Sandy	Shallow	Thin Break
Decreasers	Agropyron smithii					1.1%	
	Bouteloua eriopoda			1.5%	23.3%		
	Elymus elymoides						
	Stipa comata			0.4%			
Increasers	Atriplex confertifolia		1.1%	0.2%		6.7%	
	Chrysothamnus nauseosus			4.8%	4.4%	2.2%	
	Gutierrezia sarothrae	0.7%		16.1%	23.3%	5.6%	
	Muhlenbergia pungens			2.8%		3.3%	5.0%
Invaders	Astragalus spp.	3.3%		14.8%	11.1%	7.8%	
	Salsola kali	46.7%	37.8%	12.8%	18.9%	20.0%	45.0%

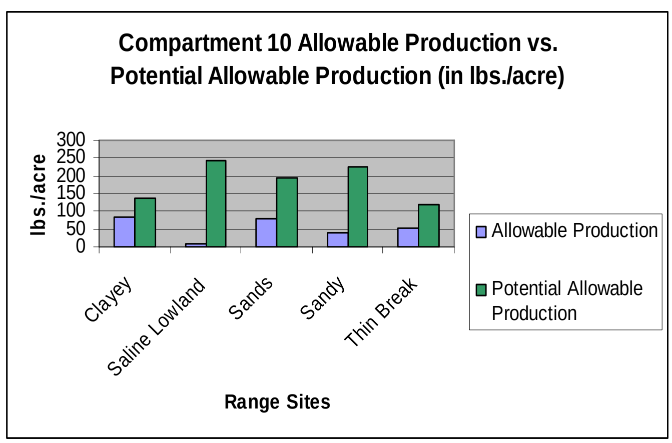
4.10 Compartment Ten

In Compartment 10 data were collected on 67 transects. Four transects were located in the Clayey Range Site, 22 transects in Saline Lowland, 30 transects in Sands, nine transects in Sandy, and two transects in Thin Break. The maximum stocking rates were 30 acres per sheep unit in the Clayey Range Site, 62 in Saline Lowland, 29 in Sands, 51 in Sandy, and 52 acres per sheep unit in the Thin Break Range Site. The recommended carrying capacity is 618 year long sheep units for Compartment 10.

Transects	Range Site	Trend	Condition Class	Seral State	Stocking Rate (Acres/SU) Year Long	Acres	Carrying Capacity in Sheep Units Year Long	Sheep Units Recommended for Deferral	Recommended Carrying Capacity SU Year Long
4	Clayey	Towards	Good	Late	30	2,551	85		
22	Saline Lowland	Away	Poor	Early	62	9,761	157	**157**	
30	Sands	Not Apparent	Fair	Mid	29	15,175	523		
9	Sandy	Away	Poor	Early	51	5,220	102	**102**	
2	Thin Break	Not Apparent	Fair	Mid	52	519	10		
67						**33,227**	**878**	**260**	**618**

The Clayey Range Site was the best Range Site in Compartment 10 with a 61% similarity indicating a late seral state. Sands and Thin Break were in mid seral states with 42% similarity in Sands and 43% similarity in Thin Break. Both Saline Lowland and Sandy were in early seral states with 4% and 18% similarity, respectively. Ground cover in Compartment 10 was primarily bare ground with only 8% vegetative cover. Compartment 10 had one of the highest frequencies of bottlebrush squirreltail (*Elymus elymoides*) in the District, and one of the lowest frequencies of *Astragalus* spp. Decreaser species were found only in the Sands Range Sites.





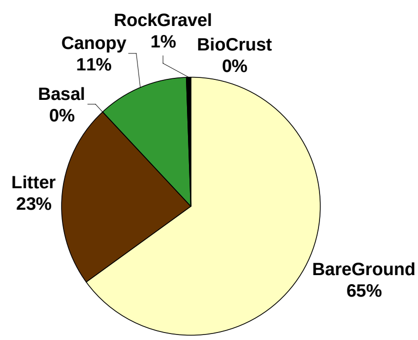
Compartment 10 Frequency of Indicator Species		Clayey	Saline Lowland	Sands	Sandy	Thin Break
Decreasers	Agropyron smithii					
	Bouteloua eriopoda			4.0%		
	Elymus elymoides			0.7%		
	Stipa comata					
Increasers	Atriplex confertifolia			1.0%	1.1%	
	Chrysothamnus nauseosus			1.7%	1.1%	10.0%
	Gutierrezia sarothrae		3.6%	30.7%	3.3%	5.0%
	Muhlenbergia pungens			10.3%		
Invaders	Astragalus spp.	2.5%		3.3%	1.1%	
	Salsola kali	25.0%	21.8%	9.3%	23.3%	15.0%

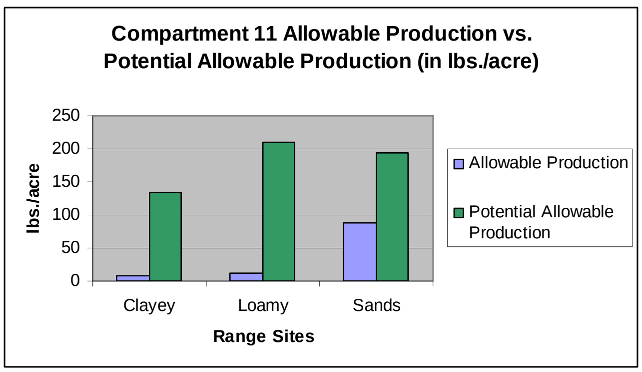
4.11 Compartment Eleven

In Compartment 11 data were collected on 34 transects. Nineteen transects were located in the Clayey Range Site, two transects in Loamy, and 13 transects in Sands. The maximum stocking rates were 102 acres per sheep unit in the Clayey Range Site, 51 in Loamy and 27 in Sands. The recommended carrying capacity is 194 sheep units year long for Compartment 11.

Transects	Range Site	Trend	Condition Class	Seral State	Stocking Rate (Acres/SU) Year Long	Acres	Carrying Capacity in Sheep Units Year Long	Sheep Units Recommended for Deferral	Recommended Carrying Capacity SU Year Long
19	Clayey	Away	Poor	Early	102	10,754	105	**105**	
2	Loamy	Away	Poor	Early	51	1,014	20	**20**	
13	Sands	Not Apparent	Good	Mid	26	5,048	194		
34						**16,817**	**319**	**125**	**194**

Transects in the Sands Range Site had an average similarity comparison of 45%, indicating a mid seral state. The Clayey and Loamy sites were in poor condition with 6% similarity each, indicating early seral states. The combined basal and canopy cover for Compartment 11 was average for the District, although it consisted almost entirely of canopy cover. Compartment 11 had extremely low frequencies of decreaser species and high frequencies of increaser and invader species. The Clayey Range Sites in the District were generally in poor condition, and Compartment 11 has a high percentage of Clayey sites; therefore the lack of basal cover and decreaser species is a consistent result.





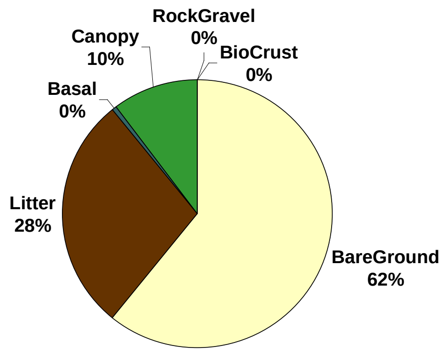
Compartment 11 Frequency of Indicator Species		Clayey	Loamy	Sands
Decreasers	Agropyron smithii	1.1%		
	Bouteloua eriopoda			
	Elymus elymoides			
	Stipa comata			
Increasers	Atriplex confertifolia			6.9%
	Chrysothamnus nauseosus			6.2%
	Gutierrezia sarothrae			18.5%
	Muhlenbergia pungens			4.6%
Invaders	Astragalus spp.		0.5%	19.2%
	Salsola kali	56.8%	6.3%	20.0%

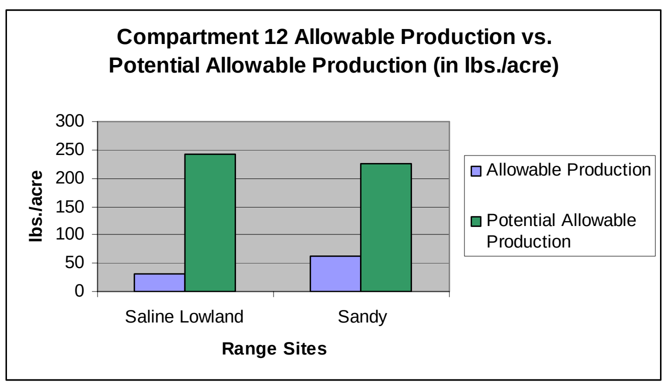
4.12 Compartment Twelve

In Compartment 12 data were collected on 27 transects. No transects were located in the Non Usable areas of Compartment 12, 25 transects were located in Saline Lowland, and two transects in Sands. The maximum stocking rates were 62 acres per sheep unit in the Saline Lowland Range Site and 44 in Sands. The recommended carrying capacity is 28 sheep units year long.

Transects	Range Site	Trend	Condition Class	Seral State	Stocking Rate (Acres/SU) Year Long	Acres	Carrying Capacity in Sheep Units Year Long	Sheep Units Recommended for Deferral	Recommended Carrying Capacity SU Year Long
0	Non Usable		N/A	N/A		762			
25	Saline Lowland	Away	Poor	Early	62	11,463	185	185	
2	Sandy	Away	Fair	Mid	43	1,211	28		
27						**13,436**	**213**	**185**	**28**

The transects in the Saline Lowland Range Site had an average similarity comparison to the climax vegetation community of 13% indicating an early seral state. The Sandy Range Site was in a mid seral state with a 27% similarity. Ground cover analysis in Compartment 12 indicated the lowest percentage of rock and gravel areas, and the highest percentage of litter in District Five. There were no decreaser species found in Compartment 12, and the frequency of increaser and invader species was not low, suggesting disturbance and grazing pressure.





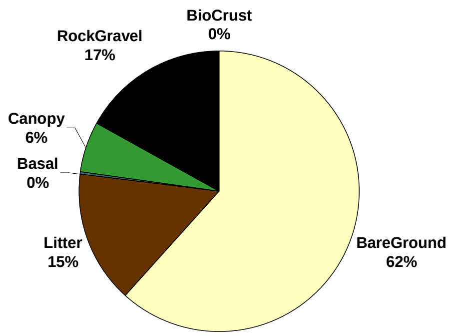
Compartment 12 Frequency of Indicator Species		Saline Lowland	Sandy
Decreasers	Agropyron smithii		
	Bouteloua eriopoda		
	Elymus elymoides		
	Stipa comata		
Increasers	Atriplex confertifolia		
	Chrysothamnus nauseosus	1.2%	5.0%
	Gutierrezia sarothrae	1.2%	5.0%
	Muhlenbergia pungens		
Invaders	Astragalus spp.		15.0%
	Salsola kali	5.2%	25.0%

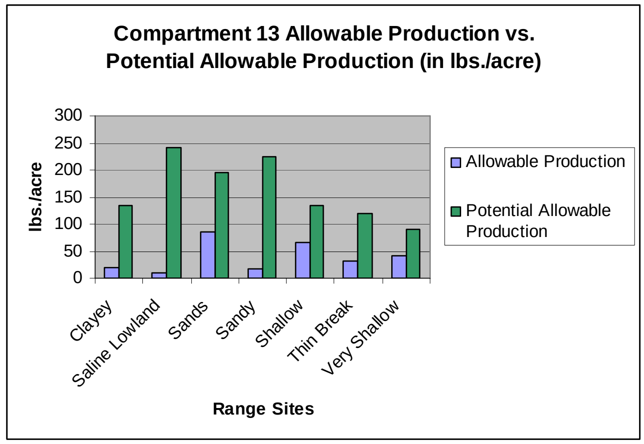
4.13 Compartment Thirteen

In Compartment 13 data were collected on 120 transects. One transect was located in a Non Usable area, seven transects were located in Badlands and 22 in Rough Broken. Seventeen transects were located in the Clayey Range Site, and 17 in Saline Lowland, 12 in Sands, eight in Sandy, 15 in Shallow, 21 in Thin Break and three in Very Shallow. The maximum stocking rates were zero acres per sheep unit in the Non Usable, Badlands and Rough Broken areas, 102 acres per sheep unit in the Clayey Range site, 62 in Saline Lowland Range Site, 27 in Sands, 51 in Sandy, 36 in Shallow, 73 in Thin Break, and 66 in Very Shallow. The recommended carrying capacity is 560 sheep units year long for Compartment 13.

Transects	Range Site	Trend	Condition Class	Seral State	Stocking Rate (Acres/SU) Year Long	Acres	Carrying Capacity in Sheep Units Year Long	Sheep Units Recommended for Deferral	Recommended Carrying Capacity SU Year Long
1	Non Usable	N/A	N/A	N/A		197			
7	Badlands	N/A	N/A	N/A	0	4,697	0		
22	Clayey	Away	Poor	Early	102	8,912	87	**87**	
17	Rough Broken	N/A	N/A	N/A	0	11,512	0		
17	Saline Lowland	Away	Poor	Early	62	8,496	137	**137**	
12	Sands	Not Apparent	Good	Mid	26	5,554	214		
8	Sandy	Away	Poor	Early	51	4,867	95	**95**	
15	Shallow	Not Apparent	Fair	Mid	36	8,210	228		
21	Thin Break	Away	Fair	Mid	72	7,880	109		
3	Very Shallow	Not Apparent	Fair	Mid	66	577	9		
120						**60,902**	**880**	**320**	**560**

Most of the Range Sites in Compartment 13 were in poor or fair condition, but the Sands Range Site was in good condition with a 44% similarity to the climax community indicating a mid seral state. The transects in the Clayey Range Site had an average similarity of 15% indicating and early seral state. Saline Lowland had a 4% similarity indicating an early seral state. The Sandy Range Site was also in an early seral state, with an 8% similarity. The Shallow, Thin Break and Very Shallow Range Sites are in mid seral states with similarities of 49%, 27% and 45%, respectively. Vegetative cover in Compartment 13 was one of the lowest in the District at 6%. Frequency of decreaser species was also quite low in Compartment 13, while frequency of increaser and invader species was high.





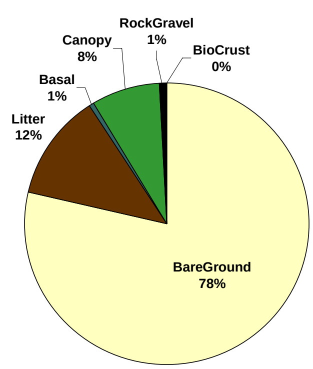
Compartment 13 Frequency of Indicator Species		Badlands	Clayey	Rough Broken	Saline Lowland	Sands	Sandy	Shallow	Thin Break	Very Shallow
Decreasers	Agropyron smithii							1.3%	1.4%	
	Bouteloua eriopoda		0.6%			4.2%			2.4%	3.3%
	Elymus elymoides									
	Stipa comata									
Increasers	Atriplex confertifolia	7.1%		12.3%		2.5%	2.5%	1.3%	15.7%	26.7%
	Chrysothamnus nauseosus		2.4%					0.7%	1.0%	6.7%
	Gutierrezia sarothrae	1.4%	2.4%	0.9%		7.5%			10.0%	16.7%
	Muhlenbergia pungens		1.2%			2.5%				
Invaders	Astragalus spp.	2.9%	1.2%	1.8%	0.6%	1.7%		2.0%	2.9%	3.3%
	Salsola kali	7.1%	32.9%	1.4%	15.9%	50.0%	47.5%	32.0%	1.0%	6.7%

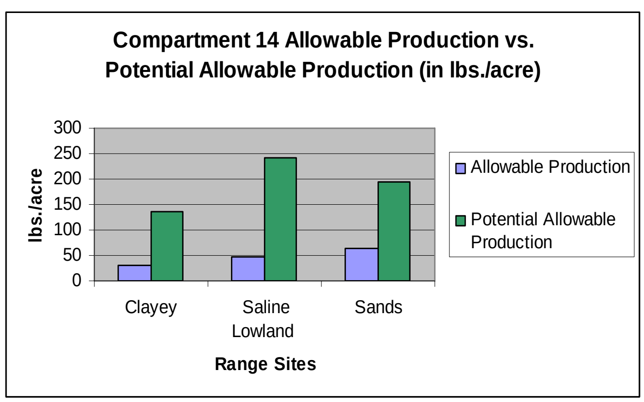
4.14 Compartment Fourteen

In Compartment 14 data were collected on 51 transects. There were no transects located in the Shallow and Very Shallow Range Sites. As described earlier, the stocking rates for these areas were derived from the average stocking rates of the Shallow and Very Shallow Range Sites throughout the District. One transect was located in a Non Usable area, 12 transects were located in the Clayey Range Site, and 31 in Saline Lowland, and seven in Sands. The maximum stocking rates were 33.1 acres per sheep unit in the Shallow Range Site, 43.7 acres per sheep unit in the Very Shallow site, zero in the Non Usable acres, 84 in Clayey, and 56 in Saline Lowland and 41 acres per sheep unit in the Sands Range Site. The recommended carrying capacity is 442 sheep units year long for Compartment 14.

Transects	Range Site	Trend	Condition Class	Seral State	Stocking Rate (Acres/SU) Year Long	Acres	Carrying Capacity in Sheep Units Year Long	Sheep Units Recommended for Deferral	Recommended Carrying Capacity SU Year Long
0	Shallow	N/A			33	424	13		
0	Very Shallow	N/A			44	374	9		
1	Non Usable	N/A	N/A	N/A		411			
12	Clayey	Away	Fair	Early	83	5,544	67		
31	Saline Lowland	Away	Fair	Early	55	15,857	288		
7	Sands	Away	Fair	Mid	41	2,925	71		
51						**25,534**	**448**		**442**

All Range Sites in Compartment 14 were in fair condition. The Sands Range site was in a mid seral state with a 33% similarity to the climax vegetation community described in the Range Site. Clayey and Saline Lowland averaged 24% and 19% similarity and were in early seral states. At 78% Compartment 14 had one of the highest percentages of bare ground of any compartment in District Five, and a low percentage of litter. Compartment 14 had one of the highest frequencies of Russian thistle (*Salsola kali*), an invader species. Increaser and invader species were much more frequent than decreaser species in the Compartment.





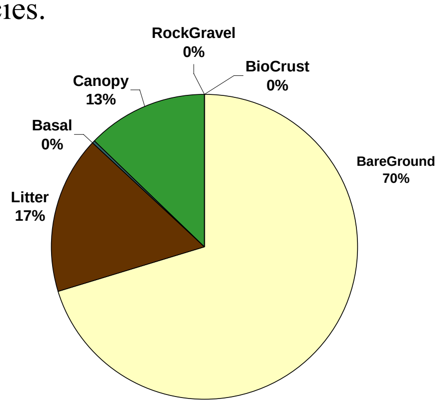
Compartment 14 Frequency of Indicator Species		Clayey	Saline Lowland	Sands
Decreasers	Agropyron smithii			
	Bouteloua eriopoda			14.3%
	Elymus elymoides			
	Stipa comata			
Increasers	Atriplex confertifolia			
	Chrysothamnus nauseosus	2.5%	3.5%	12.9%
	Gutierrezia sarothrae	20.8%		24.3%
	Muhlenbergia pungens			
Invaders	Astragalus spp.	10.8%		18.6%
	Salsola kali		5.2%	67.1%

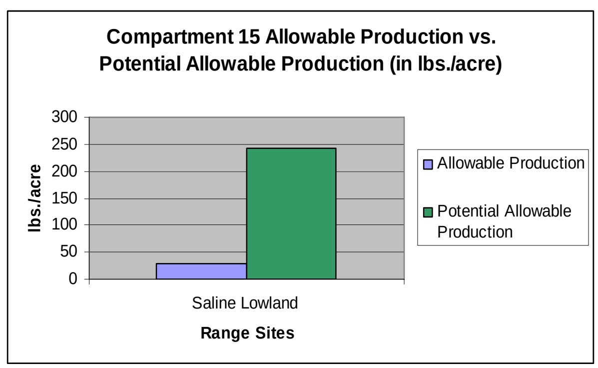
4.15 Compartment Fifteen

In Compartment 15 data were collected on 11 transects, all in the Saline Lowland Range Site. The maximum stocking rate was calculated at 62 acres per sheep unit. However, this entire compartment was in poor condition and the total carrying capacity of 89.3 sheep units are recommended for deferred grazing to rest and regenerate the rangeland resource.

Transects	Range Site	Trend	Condition Class	Seral State	Stocking Rate (Acres/SU) Year Long	Acres	Carrying Capacity in Sheep Units Year Long	Sheep Units Recommended for Deferral	Recommended Carrying Capacity SU Year Long
11	Saline Lowland	Away	Poor	Early	62	5,535	89	89	
11						**5,535**	**89**	**89**	**0**

The Saline Lowland Range Site covering Compartment 15 was in an early seral state with a low similarity comparison to the climax community of only 11%. Accordingly, basal cover was very low, but canopy cover was high. Bare ground was also prevalent in the Compartment. Frequency of all indicator species was very low as a result of a lack of vegetation in Compartment 15, but the frequency of decreaser species was higher than the frequencies of increaser and invader species.





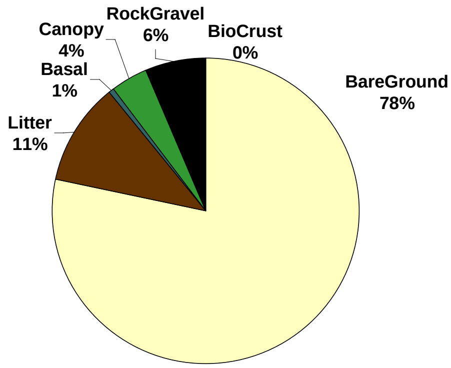
Compartment 15 Frequency of Indicator Species		Saline Lowland
Decreasers	Agropyron smithii	6.4%
	Bouteloua eriopoda	
	Elymus elymoides	2.7%
	Stipa comata	
Increasers	Atriplex confertifolia	
	Chrysothamnus nauseosus	
	Gutierrezia sarothrae	
	Muhlenbergia pungens	
Invaders	Astragalus spp.	
	Salsola kali	0.9%

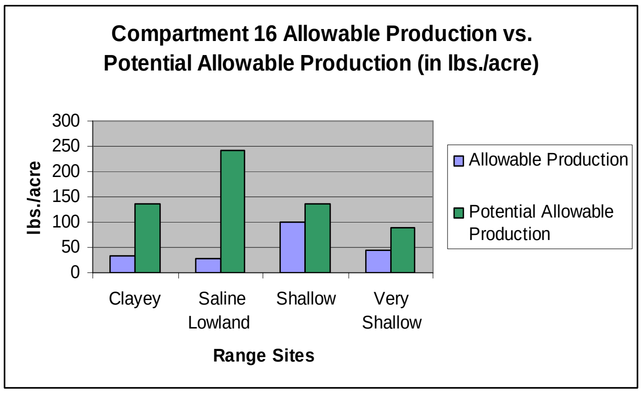
4.16 Compartment Sixteen

In Compartment 16 data were collected on 87 transects. Two transects were located in a Non Usable area, 30 transects were located in the Clayey Range Site, and 37 in Saline Lowland, four transects in Shallow and 14 in Very Shallow. The maximum stocking rates were zero acres per sheep unit in the Non Usable areas, 82 in Clayey, 62 in Saline Lowland, 24 in Shallow and 53 acres per sheep unit in the Very Shallow Range Unit. The recommended carrying capacity is 377 sheep units year round for Compartment 16.

Transects	Range Site	Trend	Condition Class	Seral State	Stocking Rate (Acres/SU) Year Long	Acres	Carrying Capacity in Sheep Units Year Long	Sheep Units Recommended for Deferral	Recommended Carrying Capacity SU Year Long
2	Non Usable	N/A	N/A	N/A		1,799			
30	Clayey	Away	Fair	Early	81	12,263	151		
37	Saline Lowland	Away	Poor	Early	62	19,567	316	316	
4	Shallow	Towards	Good	Late	24	1,694	71		
14	Very Shallow	Not Apparent	Fair	Mid	53	8,239	155		
87						**43,562**	**693**	**316**	**377**

The Shallow Range Site was in good condition with a 74% similarity comparison to the climax vegetation community, indicating a late seral state. The Very Shallow Range Site had a 49% similarity indicating a mid seral state. The Clayey and Saline Lowland Range Sites were in early seral states with 24% and 11% similarity, respectively. Ground cover data for Compartment 16 indicated the lowest overall percentage of litter cover in the District at 11%. Canopy cover was also the lowest at 4%, while Bare Ground was very high at 68%. Compartment 16 had a very low frequency of decreaser species, all of which occurred in the Clayey Range Sites.





Compartment 16 Frequency of Indicator Species		Clayey	Saline Lowland	Shallow	Very Shallow
Decreasers	Agropyron smithii				
	Bouteloua eriopoda	2.3%			
	Elymus elymoides				
	Stipa comata				
Increasers	Atriplex confertifolia	1.7%	5.7%	17.5%	20.7%
	Chrysothamnus nauseosus	1.7%	0.3%		1.4%
	Gutierrezia sarothrae	1.3%			2.9%
	Muhlenbergia pungens				
Invaders	Astragalus spp.	0.7%			3.6%
	Salsola kali	12.7%	5.7%	27.5%	26.4%

4.17 Statistical Analyses

Descriptive statistics were developed for the production data in District Five. Preliminary examination of the data for District Five as a whole revealed a non-normal data set, therefore medians as well as means are reported in the summary table in Appendix I. The data were divided into Units (Range Sites within Compartments) for analysis and most Units contained a normal data set.

Confidence intervals are reported with the summary data table in Appendix I. Confidence intervals ranged widely from 17 to 662 grams per transect, or pounds per acre. Standard deviations were generally high. Sample size was an influencing factor and one that can be easily adjusted for future monitoring.

For purposes of analysis we examined the data using parameters suggested by the BIA for the design of a vegetation inventory. The following tables illustrate the results using those parameters, as well additional results using more constrictive, standard biological parameters. These two examples compare a change in confidence interval (CI) width and the resulting changes in the desired CI and sample size (*n*) for two different Range Compartments sampled in District Five.

Compartment: 1, Range Site: Limestone (*n* = 16)		
	CI width = 0.25	CI width = 0.20
Mean (pounds/acre)	381	381
B (Desired CI)	95	76
SD	276	276
n (predicted transects)	14	22

Compartment: 3, Range Site: Very Shallow (*n* = 9)		
	CI width = 0.25	CI width = 0.20
Mean (pounds/acre)	471	471
B (Desired CI)	118	94
SD	192	192
n (predicted transects)	4	7

For Compartment 1, Range Site Limestone, 16 transects were sampled in 2006. From the data collected at each transect, descriptive statistics were summarized and statistical analyses were conducted (Elzinga et al. 1989) to determine the optimal sample size under the suggested management objectives provided by the BIA. The formula provided by Elzinga et al. (1998) is

$$n = \frac{(Z_\alpha)^2 (s)^2}{(B)^2}$$

where Z_α = the standard normal coefficient, s = standard deviation, and B = desired precision level (effect size) specified in absolute terms rather than a percentage, or in this case, the confidence interval width 0.25 x *n*.

This objective was to obtain the mean plant production for the population with an 80% confidence level that is within 25% of the estimated true value. Examining the mean value of pounds per acre, a change in the plant production of <95 pounds per acre for that Unit would not be detected under these management objectives. By reevaluating the management objectives and changing the desired CI width from 0.25 to 0.20 the power of the test essentially increases from 75% to 80%. Under this management objective, a change in plant production of <76 pounds per acre would be detected. The same trend holds true for Example 2 in Compartment 3, Range Site Very Shallow where 9 transects were sampled. Increasing the power would increase the ability of the test to detect a change in plant production from 118 pounds per acre to 94 pounds per acre by sampling only three more transects. An additional approach to improving the power of these analyses under the current management objective is to improve the standard deviation (SD) by revisiting the sampling methods. The SD for each of the data in these two examples, as well as for the other Range Compartments in District Five, is very high.

Finally, if the suggested statistical parameters are upheld, this analysis indicates that each range compartment was over-sampled. However, we strongly caution against using these wide parameters because the power of detecting any change in plant production for each range compartment is quite low. We propose that the range management prescriptions be reviewed and incorporated into more site-specific management objectives that will result in detectable changes in plant production as is appropriate for each Range Site.

5.0 DISCUSSION

5.1 Grazing Overview

Movement of animals, timing of grazing, and animal numbers are all factors that must be considered when optimizing livestock production. Prior to considering these factors, managers should first recognize animals' ability to efficiently harvest the nutrients present in their surroundings. This requires an understanding of foraging behavior as influenced by an animal's environment. Established grazing patterns are dictated by topography, plant distribution, and location of water, shelter and minerals (Heitschmidt 1991). Overall production of a given pasture or grazing unit does not necessarily reflect the amount of forage available to livestock. Therefore, it is important to recognize specific areas that restrict animals due to inaccessibility, long distances to water, steep slopes, or other factors. Once identified, production from these areas can be subtracted from the total or plans can be made to possibly include these areas. An example of this would be to develop additional water sources in areas rarely visited by livestock due to a scarcity of water. Plant availability and composition also helps to determine where animals are likely to congregate.

After likely foraging patterns have been determined for a given area, production and similarity index data can be used to help determine how many animals should be allowed to graze in the given area, which is a crucial step. Low stocking rates benefit individual animals because there tend to be more available resources as a result of lowered competition with other animals. Conversely, high stocking rates can inhibit the individual, but the increase in animal production allows for greater, short-term gains for the producer. The final stocking-rate decision must take into consideration the ecosystem as a whole. Maintaining long-term viable rangelands provides for the continued health of livestock and long-term financial gains for producers or permittees.

Early season grazing during the initial growing season and late season grazing at the time of seed development can be very detrimental to plant vigor and root development. This will remain a problem for rangeland managers as long as livestock grazing permits are continue to be issued for year round grazing. However, Holecheck (1999) argues that stocking rate has a much greater impact on range condition than the season of use.

Stocking rates are correlated with the prevention of overgrazing. When livestock, wildlife, and feral horses graze and browse on a site, they each select their own preferred species. If the site is stocked too heavily and for too long a time, the desired species will become overgrazed. These preferred species are weakened and their mortality rate increases, resulting in a reduction of their percent composition on the site. If the process continues, both the preferred and secondary plant species will be severely reduced and replaced with non-preferred or invasive species.

Overgrazing can be an awkward term when applied over an entire landscape. In most cases, plants that have been severely reduced by grazing can be found growing next to plants that have been left untouched. Therefore, it is more appropriate to view overgrazing at a species or individual level. Savory (1999) sums up overgrazing as "the grazing of roots." This is an apt description and refers to plants that are grazed severely during the growing season and then suffer additional losses due to grazing of re-growth during the same season. When this occurs, root growth essentially stops as energy reserves located in the roots and the lower portion of the plant are used for re-growth. The resulting energy depletion severely curtails new growth in the following season and often results in plant mortality.

In general, managers should be aware that the final products of this inventory are subject to a variety of factors. The application of carrying capacity to determine stocking rates should be used with care and in context to seasonal, topographic, and behavioral factors.

5.2 Frequency

On rangeland, regeneration of desirable plants maintains good range conditions. Grazing by too many animals (livestock and wildlife) or too heavy utilization by a few animals results in overuse, loss of vigor, and ultimately disappearance of the preferred and desirable plants. Deterioration of the range vegetation begins when less valuable forage species replace the desirable species. If deterioration continues, the less valuable forage species begin to be replaced by invaders and noxious weeds.

Frequency of preferred and desirable species can be monitored relatively easily by range technicians and managers as long as species are correctly identified. Monitoring the trend of key climax species is a recommended management objective. If frequency declines over time for key climax plants, then the range resource is being over utilized and negative impacts to the resource will result. If the frequency of key species increases over time, then the range resource and condition is recovering.

This report provides baseline data for frequency. This data exists as a “snapshot” of current species frequency, but does not indicate trend by itself. Future studies should repeat the collection of species frequency data in order to compare with data collected on this inventory.

5.3 Ground Cover

Ground cover measurements are used to quantify ground cover of litter, biological crusts, and soil surface condition. Cover is also important from a hydrologic perspective when the variables of interest may include basal and canopy (foliar) cover of perennial and annual species and litter cover.

Cover data can assist in determining the proper hydrologic function of a site, as well as the biotic integrity of a site. Point interception cover measurements are highly repeatable and lead to more precise measurements than cover estimates using quadrants. For trend comparisons in herbaceous plant communities, basal cover is generally considered to be the most stable. Basal cover does not vary as much due to climatic conditions (compared to canopy cover). Canopy cover can vary widely over the course of the growing season. The change in cover over the course of the growing season can make it hard to compare results from different portions of large areas where sampling takes several weeks or a few months. In the future, cover monitoring for the District Five area should take place near the conclusion of the growing season to replicate the sampling time period from this baseline inventory.

5.4 Production

Weight is the most meaningful expression of the productivity of a plant community or an individual species. It has a direct relationship to feed units for grazing animals that other measurements do not have. Production is determined by measuring the annual aboveground growth of vegetation. Some aboveground growth is used by insects and rodents, or it disappears because of weathering before production measurements are made. Therefore, these determinations represent a productivity index. They are valuable for comparing the production of different Range Sites. Production data must be obtained at a time of year when measurements are valid for comparison with similar data from other years, other sites, and various conditions being evaluated.

The total annual production can be misleading. Total annual production includes production from all species of a plant community during a single year, including invasive, noxious, toxic, and non-forage species. Total annual production does not indicate the amount of forage available to livestock or other herbivores, or whether or not it is a climax plant species expected to occur. Total annual production is often measured in a monitoring program, but may not be the best vegetative attribute for which to manage. Total annual production is simply a baseline assessment of what is actually on the ground.

Potential production is the expected production of a particular Range Site. The potential production of a site is given in the Range Site description. The information in the Range Site description is based on field data collected in sites with similar soils, climate, water resources, vegetation and land use. Comparing current total annual production to potential production is very informative because it provides a measurable difference between current conditions and expected conditions.

Allowable production is production found on the ground at the site that was expected to occur in the climax plant community. This information is based on the field data collected for development of the Range Site description. Allowable production may include production from preferred, desirable, and undesirable forage species, as well as toxic plants such as *Astragalus* species. Care should be taken to examine the allowable quantity of these species in Range Site descriptions because they can influence the perceived forage available of the rangeland. Allowable production is much more indicative of range condition than total annual production. The most accurate picture of current conditions can be made by comparing allowable production to expected production from the climax plant community or PNC. This can be accomplished with a condition class rating calculation. When possible, it is recommended that management objectives focus on monitoring allowable production and comparing that data to the expected climax community through condition class ratings or, preferably, similarity index calculations using Ecological Site Descriptions where they are available.

5.5 Drought

Drought is one of the biggest variables in Southwestern U.S. rangelands. Livestock operators must plan for drought as a normal part of the range-livestock business. Failure to prepare and manage before, during, and after drought conditions is probably one of the biggest reasons why range areas are in early seral states or irreversible states.

The measure of forage production based upon a normal year allows managers to establish a "ceiling" or carrying capacity for their land. These measures should not be used to generate stocking rates when precipitation is below normal, especially during drought conditions. In a continuous grazing system, it is difficult to prepare for times of scarce moisture. Successful plans often implement a standard of light to moderate livestock numbers and adjust upwards as precipitation increases.

6.0 RECOMMENDATIONS

The most important recommendation that can be made as a result of this inventory is to caution against the direct application of the stocking rates provided in the results. The provided stocking rates should be used as a guide to be adjusted appropriately with consideration of a variety of factors including the confidence intervals of the data collected, the variability of precipitation, and distance to water sources, and the percentage of acreage with steep slopes.

6.1 Carrying Capacity and Stocking Rate Selection

"Although carrying capacity has important applications to management, shortcomings associated with its application should also be recognized. The primary complication in interpreting carrying capacity involves the incorporation of spatial and temporal variability. That is, both forage and animal intake are dynamic factors that vary according to site selection, time of sampling, species composition of the vegetation, utilization patterns, dietary preferences, livestock nutritive requirements, and resources available to the manager. Therefore, an evaluation of carrying capacity should be treated as a preliminary gauge to animal numbers for the management unit that will be revised in the light of monitoring information and immediate forage conditions."
http://cals.arizona.edu/agnic/az/inventorymonitoring/carryingcapacity.html

6.2 Stocking Rates during Drought

If there is very little precipitation during the winter and early spring numbers, stock numbers should not be permitted at the rate of an average years' production. Range managers need to have the ability to increase stock numbers and reduce stock numbers based on current resource conditions. Ideally, permits would require an estimate of the current climate and production of the range resource at periodic intervals. The stock numbers should be adjusted accordingly.

6.3 Distance to Water

Forage utilization generally increases with proximity to water sources. Livestock managers should consider the number and locations of water sources within a rangeland management unit and adjust stocking rates accordingly. Areas further than 3,200 meters from a water source can be considered ungrazable and that acreage should be removed from stocking rate calculations.

Permanent and temporary water sources in District Five are not currently mapped, or may be incompletely mapped. Livestock will rarely range more than 3,200 meters(m) from a water source. Holechek (1988) recommends no stocking rate reductions for the zone under 1,600 m from water, a 50% reduction for the zone 1,600 to 3,200 m from water and that the zone over 3,200 m from water be considered ungrazable (Figure 6.1). The area between 1,600 m and 3,200 m is 5,959 acres.

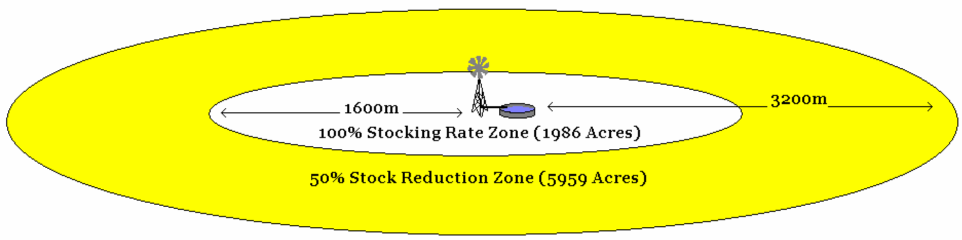


Figure 6.1 Recommended Stock Reduction Zone

All water sources in District Five should be mapped, and designated as seasonal or permanent. Forage should be allocated only in areas within 3,200 m from a water source. The total Sheep Units should only be within 3,200 m from a water source. Permitting in areas beyond 3,200 m will lead to overgrazing and deterioration. If permittees are hauling water to their stock, this should be considered when determining stocking rates. In these cases, utilization should be monitored more regularly at their grazing locations with permanent water sources (if any exist). Utilization should always be monitored within the 3,200 m from a water source. Care should be taken not to monitor utilization too close or too far from the water source to avoid skewed utilization data.

6.3.1 Little Colorado River

The results of this survey indicate that the areas near the Little Colorado River Basin appear to be the more deteriorated areas of District Five. Deferred grazing is recommended along the river. This action would reduce erosion along the river, restore river banks, increase productivity, as well as wildlife habitat. A clear alternative location for displaced livestock is to develop additional water sources in other areas that are currently ungrazable because of the distance from a water source. Livestock could be removed from areas in deteriorated condition and moved to areas in a late-seral or potential natural community conditions. Newly opened areas should be stocked conservatively based upon the distance from the new water source and other factors. The benefits would include improved conditions along the river. The risk with this alternative is new areas being poorly managed and over-stocked. It is imperative that any new areas opened up to livestock be stocked conservatively to prepare for drought conditions.

6.4 Other Considerations for Stocking Rate Selection

Control of livestock numbers (stocking rate) is the first and most important range management principle. As livestock graze, they reduce available forage both in quantity and quality, thereby changing the habitat for itself and altering future animal/habitat relations. The timing and degree of forage utilization by animals are the principal controls over species composition and forage production in the manager's hands. Excessive forage utilization by livestock and/or wildlife reduces growth rates, weight gains, and animal values. "Coordination of forage utilization with forage growth through control of animal numbers usually determines the success or failure of other range practices and economic stability of the operation. This principle cannot be overemphasized (Heady and Child, 1994)." Numerous stocking rate experiments have shown that moderate and conservative stocking rates give greater long-term returns than does a high stocking rate. Long term results include improved animal condition, additional wool production, higher weaning weights and correlated increased selling value.

Wildlife directly competes with livestock for forage resources. Failure to account for wildlife in a management area when establishing a stocking rate will result in overgrazing and degradation of the resource.

Homesites, roads, and other unusable areas should be removed from the calculations of acres of rangeland. Inaccessible areas should also be removed from the total acreage calculations. Holecheck (1988) suggests that stocking rates should be reduced by 30% for slopes from 11 to 30%. Slopes from 31 to 60% should have a 60% reduction in stocking rates and slopes beyond 60% should be removed entirely from stocking rate calculations.

6.4.1. Using Forage Values for Stocking Rates

The NRCS has shifted away from including recommended stocking rates in ecological site descriptions. The current, and more progressive, NRCS method involves quantifying the total production of preferred and desirable forage species by the following five steps:

1. The primary livestock class which will be utilizing the area is identified.

2. The plant species that are preferred and desirable to that class of livestock are identified and quantified.

3. The total pounds of production of the preferred and desirable species found on the transect are totaled together to give an estimate of production for the area (with reconstruction factors).

4. A harvest efficiency factor of 25% is applied to rangeland sites. This means that 25% of the forage is allocated for livestock. The remainder is set aside for soil protection, trampling losses, wildlife, and other factors.

5. Stocking rates are then established for the available forage.

There are no forage preference values for the District Five project area, but applicable forage preference data from adjacent areas may be available. According to Steve Cassady (Arizona NRCS State Range Management Specialist) forage preference values have been established by the Bureau of Land Management on the Arizona Strip region and would be fairly applicable to the District Five project area (Personal Communication with Steve Cassady, Arizona NRCS State Range Conservationist and Kent Ferguson, Texas NRCS State Range Conservationist).

6.5 Range Sites

The Range Site Similarity comparisons allows for 100% of some shrubs to be counted towards the allowable production. This causes similarity comparisons in shrub dominated areas to have higher percentage of similarity. A simple solution for this problem would be to establish a maximum allowable percentage for each component of the site such as: grasses 85%, forbs 10%, and shrubs/trees 5%, but the total of the three cannot be over 100%.

6.6 Statistical Efficiency

The sample set of transects were distributed evenly throughout the project area. A more precise, accurate, and efficient method of distributing the sample set would have considered the unit of analysis. In this situation, the unit of analysis was each Compartment, and more precisely, the Range Sites within each Compartment. With the current sample design, some Range Sites within Compartments were over sampled, while other Units were under sampled. Had the Range Sites been digitally delineated prior to the initiation of field work, the transects could have been dispersed throughout the Range Sites in order to achieve maximum statistical efficiency. For future monitoring it is recommended that the distribution of transects occur using a stratified random selection of locations by Range Sites within Compartments. Alternatively, distribution by Range Sites alone.

7.0 SUMMARY

The vegetation inventory of the District Five rangelands can be described as a measurement of the condition of the range resource. The general condition of the range resource was compared to the conditions described in the 1971 Soil and Range Inventory. Other information collected during the inventory provides a baseline for future monitoring efforts. Data were analyzed at the Range Site level for each Compartment. The results of the vegetation inventory indicated varying range conditions throughout inventoried area of District Five. The data indicate improvement of range conditions in many areas of District Five. Future management decisions and actions should attempt to continue improve range resource conditions and production.

General management objectives should include increasing composition and species production to levels closer to the PNC. Close attention should be paid to water sources, slope, and precipitation influences. Developing a stocking and monitoring program with these criteria is vital for measuring the success of the management strategy.

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9.0 APPENDICES