Land Management Districts 9 And 12

2013 Vegetation Inventory

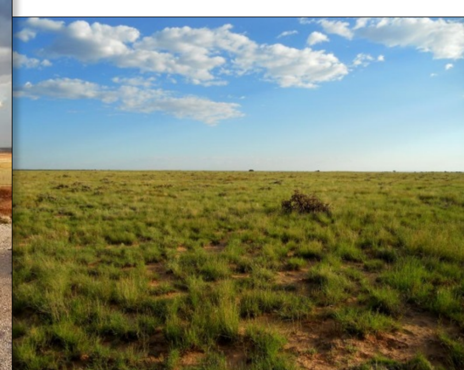
Beclabito, Shiprock, and Teec Nos Pos Chapters

Prepared for:

Bureau of Indian Affairs
Northern Navajo Agency
Natural Resources

2013





Ecosphere
Environmental Services

Durango, CO
Cortez, CO
Pagosa Springs, CO
Farmington, NM

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ACRONYMS AND ABBREVIATIONS

2,4-D	2,4-dichlorophenoxyacetic acid
ADW	air-dry weight
AUM	animal unit months
BIA	Bureau of Indian Affairs
District	Land Management District
Ecosphere	Ecosphere Environmental Services
ESD	ecological site description
ft^2	square foot
GIS	geographic information system
GPS	Global Positioning System
HCPC	historic climax plant community
lbs	pounds
MLRA	Major Land Resource Area
NNDOA	Navajo Nation Department of Agriculture
NRCS	Natural Resources Conservation Service
p.z.	precipitation zone
PNC	potential natural community
RMU	Range Management Unit
SOW	Statement of Work
SUYL	sheep unit year long
USDA	United States Department of Agriculture
USDOI	United States Department of Interior
UTM	Universal Transverse Mercator

ABSTRACT

Ecosphere Environmental Services was contracted by the Bureau of Indian Affairs to collect and compile vegetation data on portions of Land Management Districts 9 and 12, of the Northern Navajo Agency. Data collection occurred during July and August of 2013. Measurements were taken for biomass production, ground cover, and species frequency. The data were analyzed to determine the carrying capacity of the range resource, as well as the similarity to the historic climax plant community.

Data were analyzed by soil map units and ecological sites within the pastures and range management units. Carrying capacities and recommended stocking rates were calculated using available forage. The data were then applied according to the acreage of ecological sites within each pasture or range management unit.

1. Introduction

Ecosphere Environmental Services (Ecosphere) was contracted by the Bureau of Indian Affairs (BIA) to conduct understory rangeland vegetation inventories on portions of Land Management Districts (Districts) 9 and 12 of the Northern Navajo Agency, specifically in the Beclabito, Shiprock, and Teec Nos Pos chapters. Each chapter was divided into analysis units consisting of either range management units (RMUs) or pastures. Species-specific vegetation data measurements included biomass production and cover. These data also were used to calculate frequency, annual production, and carrying capacity based on available forage production. Information derived from these calculations can be used to guide management decisions, including stocking rates. This report supplies the results of the vegetation inventory as well as the background, methodology, and discussion necessary for management planning.

1.1 Purpose and Need

It is essential to have baseline range condition data to properly establish quality range management practices. The purpose of this inventory was to provide baseline information about the existing range resource to enable resource managers and permittees to improve or maintain the condition of the range resource. The results of this inventory will facilitate determination of adjusted stocking rates in Districts 9 and 12, as well as more comprehensive range management plans that are crucial for future range productivity.

1.2 Regulatory Entities

The Navajo Nation Department of Agriculture (NNDOA) manages livestock grazing activities on the Navajo Nation primarily through District Grazing Committees. Livestock grazing permits are administered by the BIA Natural Resources Program in accordance with the Navajo Grazing Regulations (25 CFR §167). All three parties (BIA, NNDOA, and the Grazing Committees) coordinate their activities to utilize and manage the range resources.

1.2.1 BIA Agency Natural Resources Program

The BIA is responsible for complying with all federal and tribal statutes, orders, and regulations. According to the BIA, their obligation is "to protect and preserve trust the resources on the land, including the land itself, on behalf of the Indian landowners. Protection and preservation includes conservation, best management practices, and protection against misuse of the property. BIA uses the best scientific information available and reasonable and prudent conservation practices to manage trust and restricted Indian lands. Conservation practices must reflect tribal land management goals and objectives." A summary of the BIA Range Policy as stated in the Range Management Handbook (United States Department of Interior [USDOI] BIA 2012) is outlined as follows:

- 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, 25 CFR 167 - Navajo Grazing Regulations, and 25 CFR 166 - Grazing Permits.
- Seek tribal participation in BIA agricultural 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 permittees/lessees.
- 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 develop 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, formally called Land Management Districts, were established in 1936 by the Soil Conservation Service (SCS), (which became the Natural Resources Conservation Service [NRCS] in 1994) and adopted by the BIA. Within each district are several chapters. Chapters are locally organized entities similar to counties and are the smallest political unit; there are 110 chapters on the Navajo Nation.

District Grazing Committees consist of elected representatives from each chapter who are responsible for monitoring livestock grazing within their respective chapters. District Grazing Committees approve the carrying capacities of their districts, as discussed in the Code of Federal Regulations, Part 167 – Navajo Grazing Regulations (USDOI 2012).

The periodic sampling of rangelands allows District Grazing Committees to evaluate the carrying capacity and resulting stocking rates of rangelands (Goodman 1982). The District Grazing Committee members are responsible for attending District Grazing Committee meetings and Chapter meetings, and for ensuring that permittees respect applicable laws, regulations, and policies. Individual District Grazing Committee members are directly accountable to their local chapters and administratively accountable to the Director of the NNDOA.

The NNDOA is responsible for annual livestock tallies to determine if permittees are in compliance with their permits. In addition, the NNDOA and District Grazing Committee are responsible for enforcing range management and resolving grazing disputes.

1.3 Grazing Overview

Timing of grazing, movement and dispersal of livestock, and livestock numbers are factors that must be considered when optimizing livestock production. Prior to considering these factors, managers need an understanding of foraging behavior, as influenced by an animal's environment. Established grazing patterns are dictated by topography; plant distribution; plant composition; and location of water, shelter, and minerals (Heitschmidt 1991). The total forage production of a given analysis unit does not necessarily reflect the amount of forage available to livestock; therefore, it is important to recognize specific factors restricting forage availability such as fencing, long distances to water, or steep slopes. Once identified, total forage production can be adjusted for these inaccessible areas. An example of a management strategy that would result from this type of analysis would be to develop additional water sources in areas rarely visited by livestock because of the long distance to water. Section 6.5 explains how fencing can be used to more accurately manage forage production.

After likely foraging patterns have been ascertained, production and forage value data can be used to help determine the number of animals that could sustainably graze in a given pasture. Stocking rates are a trade-off between short-term and long-term benefits. Low stocking rates benefit individual animals, as more resources are available due to lowered competition with other animals. Conversely, high stocking rates can inhibit individual animals, but the increase in total livestock production allows for greater, short-term gains for the producer. The final stocking rate decision must consider 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. Viable rangelands also provide for the continued health of the local air, water, and other ecological resources.

Stocking rates are correlated with the prevention of overgrazing. When livestock, wildlife, and feral horses graze and browse on a site, each selects its own preferred species. If the site is stocked too heavily and for too long a time, the desired forage 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 deterioration continues, invaders and noxious weeds replace the less valuable forage species.

Plant vigor and root development can be adversely affected when grazing occurs during initial plant growth or seed development. This will remain a problem for rangeland managers as long as livestock grazing permits are issued for year-round grazing. However, Holecheck et al. (1999) argue that stocking rates have a much greater impact on range condition than the season of use.

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

2. Resource Descriptions

Knowledge of resource issues affecting rangeland health and productivity is essential to any management plan. Stocking rates, season of use, annual precipitation, soils, location of water sources, and topography strongly influence the variety and quality of forage on rangelands. The results of this vegetative inventory quantify the current conditions of the rangelands in the Beclabito, Shiprock, and Teec Nos Pos chapters. This information can be used to document future changes on the rangelands and assist with management decisions.

2.1 Geographic Setting

Districts 9 and 12 lie within two Major Land Resource Areas (MLRAs): Colorado Plateau (MLRA 35) and Southwestern Plateaus, Mesas, and Foothills (MLRA 36). The project area stretches from Arizona and Utah northwest of Teec Nos Pos, southeast to the flatlands surrounding Highway 491 in New Mexico. The Teec Nos Pos chapter is the northernmost of the three communities. The northern half of the project area extends into San Juan County, Utah while most of the southern half resides within Apache County, Arizona. A small portion of the southern half of the project area reaches into San Juan County, New Mexico. The Shiprock Community anchors the southern end of the project area and resides solely in San Juan County, New Mexico. The Beclabito Community is located between the other two communities. The bulk of Beclabito Community also is in San Juan County, New Mexico though its western extremity lies within Apache County, Arizona, along the eastern foothills of the Carrizo Mountains.

The lowest point of the project area (approximately 4,900 feet) can be found at the San Juan River. From the river, the land increases in elevation to nearly 9,400 feet at the top of the Carrizo Mountains. The areas along the San Juan River consist of floodplains dominated by saltgrass (*Distichlis spicata*), greasewood (*Sarcobatus vermiculatus*), rubber rabbitbrush (*Ericameria nauseosa*), five-stamen tamarisk (*Tamarix chinensis*), coyote willow (*Salix exigua*), and groves of cottonwood (*Populus* spp.). Above the river are terraces containing a mix of perennial grasses interspersed with fourwing saltbush (*Atriplex canescens*), shadscale (*Atriplex confertifolia*), jointfir (*Ephedra* species), and Russian thistle (*Salsola tragus*). This plant combination also is common along the margins of the valleys and drainages near the river. Moving farther away from the river, many of the larger valleys contain large deposits of Aeolian deposits that have formed sand dunes. Most of these dune areas have been stabilized by populations of sand sage, perennial grasses, and perennial forbs. The sides of the valleys and larger drainages are delineated by sparsely vegetated clay hill badlands surrounded by low, narrow mesas. The mesas are capped by sandstone cliffs and contain a mixture of pinyon-juniper woodland, shrubland, and exposed bedrock on their summits. Further west, the broken mesa country gives way to level flats that extend all the way to Red Mesa. This region is characterized by sandy soils and shrublands consisting of primarily broom snakeweed (*Gutierrezia sarothrae*), Greene's rabbitbrush (*Chrysothamnus greenei*), and various forbs and grasses.

The southwestern portion of the project area is occupied by the Carrizo Mountains. The lower slopes and foothills are covered in a moderate to dense canopy of pinyon-juniper woodland with occasional openings containing big sagebrush (*Artemisia tridentata*), Bigelow sagebrush (*Artemisia bigelovii*), plains prickly pear (*Opuntia polyacantha*), fourwing saltbush, Mormon tea (*Ephedra viridis*), broom snakeweed, and perennial grasses and forbs. Stansbury cliffrose (*Purshia stansburiana*) is common in rock outcrops and on cliff edges while other areas have become invaded by exotic species such as Russian thistle and cheatgrass (*Bromus tectorum*). Large outcrops of rounded Navajo sandstone occupy much of the eastern toe slopes and a variety of indigenous shrubs and forbs are found including singleleaf ash (*Fraxinus anomala*), skunkbush sumac (*Rhus trilobata*), and various buckwheats (*Eriogonum* spp.), and species of milkvetch (*Astragalus* spp.). Occasional hills and knobs of shale, siltstone, and mudstone are scattered throughout this area and have a dominant vegetative cover of perennial grasses, shadscale, mound saltbush (*Atriplex obovata*), broom snakeweed, and bud sagebrush (*Picrothamnus desertorum*). The upper slopes transition into ponderosa pine (*Pinus ponderosa*) with Douglas fir (*Pseudotsuga menziesii*) and occasional spruce (*Picea* spp.) occupying moist drainages. Common understory species include Gambel oak (*Quercus gambelii*), snowberry (*Symphoricarpos* spp.), and muttongrass (*Poa fendleriana*).

The central region of the survey area is divided by Red Wash, which flows to the north and empties into the San Juan River. This region is characterized by fan terraces, low hills, cuestas, and benches above the larger washes. The higher points are composed of Dakota sandstone underlain by Mancos Shale. Overall, this area is not particularly productive given the dry climate and predominance of saline and sodic soils. The dominant vegetation includes several species of saltbush (*Atriplex* spp.), Greene's rabbitbrush, winterfat (*Krascheninnikovia lanata*), plains prickly pear, Indian ricegrass (*Achnatherum hymenoides*), galleta grass (*Pleuraphis jamesii*), and alkali sacaton (*Sporobolus airoides*). The southernmost area encompasses the highly dissected plains surrounding the town of Shiprock to the south and west. Numerous volcanic cores dot the landscape including the singular, winged rock Tsé Bit'a'í. Plant communities are typical of those found in dry soils with a high salt and sodium content. Mat saltbush (*Atriplex corrugata*) tends to dominate with other species of saltbush dispersed throughout the shrublands. Buckwheats and scarlet globemallow (*Sphaeralcea coccinea*) are common forbs, but Russian thistle is the most abundant. Grasses are scarce, but when encountered, tend to include alkali sacaton, Indian ricegrass, and bottlebrush squirreltail (*Elymus elymoides*).

2.2 Precipitation

An accurate precipitation monitoring system is essential to range management programs. Biomass production estimates are directly affected by precipitation measurements when reconstructing the plant community for a normal production year. If precipitation is overestimated in the reconstruction factor, the total annual production estimate decreases. If precipitation is underestimated in the reconstruction factor, the total annual production estimate increases. Precipitation gauges are located throughout the Navajo Nation; the Navajo Nation Division of Water Resources manages the corresponding data. Eleven precipitation gauges with complete data sets located throughout the Northern Navajo Agency were averaged to provide a measurement for the 2013 water year up until the time of data collection.

2.3 Soils

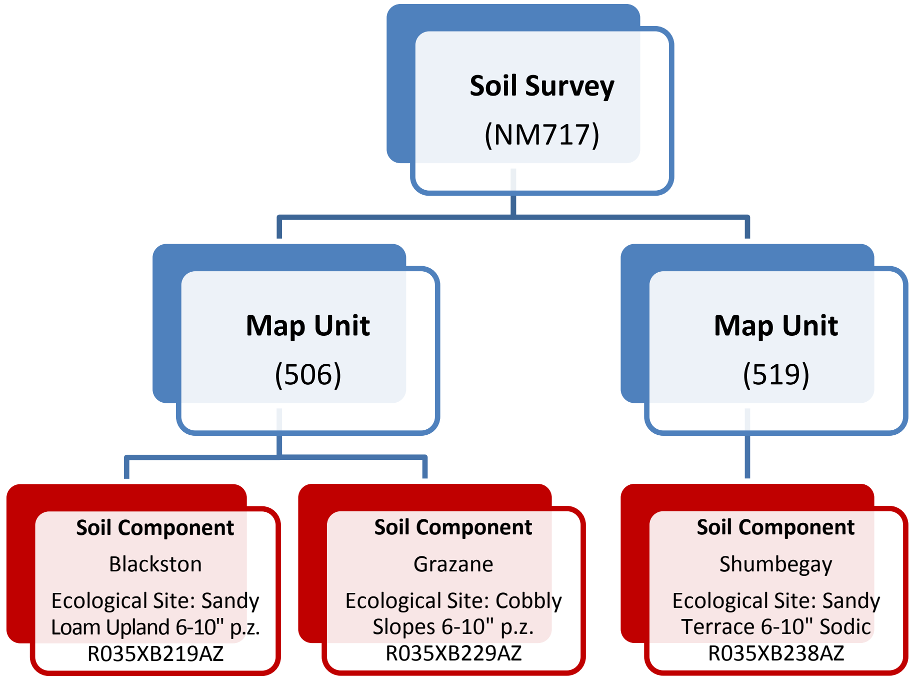
Knowledge of the soil properties in a particular area can help predict forage production. Soil properties such as texture, depth, moisture content, and capacity can dictate the type and amount of vegetation that will grow in that soil. The application of soil survey information enables rangeland managers to provide estimates of forage production in an analysis unit.

"The type and size of map unit delineations, scale of data collection, sampling protocols, and date of the last inventory completed are all factors to consider when using existing soil surveys and rangeland inventories" (USDOI BIA 2012).

The vegetation inventory project area is located within the boundaries of two soil surveys produced by the United States Department of Agriculture (USDA), NRCS/SCS: Shiprock area, parts of San Juan County, New Mexico and Apache County, Arizona (NM717) (Chiaretti 2001), and Navajo Indian Reservation San Juan County, Utah (UT643) (Nielson and Erickson 1980).

These soil surveys are Order III mapped, which means they include soil and plant communities at association or complex levels (called map units). Within each soil map unit, finer levels (called soil components) are described, but not mapped. Each soil map unit contains one, two, or three soil components within it. Each soil component is correlated with a specific ecological site.

Some of the associated ecological site descriptions that correspond to soils in these soil surveys are in draft form and have not yet been finalized, or have changed. Soil surveys and ecological site descriptions are valuable for rangeland managers, as long as their limitations are understood. Figure 2-1 illustrates the hierarchy of *unmapped* soil components and their corresponding ecological sites within a *mapped* soil unit within a given soil survey. The examples in the chart are extracted from the soil survey used for this project. The soil survey and map units (indicated in blue) are mapped. The soil components and correlated ecological sites (indicated in red) are unmapped.



Note: p.z. = precipitation zone.

Figure 2-1. Soil Survey Hierarchy

It is worth noting that biological soil crusts occur occasionally throughout the study area. Biological soil crusts are a complex mosaic of organisms that weave through the top few millimeters of soil, gluing loose particles together to stabilize and protect soil surfaces from erosive forces. Additionally, roughened soil surfaces created by biological crusts act to impede overland water flow, resulting in increased water infiltration into the soil (Belnap et al. 2001). Biological soil crusts can provide a vital component for healthy, functioning soils.

3. Ecological Sites

Ecological sites are differentiated from each other based on significant variances in species and species groups of the characteristic plant community, and their proportional composition and production. Additional determining factors include soils, hydrology, and other differences in the overstory and understory plants due to distinctions in topography, climate, and environmental factors or the response of vegetation to management. Each ecological site description (ESD) describes the historic climax plant community (HCPC) that was present during European settlement of North America. Many rangelands have undergone significant transitions to the point that they are never again expected to display the characteristics of the HCPC. In their best condition, these rangelands would instead reach their potential natural community (PNC). PNCs may include non-native plant species and other factors, which differentiate them from an HCPC on the same site.

Ecological sites are directly associated with soil components. The determination of ecological site for each transect was complicated due to inconsistencies of scale in the soil surveys. As described in Section 2.3, the soil survey was mapped at the soil complex scale (Order III), meaning there are up to three soil components within a mapped soil complex. The soil components are not mapped. Since each soil component has a single ecological site assigned to it, the map unit has up to three unmapped ecological site possibilities. Therefore, ecological sites cannot be mapped directly from Order III soil map information because they are not correlated with the soil map units; ecological sites are correlated with the finer levels of unmapped soil components.

Rangeland managers should be aware that maps of ecological sites are available on the NRCS Web Soil Survey website. The mapping, however, is by dominant ecological site. Unfortunately, this may grossly misrepresent soil units. For example, in soil map units where the dominant soil component/ecological site is 60 percent of the soil map unit, then the other 40 percent of the soil unit would be mapped incorrectly. An analogy might use a basket of fruit containing six apples and four oranges. Using the dominant system, the entire basket of fruit would be labeled as apples. While the dominant ecological site map may be appropriate at a landscape level, it is usually too coarse to use with rangeland management of pastures. In most cases of rangeland fieldwork, it is possible to provide field staff with descriptions of the dominant ecological site, as well as descriptions for non-dominant soil components and ecological sites. A decision regarding which ESD best fits a given transect can then be made based upon field examination of soils and the plant community.

For this inventory, the soil component and ecological site for each transect was determined primarily using soil profile and texture test results and the map unit descriptions from the soil survey, supplemented with interpretation of the current vegetative community compared to the expected HCPC. In cases where the ESD was not developed, no ESD was assigned. Generally, the ESDs represent the most up-to-date information available at the time of this study. It should be noted that they also are continually updated as new information is brought forth from field studies. The ESDs in this report should not be relied upon for future studies; instead the most recent information should be collected from the NRCS. Approved and published ESDs are available on the internet at http://esis.sc.egov.usda.gov/.

The ecological sites from the Districts 9 and 12 analysis area in the Beclabito, Shiprock, and Teec Nos Pos chapters are listed in Table 3-1, followed by representative photographs of ecological sites containing transects, with transect locations identified. Some sites had only one transect located within the ecological site. Many ecological sites contain no transects, especially those with few acres; those ecological sites have no representative photographs.

Table 3-1. Ecological Sites in the Analysis Area

Ecological Site Number	Ecological Site Name	Number of Transects	Acres	% of Project Area
F035XG134NM	Gravelly- Woodland	49	29,157.32	7.28%
F035XH005NM	Douglas Fir – Ponderosa Pine/Common Snowberry	2	4,002.24	1.00%
F036XA001NM	Pinyon Pine – One-seed Juniper/Big Sagebrush	11	4,083.21	1.02%
R035XA101AZ	Breaks 10-14" p.z.	0	945.48	0.24%
R035XA113NM	Sandy	9	4,418.80	1.10%
R035XA117AZ	Sandy Loam Upland 10-14" p.z.	4	3,565.54	0.89%
R035XB016NM	Clay Loam Terrace (sodic) 7-10" p.z.	16	5,500.27	1.37%
R035XB017NM	Cobbly Slopes 6-10" p.z.	15	7,506.61	1.87%
R035XB020NM	Loamy 6-10" p.z. terrace	1	258.65	0.06%
R035XB021NM	Loamy Upland 7-10" p.z.	21	10,217.87	2.55%
R035XB022NM	Loamy Upland Sodic	7	4,678.79	1.17%
R035XB024NM	Saline Bottom 6-10"	0	89.01	0.02%
R035XB028NM	Sandy Bottom 6-10"	2	918.17	0.23%
R035XB030NM	Sandy Loam Upland 6-10" p.z.	39	18,854.29	4.71%
R035XB034NM	Sandy Terrace 6-10" sodic	0	2,108.11	0.53%
R035XB035NM	Sandy Upland 6-10" p.z.	0	511.81	0.13%
R035XB201AZ	Breaks 6-10" p.z.	5	1,397.26	0.35%
R035XB204AZ	Sandstone Upland 6-10" p.z. Very Shallow	10	4,060.96	1.01%
R035XB215AZ	Sandstone/Shale Upland 6-10" p.z.	0	51.60	0.01%
R035XB216AZ	Sandy Bottom 6-10" p.z.	2	246.21	0.06%

Ecological Site Number	Ecological Site Name	Number of Transects	Acres	% of Project Area
R035XB217AZ	Sandy Upland 6-10" p.z.	20	8,393.51	2.10%
R035XB219AZ	Sandy Loam Upland 6-10" p.z.	9	4,936.76	1.23%
R035XB222AZ	Sandy Terrace 6-10" p.z.	9	3,814.58	0.95%
R035XB224AZ	Clayey Slopes 6-10" p.z. Bouldery	3	3,057.48	0.76%
R035XB225AZ	Clayey Upland 6-10" p.z. Sodic	5	4,231.15	1.06%
R035XB227AZ	Sandy Loam Upland 6-10" p.z. Sodic	1	3,660.12	0.91%
R035XB228AZ	Loamy Upland 6-10" p.z. Sodic	5	2,440.08	0.61%
R035XB229AZ	Cobbly Slopes 6-10" p.z. Grazane	4	1,077.67	0.27%
R035XB230AZ	Sandstone Upland 6-10" p.z. Calcareous	0	2.63	0.00%
R035XB238AZ	Sandy Terrace 6-10" p.z. Sodic	1	236.56	0.06%
R035XB239AZ	Clayey Fan 6-10" p.z.	1	731.75	0.18%
R035XB267AZ	Sandy Loam Upland 6-10" p.z. Limy	4	4,018.66	1.00%
R035XB268AZ	Shale Hills 6-10" p.z.	0	18.32	0.00%
R035XB269AZ	Loamy Bottom 6-10" p.z. Perennial	0	847.79	0.21%
R035XB270AZ	Porcelanite Hills 6-10" p.z.	0	7.85	0.00%
R035XB271AZ	Loamy Upland 6-10" p.z. Saline-Sodic	19	17,713.55	4.42%
R035XB272AZ	Loamy Bottom 6-10" p.z. Perennial, Saline	0	445.05	0.11%
R035XB273AZ	Sandy Bottom 6-10" p.z. Perennial	1	2,034.71	0.51%
R035XB274AZ	Sandy Loam Upland 6-10" p.z. Saline	67	29,273.73	7.31%
R035XB275AZ	Loamy Fan 6-10" p.z.	23	14,894.64	3.72%
R035XB276AZ	Siltstone Upland 6-10" p.z. Saline	16	15,945.82	3.98%
R035XB277AZ	Siltstone Upland 6-10" p.z. Limy	28	17,224.48	4.30%
R035XB278AZ	Loamy Upland 6-10" p.z. Saline, Gypsic	11	7,085.50	1.77%
R035XB279AZ	Clay Loam Upland 6-10" p.z. Sodic, Gypsic	12	7,137.00	1.78%
R035XC302AZ	Breaks 10-14" p.z.	1	90.59	0.02%
R035XC313AZ	Loamy Upland 10-14" p.z.	0	105.38	0.03%
R035XC314AZ	Sandstone Upland 10-14" p.z.	3	1,488.87	0.37%
R035XC315AZ	Sandy Upland 10-14" p.z.	13	4,017.88	1.00%

Ecological Site Number	Ecological Site Name	Number of Transects	Acres	% of Project Area
R035XC316AZ	Clay Loam Swale 10-14" p.z. Limy, Shallow	9	5,953.93	1.49%
R035XC317AZ	Sandy Loam Upland 10-14" p.z.	1	290.03	0.07%
R035XC324AZ	Clayey Slopes 10-14" p.z. Bouldery	9	2,933.68	0.73%
R035XC325AZ	Stony Slopes 10-14" p.z.	7	2,230.16	0.56%
R035XC326AZ	Sandy Loam Upland 10-14" p.z. Saline	8	2,907.50	0.73%
R035XC327AZ	Clayey Upland 10-14" p.z. Sodic	5	3,573.29	0.89%
R035XC328AZ	Cobbly Slopes 10-14" p.z.	4	3,052.42	0.76%
R035XC329AZ	Loamy Upland 10-14" p.z. Gravelly	18	9,567.37	2.39%
R035XC330AZ	Sandy Terrace 10-14" p.z. Stony	2	1,439.38	0.36%
R035XC335AZ	Clay Loam Upland 10-14" p.z. Limy	0	45.30	0.01%
R035XH813AZ	Silty Upland 17-25" p.z.	5	1,641.06	0.41%
R035XH814AZ	Sandstone Upland 17-25" p.z. Cobbly	0	2,344.37	0.59%
R035XY009UT	Alkali Flat (Greasewood)	5	2,903.42	0.72%
R035XY012UT	Semiwet Saline Streambank (Fremont Cottonwood)	4	2,591.96	0.65%
R035XY015UT	Sandy Bottom (Fourwing Saltbush)	4	2,002.50	0.50%
R035XY109UT	Desert Loam (Shadscale)	24	9,107.85	2.27%
R035XY115UT	Desert Sand (Sand Sagebrush)	8	3368.06	0.84%
R035XY118UT	Desert Sandy Loam (Fourwing Saltbush)	35	27,645.67	6.90%
R035XY215UT	Semidesert Sandy Loam (Fourwing Saltbush)	5	2,112.01	0.53%
R035XY220UT	Semidesert Shallow Loam (Black Grama)	4	1,368.18	0.34%
	Riverwash	0	1,024.36	0.26%
	Rock Outcrop	9	14,873.54	3.71%
	Badlands	25	34,894.99	8.71%
	No Ecological Site	1	5158.14	1.29%
Total		641	400,533.48	100%

Notes: " = inches, p.z. = precipitation zone.

F035XG134NM Gravelly - Woodland (Transects 107TNP2 and 326B1)

F035XH005NM Douglas Fir - Ponderosa Pine/Common Snowberry (Transects 252B1 and 196TNP2)

F036XA001NM Pinyon Pine – One-seed Juniper/Big Sagebrush (Transects 101TNP2 and 192TNP2)

R035XA113NM Sandy (Transects 062TNP2 and 106 TNP2)

R035XA117AZ Sandy Loam Upland 10-14" p.z. (Transects 216TNP2 and 130TNP3)

R035XB016NM Clay Loam Terrace (sodic) 7-10" p.z. (Transects 602B2 and 623RMU9)

R035XB017NM Cobbly Slopes 6-10" p.z. (Transects 383B2 and 393B2)

R035XB020NM Loamy 6-10" p.z. terrace (Transect 383B2)

R035XB021NM Loamy Upland 7-10" p.z. (Transects 371B2 and 417B2)


R035XB022NM Loamy Upland Sodic (Transects 418SR4 and 421B1)


R035XB028NM Sandy Bottom 6-10" (Transects 415SR4 and 416B2)


R035XB030NM Sandy Loam Upland 6-10" p.z. (Transects 433SR4 and 047TNP2)


R035XB201AZ Breaks 6-10" p.z. (Transects 197TNP3 and 150TNP3)


R035XB204AZ Sandstone Upland 6-10" p.z. Very Shallow (Transects 333TNP1 and 507SR4)

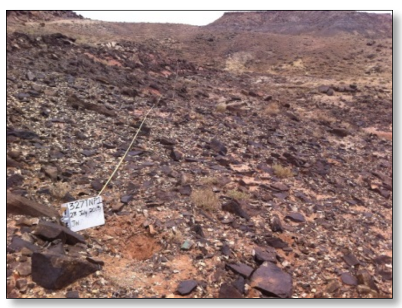

R035XB216AZ Sandy Bottom 6-10" p.z. (Transects 0298TNP3 and 299TNP3)


R035XB217AZ Sandy Upland 6-10" p.z. (Transects 35TNP3 and 243TNP3)


R035XB219AZ Sandy Loam Upland 6-10" p.z. (Transects 236TNP3 and 238TNP3)

R035XB222AZ Sandy Terrace 6-10" p.z. (Transects 043TNP2 and 120TNP3)

R035XB224AZ Clayey Slopes 6-10" p.z. Bouldery (Transects 287TNP1 and 327TNP1)

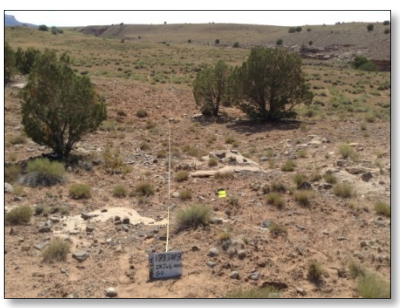


R035XB225AZ Clayey Upland 6-10" p.z. Sodic (Transects 285TNP1 and 343TNP1)

R035XB227AZ Sandy Loam Upland 6-10" p.z. Sodic (Transect 292TNP1)

R035XB228AZ Loamy Upland 6-10" p.z. Sodic (Transects 255TNP3 and 325TNP1)

R035XB229AZ Cobbly Slopes 6-10" p.z. Grazane (Transects 173TNP3 and 199TNP3)



R035XB238AZ Sandy Terrace 6-10" p.z. Sodic (Transect 061TNP3)

R035XB239AZ Clayey Fan 6-10" p.z. (Transect 098TNP3)

R035XB267AZ Sandy Loam Upland 6-10" p.z. Limy (Transects 345TNP1 and 367B2)

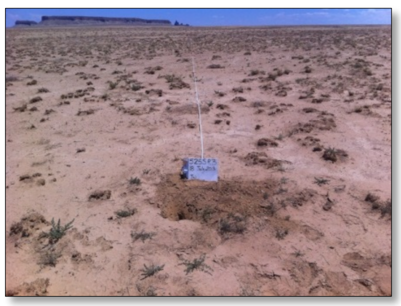
R035XB271AZ Loamy Upland 6-10" p.z. Saline-Sodic (Transects 546SR4 and 563SR4)

R035XB273AZ Sandy Bottom 6-10" p.z. Perennial (Transect 546SR4)

R035XB274AZ Sandy Loam Upland 6-10" p.z. Saline (Transects 467RMU5 and 482RMU2)

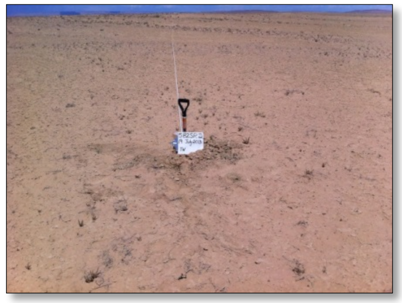

R035XB275AZ Loamy Fan 6-10" p.z. (Transects 537RMU8 and 523SR3)


R035XB276AZ Siltstone Upland 6-10" p.z. Saline (Transects 509SR4 and 525SR3)

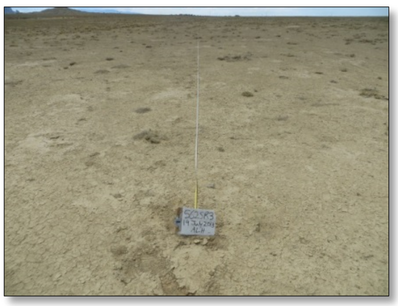



R035XB277AZ Siltstone Upland 6-10" p.z. Limy (Transects 407B1 and 586SR2)


R035XB278AZ Loamy Upland 6-10" p.z. Saline, Gypsic (Transects 543SR3 and 582SR2)

R035XB279AZ Clay Loam Upland 6-10" p.z. Sodic, Gypsic (Transects 5462R3 and 593SR1)




R035XC302AZ Breaks 10-14" p.z. (Transect 324B1)

R035XC314AZ Sandstone Upland 10-14" p.z. (Transects 359B2 and 388B1)


R035XC315AZ Sandy Upland 10-14" p.z. (Transects 034TNP2 and 267TNP2)

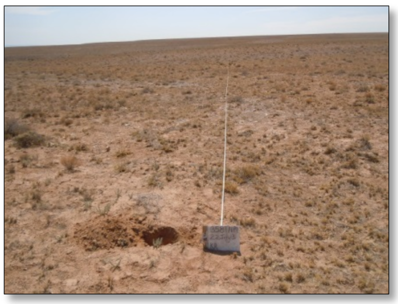
R035XC316AZ Clay Loam Swale 10-14" p.z. Limy, Shallow (Transects 151TNP1 and 306TNP1)

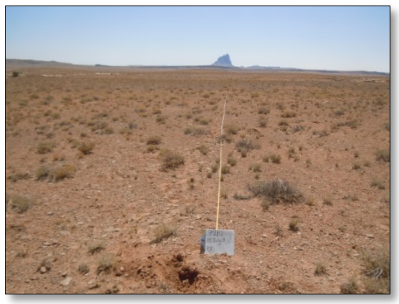
R035XC317AZ Sandy Loam Upland 10-14" p.z. (Transect 157TNP2)

R035XC324AZ Clayey Slopes 10-14" p.z. Bouldery (309TNP1 and 212TNP3)

R035XC325AZ Stony Slopes 10-14" p.z. (Transects 297B1 and 331B2)

R035XC326AZ Sandy Loam Upland 10-14" p.z. Saline (Transects 358TNP1 and 391B1)





R035XC327AZ Clayey Upland 10-14" p.z. Sodic (Transects 361B2 and 380B1)

R035XC328AZ Cobbly Slopes 10-14" p.z. (Transects 201TNP2 and 263TNP2)

R035XC329AZ Loamy Upland 10-14" p.z. Gravelly (Transects 133TNP2 and 240TNP2)

R035XC330AZ Sandy Terrace 10-14" p.z. Stony (Transects 144TNP2 and 308B1)

R035XH813AZ Silty Upland 17-25" p.z. (Transects 179TNP2 and 182TNP2)

R035XY009UT Alkali Flat (Greasewood) (Transects 050TNP3 and 097TNP3)

R035XY012UT Semiwet Saline Streambank (Fremont Cottonwood) (Transects 251TNP3 and 254TNP3)

R035XY015UT Sandy Bottom (Fourwing Saltbush) (Transects 105TNP3 and 103TNP3)

R035XY109UT Desert Loam (Shadscale) (Transects 261TNP3 and 290TNP3)

R035XY115UT Desert Sand (Sand Sagebrush) (Transects 208TNP3 and 221TNP3)

R035XY118UT Desert Sandy Loam (Fourwing Saltbush) (Transects 003TNP3 and 036TNP3)

R035XY215UT Semidesert Sandy Loam (Fourwing Saltbush) (Transects 082TNP3 and 096TNP3)

R035XY220UT Semidesert Shallow Loam (Black Grama) (Transects 038TNP3 and 064TNP3)

Rock Outcrop (Transects 378B1 and 355B1)

Badlands (Transects 146TNP3 and 156TNP3)

4. METHODOLOGY

The methods used to collect these data included protocols provided by the BIA and modified to standards used in federally published Technical References. The Statement of Work (SOW), provided by the BIA to Ecosphere, described the study design and cited specific methodologies for data collection (Coulloudon et al. 1999, Habich 2001, and USDA NRCS 2003). The field methodology was based on the SOW and technical references, with modifications approved by the BIA.

4.1 Field Methodology

Data collection in the field occurred between July 8 and August 2, 2013. The Universal Transverse Mercator (UTM) coordinates of transect locations were downloaded into hand-held Global Positioning System (GPS) units. A GPS unit was used in combination with topographic maps to navigate to the transect locations by vehicle and on foot. Transects were established within 1 to 10 meters of the GPS coordinates.

Transects consisted of a 200-foot line measured with an open reel tape placed flat and straight along the ground and stretched as taut as possible. Using field maps and topography as a guide, each transect was placed within a single soil unit and vegetation community. The transect azimuth was randomly determined by selecting a prominent distant landmark, such as a mountain or lone tree. The transect azimuth was read with a compass and recorded. The 200-foot tape was then extended along the transect azimuth. Vegetation attributes were recorded from ten plots at 20-foot intervals along the open reel tape, starting at the 20-foot mark, not at zero. The plots were measured with a square 9.6-square-foot (ft^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 of the tape. The point intercept for ground cover was measured from the left side of the tape. Aspect, slope, surface soil texture, and notes also were recorded. All plant species names were consistent with the NRCS Plants Database (USDA NRCS 2013).

4.1.1 Production Data Collection

Production is determined by measuring the weight of annual aboveground growth of vegetation because it has a direct relationship to feed units for grazing animals. 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 aboveground and available to herbivores. The peak standing crop is the greatest amount of plant biomass aboveground present during a given year (Coulloudon et al. 1999). Production includes the aboveground parts of all plants produced during a single growth year. Excluded are underground growth, production from previous years, and any increase in the stem diameter of shrubs.

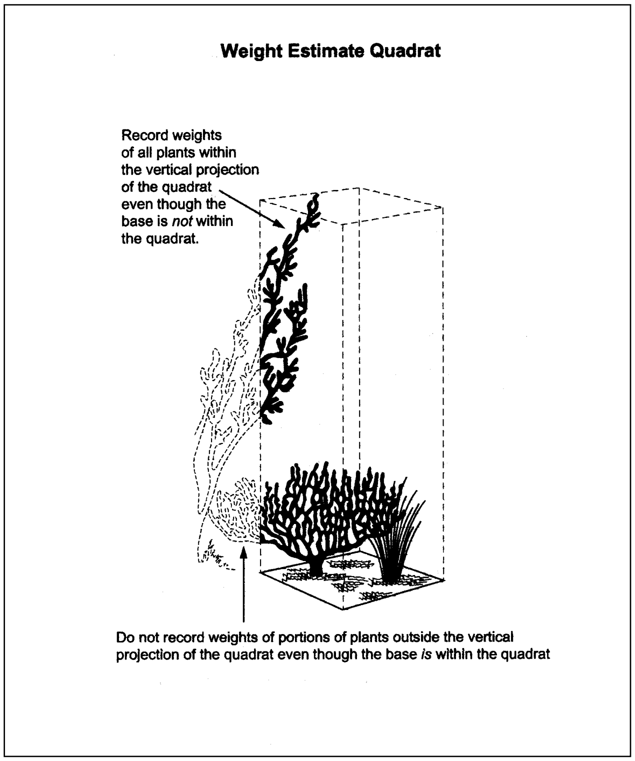
Production and composition of the plant communities were determined using the USDA double sampling methodology with a combination of estimating and harvesting. For this survey, Ecosphere followed the USDA's double sampling methodology, NRCS's modified standards outlined in the SOW, and modifications generated from the pre-work conference. The double sampling method is detailed in the following sections.

4.1.1.1 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 to assess production. A weight unit is created by visually selecting part of a plant, an entire plant, or a group of plants that will most likely equal a particular weight. For example, a fist-sized clump of healthy, un-grazed Indian ricegrass may be visually estimated to equal 10 grams. This clump of grass is then harvested and weighed with a hand scale to determine actual weight. This process is repeated until 10 grams of Indian ricegrass can be visually estimated with accuracy. After weight units are established, field teams can accurately estimate production. The field team maintained proficiency by regularly harvesting and weighing to check estimates of production.

4.1.1.2 Double Sampling Methodology (Estimating and Harvesting)

Production (measured in grams) was estimated by counting the weight units of each species in each plot. All plants and parts of plants inside a quadrant outlined by the 9.6-ft^2 frame up to a height of 4 feet were estimated by the field team (Figure 4-1). Plants outside the quadrant were excluded from the weight estimate. Two plots on each transect were chosen for harvesting. On the harvested plots, all species were estimated *in situ* and then harvested at ground level (¼-inch stubble height).



Source: Coulloudon et al. 1999

Figure 4-1. Weight Estimate Box

Harvested biomass was weighed with a hand scale, and both estimated and harvested (green) 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 allowed to air dry for at least 10 days before re-weighing to convert from green weight to air-dry weight (ADW). The purpose of the double sampling was to correct any variability between the estimation of production and the actual weighed production. This was accomplished by using an estimation correction factor, which is calculated in the post-field data processing.

In many cases, vegetation in the transect was diverse and widespread so two plots could not effectively represent all species. Furthermore, Ecosphere has determined, through several years of data collection and analysis, that intermittently occurring species are under-represented in the harvested material. In an effort to include more species in the harvested material, a weight unit of any species that contributed 10 grams or more of estimated production on the transect, but did not occur in the two selected harvested plots, was estimated and harvested individually outside of the transect. This was called a calibration sample.

4.1.1.3 Large Shrub Plots

Extended plots were established when “large” shrubs were encountered in the area of a transect. Neither the SOW nor the National Range and Pasture Handbook (USDA NRCS 2003) adequately define the large shrub plot methodology. However, Ecosphere understands that the purpose of the large shrub plots is to capture the production of shrubs that are too wide to be adequately measured within the 9.6-ft^2 frame.

Large shrub plots were established if shrubs that were larger than the plot frame were present in the shrub belt area defined as the length of the transect (200 feet) and the width of a large shrub plot (20.8 feet) on the right side of the transect tape. Examples of areas with large shrub plots include shrublands with big sagebrush, greasewood flats, or on rolling hills with antelope bitterbrush (*Purshia tridentata*) and mountain mahogany (*Cercocarpus montanus*).

For transects with large shrubs, two 0.1-acre extended plots were established at fixed points along the transect (60 feet and 140 feet along the 200-foot tape). These extended plots formed the large shrub plots where only large shrub species were estimated. After a weight unit was established for each species of large shrub (see Section 4.1.1.1), the number of weight units occurring within the plot was counted. Annual production was estimated by multiplying the number of weight units by the value of the weight unit. Large shrubs were not measured inside the ten 9.6- ft^2 plots on the transect to avoid double counting them.

4.1.1.4 Ocular Estimates of Utilization

Utilization is the proportion of annual growth that has been consumed by grazing animals. The purpose of estimating utilization is to include in the vegetation measurements the forage that has been consumed prior to the vegetation inventory. With the Ocular Estimation Method (Coulloudon et al. 1999), utilization is determined by visually inspecting forage species. This method is reasonably accurate, commonly applied, and suited for use with grasses and forbs. Field team personnel were thoroughly trained and practiced in making ocular estimates of plant utilization. An attempt was made to locate un-grazed plants near the transect. These un-grazed plants were assumed to approximate the species condition before grazing occurred. Un-grazed 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 impossible to determine what re-growth, if any, may have occurred. The percentage of un-grazed plant remaining was recorded for each species on each transect.

4.1.1.5 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 harvested. Cacti and yucca species were not harvested; instead, their annual production was estimated using standard protocols as described in the National Range and Pasture Handbook (USDA NRCS 2003). Production for yuccas was considered 15 percent of total green weight. Cholla cacti production was considered 15 percent of active tissue. Similarly, 10 percent of prickly pear and 5 percent of barrel cacti active tissue was considered in measuring production.

4.1.2 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.

On rangeland, regeneration of desirable plants maintains good range conditions. Grazing by too many animals (livestock and wildlife), or heavy utilization by a few animals results in overuse, loss of vigor, and disappearance of the preferred and desirable plants. Deterioration of range vegetation begins when less valuable forage species replace the desirable species. If deterioration continues, invaders and noxious weeds replace the less valuable forage species. The frequency and composition of preferred and desirable species compared to less valuable forage is used as an indication of range condition.

4.1.3 Cover Data Collection

Ground cover measurements are used to quantify the amount of vegetation, organic litter, biological crusts, and exposed soil surface throughout an area. Cover also is important from a hydrologic perspective when examining basal vegetation and canopy (foliar) cover of perennial and annual species and litter cover. This study measured understory vegetation; no trees were included in the cover data measurements.

Ground cover data can assist in determining the soil stability and proper hydrologic function and biotic integrity of a site. For trend comparisons in herbaceous plant communities, basal cover is generally considered to be the most stable because it does not vary as much from climatic and seasonal conditions (compared to canopy cover). Canopy cover can vary widely over the course of the growing season, which can make it difficult to compare results from different portions of a large area where sampling takes weeks or months. For this reason, future ground cover monitoring for each ecological site within each grazing unit should replicate the sampling period from this baseline inventory.

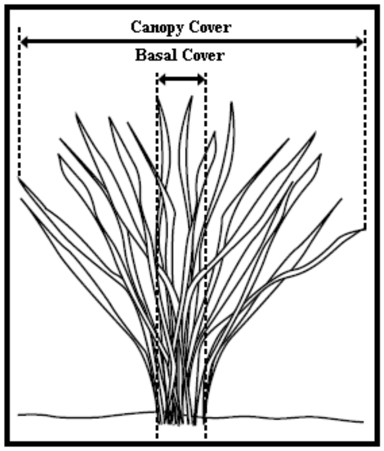
The line-point intercept method employed on this study is described in *Monitoring Manual for Grassland, Shrubland and Savanna Ecosystems* (Herrick et al. 2005). There are 50 point measurements spaced every 4 feet along a 200-foot measuring tape anchored securely at each end. At each point along the transect, a sighting device (pin flag) was placed perpendicular to the ground along the measuring tape. Three layers of point intercept were recorded as the pin flag was dropped into place: Top Canopy, Lower Canopy, and Soil Surface.

The first cover category is determined by the first plant interception of the pin flag. The species of plant that the pin flag hits is recorded as the "Top Canopy." If no plants are intercepted, "None" is recorded.

Up to three additional species intercepted by the pin flag below the top canopy are recorded as "Lower Canopy" layers. If herbaceous or woody litter is intercepted, this is recorded as a lower canopy layer.

The final point intercept, "Soil Surface," is recorded either as the base of a plant species (Figure 4-2) or one of the following categories: Rock, Bedrock, Embedded Litter, Duff, Moss, Lichen Crust, or Soil. Bare ground occurs only when the Top Canopy is “None,” there are no Lower Canopy layers, and the Soil Surface is “Soil.”

Measuring cover by points is considered one of the least biased and most objective cover measures (Bonham 1989). Results of the ground cover data analysis are included in Section 5.



Source: Elzinga et al. 1998

Figure 4-2. Vegetative Cover

4.1.4 Soil Surface Texture Test

At each transect, the soil was sampled to determine or confirm the soil component of the site. The surface was cleared of debris to bare mineral soil. A small soil pit was dug to a determining layer of the soil profile and a soil sample from this layer was analyzed using the USDA Soil Texturing Field Flow Chart. The Flow Chart uses a systematic 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. The field crew assigned a texture class to the sample based on its tested content and ribbon characteristics. The results of the soil sample determined or confirmed the soil component using Map Unit Descriptions from the Soil Survey as the primary reference, supported by soil profiles described in ESDs.

4.2 Post-Field Data Processing Methodology

After all field data were collected, the data were downloaded into a database. Harvested biomass was air dried for 10 days and dry weights were entered into the database for each species on each transect. This initial field dataset was adjusted to compare the collected production data to the amount of vegetation that would occur in a “normal” year. These adjustments included factors for utilization, climate, growth curve, and ADW.

After the production estimates were “normalized” for every species on every transect, results were grouped by ecological sites within each analysis unit. Further analysis for each analysis unit included similarity indices, available forage based on forage value and harvest efficiency factors, stocking rates, and carrying capacity.

4.2.1 Reconstructed Annual Production

Pounds per acre were estimated from field data through a series of calculations derived from technical reference 1734-7 Ecological Site Inventory (Habich 2001) and the National Range and Pasture Handbook (USDA NRCS 2003). This methodology reconstructs the measured weight of biomass to a "normal" annual air-dry production weight that accounts for physical, physiological, and climatological factors. First, the field-estimated green weight of a species was multiplied by an estimation correction factor and then by a reconstruction factor. The reconstruction factor is the percent ADW of the species divided by the product of the utilization, normal precipitation for the current water year, and growth curve for that time of year, as shown in the formula below:

$$\textit{Corrected Green Weight} = \frac{(\%\ ADW)}{(\%\ Utilization)\ (\%\ Normal\ Precipitation)\ (\%\ Growth\ Curve)}$$

The result of multiplying the green weight of a species by the reconstruction factor is the "total reconstructed annual production." Details of each of the elements in this equation are described in the following sections.

4.2.1.1 Corrected Green Weight (Estimation Correction Factor)

The harvested plots provide the data for correction factors of estimated species weights from the field. Measured (harvested) weights of species were divided by the estimated weights of the same species in the same plot to establish a correction factor. This correction factor was then applied to all estimations of that species for the entire transect. For example, if alkali sacaton was estimated to weigh 10 grams but the harvested weight was measured as 9 grams, then all estimates of alkali sacaton for that transect were multiplied by a correction factor of 0.90 as presented below:

$$\textit{Estimation Correction Factor} = \frac{\textit{Sum of Measured Weights}}{\textit{Sum of Estimated Weights}} = \frac{\textit{9 grams}}{\textit{10 grams}} = 0.90$$

If the total estimated weight for alkali sacaton on all plots in this transect was 80 grams, the resulting corrected estimated green weight (grams) x correction factor = 80 grams x 0.90 = 72 grams. The corrected green weight is 72 grams.

4.2.1.2 Biomass ADW Conversion

The ADW percentage is part of the reconstruction factor and accounts for the amount of water contained in the plant. The purpose is to remove the weight of water from the weight of the actual plant forage. All biomass collected from harvested plots was placed in paper bags; tracking information (date, transect identification, plot number, and species) was recorded on the bags. Harvested, or green, weights were immediately obtained with a hand scale, which was adjusted for the weight of the bag, and recorded. The paper bags filled with biomass were air dried for a minimum of 10 days. All bags were then weighed again and dry weights were recorded into the dataset. After drying, the weights were divided by the green weights to give a percent ADW in grams to be used in the reconstruction factor. In the example in Section 4.2.1.1, the green weight of the harvested biomass was 9 grams. If the dry weight in the lab was measured at 8 grams, then the percent ADW would be 0.89.

$$\%\ ADW = \frac{Dry\ Weight\ (lab)}{Green\ Weight\ (field)} = \frac{8\ grams}{9\ grams} = 0.89$$

This value (0.89) represents the numerator of the reconstruction factor. The three values in the denominator are explained in the following sections. (Note: for species in a transect that were not harvested, an average percent ADW was used that was generated from the same species in the same analysis unit. In the case of remaining species, the percent ADW defaulted to 1.)

4.2.1.3 Utilization

The utilization estimate is applied to adjust for portions of plants that were not measured due to grazing of the plant prior to the survey. The default is 100 percent un-grazed. Grazed or utilized species were measured according to the average amount of plants that remained un-grazed near the transect. For example, if alkali sacaton was recorded at a utilization factor of 90 percent un-grazed, then the amount of alkali sacaton estimated would represent only 90 percent of the total.

$$Utilization = 0.90$$

The total weight of the species in the transect is divided by 0.90 to bring the measured weight up to 100 percent.

4.2.1.4 Growth Curves

Growth curves are used to reconstruct the aboveground 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 that has not yet grown and thus was not measured during the vegetation inventory. A weight measurement taken in June would normally be 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. For example, if alkali sacaton was measured in a transect during August, that measurement may represent only 88 percent of the full growth of that species.

Each growth curve entry was a pro-rated value according to the day of the month. For example, using the growth curve AZ3521 and a transect that was sampled August 21, the first step in the growth curve analysis would be to estimate the percentage of growth completed up to that date by adding up the monthly categories as illustrated below:

Feb (1%) + Mar (9%) + Apr (20%) + May (27%) + June (14%) + July (10%) = 81%

Then, for the month of August, 21 days would need to be prorated and added to the total. The value is determined by dividing the percent of growth occurring in August (11 percent) by the 31 days that occur during the month of August. This calculation yields a rate of 0.35 percent per day. The number of days that have occurred up to that date (21) is multiplied by the daily rate (0.35 percent) for 7.35 percent. This is added to the 81 percent that had occurred up to the end of July for a total of 88.35 percent of the growth curve completed.

Growth curves typically are presented in an ecological site description. However, many of the ESDs in the survey area did not have growth curves, or had incorrect growth curves. If the growth curve in the ESD was determined to be incorrect, then the ESD was replaced with the most suitable growth curve in the same common resource area, if possible. The growth curve used for many sites was AZ3521, 35.2, 6-10” p.z. (all sites) In this growth curve, plant growth begins in the spring and continues through the summer with most growth occurring in spring. The percent production by month using this growth curve is shown in the chart below.

Percent production by month in AZ3521, 35.2, 6-10” p.z. (all sites) growth curve.

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0%	1%	9%	20%	27%	14%	10%	11%	5%	3%	0%	0%

The growth curve value for the example sample collected on August 21 is 0.8835.

Growth Curve = 0.88

Therefore, the total weight of the species reported in that transect is divided by 0.88 to bring the measured weight up to 100 percent of growth for the year.

4.2.1.5 Percent Normal Production

The Percent Normal Production in a sample area is directly affected by the relationship between growing conditions, especially precipitation amount, timing of precipitation, and temperature. Production varies each year depending on the favorability of these growing conditions. Biomass production measurements from year to year are not accurate without adjusting production to a “normal” year. The factors of precipitation, timing, and temperature are extremely difficult factors to quantify and apply to biomass production because the impacts vary by species. For this inventory, the variation in precipitation was used as the value for normal production percentage. The precipitation measurements from 11 rain cans in the Northern Navajo Agency were used in the calculations to determine the percent of normal production. The 13 years prior to 2013 were averaged and used as an historic comparison. The 2013 water year was 85 percent of the average.

For the example calculation, the water year was 102 percent of the average.

Percent Normal Production = 1.02

The total weight of the species in the transect is divided by 1.02 to bring the measured wet year down to 100 percent. Normalizing the precipitation to an average year helps prevent over-allocating forage.

4.2.1.6 Reconstruction Equation

Using the example carried through the previous sections, Ecosphere began with an estimated green weight (in the field) of 80 grams of alkali sacaton, multiplied by the estimation correction factor for a corrected green weight of 72 grams. This corrected green weight of 72 grams was then multiplied by the reconstruction equation:

$$\textit{Reconstruction Equation} = \frac{0.89}{(0.90 \times 1.02 \times 0.88)} = 1.10$$

The formula for the reconstruction equation, as explained earlier in Section 4.2.1, is repeated here:

$$\textit{Corrected Green Weight} = \frac{(\%\ ADW)}{(\%\ Utilization)\ (\%\ Normal\ Precipitation)\ (\%\ Growth\ Curve)}$$

When actual values from the alkali sacaton example are inserted into the formula, the equation becomes:

$$72 \textit{ grams} \times \frac{0.89}{0.90 \times 1.02 \times 0.88} = 72 \textit{ grams} \times 1.10 = 79.20 \textit{ grams}$$

The corrected green weight from the example above (72 grams) multiplied by the reconstruction factor (1.10) results in a total reconstructed annual production of 79.20 grams.

4.2.1.7 Conversion from Grams to Pounds per Acre

The conversion from the working unit of grams (per transect) into the application of pounds per acre is also factored into production estimates. The plot size, 9.6 ft^2, was repeated ten times in each transect, thereby creating 96 ft^2 of sampling area. The sampling area size accounts for the conversion from grams to pounds (453.59 grams per pound) and square feet to acres (43,560 ft^2 per acre), which calculates into a 1:1 conversion (Coulloudon et al. 1999). Therefore, in this case the conversion factor equals one and is not explicitly included into the total reconstruction annual production equation. Hence, in the example, there were 79.20 pounds per acre of alkali sacaton. The value 79.20 represents the total reconstructed annual production of the species in pounds per acre.

4.2.2 Calculating Ground Cover

Ground cover calculation categories were measured in terms of top canopy, basal cover, and bare soil surface. Fifty ground cover point intercepts were measured, so ground cover categories were divided by 50 and the result was multiplied by 100 to estimate a percentage of ground cover for each transect. For example, if 30 hits were recorded for bare ground, the percent bare ground on that transect would be 60 percent.

$$\frac{\textit{30 "bare ground" hits}}{\textit{50 total hits}} \ \textit{X 100} \quad \textit{= 60\% bare ground}$$

It is important to note that bare ground refers to situations where soil was the only substrate present. A lack of foliar or basal cover in conjunction with duff, litter, rock, or bedrock is not considered bare ground. This is because true bare soil has less soil stability than duff, litter, rock, or bedrock. Cover data were averaged by analysis unit.

4.2.3 Frequency Calculations

Species frequency was measured when weights were estimated for all species in each production plot using the intensive method (Herrick et al. 2005). For example, if alkali sacaton occurred in six of the ten plots on a given transect, the frequency would be 60 percent. Frequency of species by plot on each transect is included in the database of production data with this report in digital format. Frequency of the most common species (including large shrubs) to occur on transects within each analysis unit is presented in Section 5.

4.2.4 Similarity Index Calculations

Each ecological site has a unique HCPC described in the ESD. The similarity index is a process of comparing the plant community that currently exists on the ground to the HCPC. The similarity index is expressed as a percentage. If a current plant community contains the exact same species and proportions of species as the HCPC, the similarity index would be 100 percent, while a lower percentage would indicate that the current vegetation community is dissimilar in species weight and composition from the HCPC. A similarity index was calculated for all transects assigned to ecological sites with available ESDs.

The plant community currently present on a site may never reach HCPC, but may have changed such that its final successional state would result in a PNC. The PNC, unlike the HCPC, is a result of natural disturbances and may include non-native species. For purposes of comparison, the HCPC is used because this baseline has already been established for all ecological sites.

The recommended and accepted method of calculating a similarity index is to compare the median ESD production to the total reconstruction production value. Each ESD lists a range of expected production for above-average years and below-average years for each species (or group of species), as well as the total annual production for the site. The median of the above average and below average is used as the comparison production amount because all of the variable factors (such as above average precipitation) already have been factored into the reconstruction process. The sum total of these median values is used to compare the measured vegetation against the HCPC.

The similarity index for this survey was calculated by comparing the estimated production value for each plant species to the ESD. The ESD has an assigned production value for each species (or group of species) expected to occur in the HCPC. Production that is expected to occur in the ecological site (up to the maximum percent listed) is termed “allowable production.” If an individual species (or group of species) is not listed in the ESD, no production is assigned or “allowed” from that species. For example, a transect had 79.20 pounds/acre of alkali sacaton. Based on the information in the ESD, the allowable production for alkali sacaton is 50 pounds/acre. No more than 50 pounds may be allowed to be counted toward the similarity index for the transect. If the ESD had listed the allowable percentage of alkali sacaton at 200 pounds/acre, then all 79.20 pounds (and no more) would have been allowed to be counted toward the similarity index for the transect.

Every species on a transect was compared against the ESD. If the species was not expected to occur in the ecological site, it was given a zero percent allowable production value. If the species was expected to occur on the site, it was assigned the maximum value allowable assigned in the ESD. The total allowed production in pounds of each species was summed for each transect.

4.2.5 Calculating Available Forage

The forage value of a species is defined in terms of palatability and availability, as they apply to a particular type of livestock. Ecological site descriptions list only the values for common plant species; however, the Utah NRCS developed a list of species from the Colorado Plateau area. This list was the primary source used to assign forage values to species encountered in the survey. Forage values for plants not included in the NRCS records were obtained from other professional sources. A comprehensive list of all plant species, their forage values, and additional resources for plant information is included with the digital Excel data submitted with this report. Species are grouped into five categories; each category is weighted by preference by grazing animals. The five groups recognized by the National Range and Pasture Handbook (USDA NRCS 2003) are as follows:

Preferred plants—These plants are abundant and furnish useful forage for a reasonably long grazing period. They are preferred by grazing animals. Preferred plants generally are more sensitive to grazing misuse than other plants and they decline under continued heavy grazing.

Desirable plants—These plants are useful forage plants, although not highly preferred by grazing animals. They provide forage for a relatively short period or they are not generally abundant in the stand. Some of these plants increase, at least in percentage, if the more highly preferred plants decline.

Emergency (or undesirable) plants—These plants are relatively unpalatable to grazing animals or they are available only for a very short period. They generally occur in insignificant amounts, but may become abundant if more highly preferred species are removed.

Non-consumed plants—These plants are unpalatable to grazing animals or they are unavailable for use because of structural or chemical adaptations. They may become abundant if more highly preferred species are removed.

Toxic or Injurious—Species that can be toxic or injurious to livestock, regardless of their palatability, were also noted with the forage value. Injurious species are noted with a superscript letter “i” (^{i}) next to the forage value, and toxic species are noted with a superscript letter “t” (^{t}) next to the forage value.

Toxic and injurious species never were included in the available forage because of the year-round grazing scheme on the Navajo Nation. However, managers should be aware of their forage values because some are palatable and not toxic or injurious during certain seasons.

Many species have more than one forage value according to the season of use. For example, muttongrass is considered preferred by sheep in the spring, but only desirable during the remainder of the year. Grazing in the project area is permitted throughout the year so a single forage value is needed. The lowest seasonal forage value was chosen for each species as a conservative estimate of the forage available and to avoid overgrazing during times of the year when forage palatability is lowest. Ecosphere used forage values during the least palatable season (usually fall or winter) to calculate available forage for sheep.

Each forage group is assigned a harvest efficiency factor. The harvest efficiency factor accounts for production that is actually consumed by grazers. Not all annual production is available for livestock consumption due to trampling, loafing, and other non-livestock factors such as loss to disease, insects, or utilization by wildlife. The harvest efficiency factor is applied to the amount of production within a management area; its purpose is to ensure watershed protection and sustainability of the range resource by limiting allocation of the available forage.

The harvest efficiency factor generally averages 25 percent on rangelands with continuous grazing (USDA NRCS 2003). Using NRCS guidelines, the harvest efficiency factors applied for this project were 35 percent for preferred plants, 25 percent for desirable species, and 15 percent for undesirable/emergency plants. Non-consumed species as well as any toxic and injurious species, regardless of their forage value, were excluded from the calculations.

The available forage was calculated from the amount of production provided by preferred, desirable, and undesirable/emergency plants with harvest efficiency applied. Initial stocking rates were calculated from this estimate of available forage.

4.2.6 Grazing Area Adjustments

The amount of actual land available for grazing was quantified using geographic information system (GIS) files from the BIA. Home sites, farmland, and roads were buffered and removed from the total acreage available for livestock grazing.

Based on livestock behavior, carrying capacity was adjusted to account for distance to water and the steepness of slopes. Distance to water and slope percent were adjusted incrementally (Table 4-1). Slopes up to 10 percent had no reduction in carrying capacity; moderate slopes had a 30 percent reduced carrying capacity, while steep slopes had a 60 percent reduction in carrying capacity. Slopes greater than 60 percent are generally inaccessible to livestock and were excluded from the available grazing acres.

Table 4-1. Distance to Water Reduction and Slope/Reductions

Distance to Water (Reduction)	Slope (Reduction)
0-1 Mile (0%)	0-10% (0%)
1-2 Miles (50%)	11-30% (30%)
>2 Miles (100%)	31-60% (60%)
	>60% (100%)

Livestock will rarely range more than 2 miles from a water source (Holechek 1988). Areas farther than 2 miles from a water source can be considered un-grazeable and that acreage should be removed from stocking rate calculations. Permitting in areas beyond 2 miles will lead to overgrazing and deterioration. However, if permittees are hauling water to their stock, this should be considered when adjusting carrying capacity.

The BIA recommendations include 100-percent stocking rates and carrying capacity between 0 and 1 mile from a water source, 50-percent stocking rates between 1 and 2 miles from the water source, and no grazing more than 2 miles from the water source (Table 4-1).

Water sources included windmill and artesian well data supplied by the BIA, and wetland data created by Ecosphere for the Navajo Nation Wetland Mapping Project. Monitoring of the condition, addition, or loss of water sources should be updated in the geodatabase and resulting stocking rates.

4.2.7 Initial Stocking Rates and Carrying Capacity

The initial stocking rate and carrying capacities were calculated by the percentage of ecological site within each grazing community. Carrying capacity for rangeland management purposes is defined as the number of grazing animals that a specified area can support without depleting the forage resources. Carrying capacity may vary annually in response to forage production.

The calculations for carrying capacity are run in a GIS model to calculate the percentage of each soil component of each soil map unit within each grazing unit. Soil map units or ecological sites that had no transects were not included in the GIS analysis. Carrying capacity numbers are derived by dividing the stocking rate by the total acreage of a given ecological site within an analysis unit.

Stocking rates represent the number of acres needed to support one animal unit for 1 year. For this project, yearlong numbers are derived from a BIA-approved animal unit month (AUM) of 790 pounds per acre. The AUM is multiplied by 12 months and the result is divided by the animal unit equivalent in order to derive the amount of forage necessary to support one animal for a year. The stocking rate is figured by dividing this number by the average amount of available forage in each ecological site within an analysis unit. Table 4-2**Error! Reference source not found.** is an example calculation for sheep using an available forage amount of 100 pounds per acre.

Table 4-2. Example Stocking Rate Calculation

Description	Calculation
AUM multiplied by 12 months = Amount of forage needed to support one animal unit for a year.	(790 x 12) = 9,480 lbs per acre
Amount of forage needed to support one animal unit for a year divided by sheep forage equivalent of AUM (5) = Amount of forage to support one sheep for a year.	9,480/5 = 1,896 lbs per acre
Amount of forage needed to support one sheep for a year/available forage = Number of acres necessary to provide the yearly forage amount for one sheep (stocking rate).	1,896/100 lbs per acre = 18.96 acres per year

Notes: AUM = animal unit month, lbs = pounds.

By law (25 CFR §167), the sheep forage equivalent of one animal unit in Districts 9 and 12 is four sheep. In other words, 790 pounds of forage can support one animal unit per month, or four sheep for a month.

5. RESULTS

Six hundred and thirty nine transects were read on the Land Management District 9 and 12 project area, and included three grazing communities: Beclabito, Shiprock, and Teec Nos Pos. The project area was subdivided into analysis units consisting of eleven pastures and nine range management units (RMUs). The attributes collected at each transect were biomass production, ground cover, and species frequency. From the production data, annual forage production and initial stocking rates were calculated by ecological sites in soil map units within each analysis unit. Carrying capacity was calculated by GIS analysis of the potential acres of ecological sites within each analysis unit.

Table 5-1 displays the carrying capacity of the range resource in the project area. The total size of the project area is 439,812 acres. Areas considered non-range were removed from the analysis; these include 28,354 acres of roads, home sites, water, and farmlands. There were 52,756 acres that could not be analyzed due to a lack of transects within the ecological sites in each grazing community.

The study results show an unadjusted carrying capacity of 2,448 sheep units in the entire Land Management District 9 and 12 project area. The carrying capacity is not consistent across a pasture or RMU; therefore, it is important to examine the stocking rates of each ecological site to determine which areas within the analysis unit may tolerate more livestock and which areas may be exceeding the carrying capacity. The discussion in Section 6 identifies ways that carrying capacity could be improved.

Table 5-1. Carrying Capacity Results Summary

Analysis Unit	Number of Transects	Acres (Non-Range Excluded	Initial Carrying Capacity (SUYL)	Adjusted Carrying Capacity (SUYL)
Beclabito 1	64	39,822.7	263.75	113.68
Beclabito 2	80	50,552.5	345.19	91.58
RMU 1	3	1,241.3	2.38	2.32
RMU 2	3	1,016.9	4.41	4.39
RMU 3	5	2,051.2	4.82	4.61
RMU 4	4	844.8	15.39	14.45
RMU 5	6	5,154.7	19.40	16.66
RMU 6	3	2,011.9	1.52	1.46
RMU 7	3	2,962.7	1.84	1.49
RMU 8	5	3,238.1	16.67	5.98
RMU 9	6	1,758.4	10.80	0.00
Shiprock 1	7	6,479.6	3.60	1.41
Shiprock 2	18	9,285.1	2.83	1.98
Shiprock 3	25	17,224.2	32.74	7.28
Shiprock 4	64	43,831.4	170.06	64.20
Shiprock 5	8	4,752.1	6.27	1.84
Shiprock 6	4	3,434.1	12.63	0.00
Teec Nos Pos 1	38	21,118.3	104.25	62.84
Teec Nos Pos 2	110	65,996.0	721.19	253.80
Teec Nos Pos 3	183	128,681.9	707.97	268.75
Total	**639**	**411,457.9**	**2,447.71**	**918.72**

Note: SUYL = sheep unit year long.

5.1 Description of Results by Analysis Unit

The results of this study have been broken down into the following categories: carrying capacity, initial stocking rates, similarity indices, available forage, ground cover, and species frequency. An initial description of each category is presented below, followed by a more detailed analysis of each analysis unit.

5.1.1 Initial Stocking Rates and Carrying Capacity

In general, the derived stocking rates are an accurate depiction of available forage. In some cases, however, only one transect was located in an ecological site. If the single transect happened to have extra high or extra low production, the resulting high or low stocking rate was applied to all acres of the ecological site within the analysis unit. In these situations, it may be necessary to gather additional data prior to adjusting animal numbers.

Results include the number of transects in each ecological site in each grazing community. Sites without transects, and therefore no carrying capacity, can be identified and range managers can collect site-specific data in those areas in order to assess the available forage and calculate carrying capacity. The areas also are visible on the accompanying maps.

The carrying capacity is not evenly dispersed across a grazing community or range unit; therefore, it is important to examine the stocking rates of each ecological site to determine which areas may be able to tolerate more livestock and which areas may be exceeding the carrying capacity.

5.1.2 Similarity Indices

Similarity indices were calculated for all transects associated with a given, described ecological site. Index values are meant to be used as a management tool and do not factor into stocking rate and carrying capacity. For example, a given ecological site may be producing over 2,000 pounds of galleta grass and alkali sacaton. These two grasses are considered to be “available forage” and all of this weight would be factored into the stocking rate and carrying capacity calculations. As a result, both the stocking rate and carrying capacity would be relatively high. However, the reference plant community in the ecological site description may be comprised of a small percentage of the two aforementioned grass species. This would likely result in a low similarity index. In this case, it becomes a management decision as to whether it is more beneficial to manage for the current, high-producing plant community or try to establish a plant assemblage more similar to the reference community. The benefit of managing toward this community is that the reference community is typically comprised of the suite of species best adapted to the area which, in turn, leads to improved biological functioning such as water retention, soil building, and plant growth. The type of livestock being grazed also should be taken into consideration. For example, if a given reference community is composed primarily of grass species, but the producer is raising sheep, then it would make more sense to manage for a community containing a mix of grasses, forbs, and shrubs.

5.1.3 Available Forage Production

Available forage is the portion of the total reconstructed production classified as preferred, desirable, or emergency forage. This quantity is used to calculate stocking rates. Forage production is low throughout the project area. The highest average production of available forage is in RMU 9 (36 pounds per acre), followed by RMU 4 (33 pounds per acre) and Teec Nos Pos 2 (31 pounds per acre). However, average available forage does not reflect the size of a given RMU or analysis unit. For example, both RMU 4 and RMU 9 are less than 2,000 acres in size, while the Teec Nos Pos unit encompasses nearly 66,000 acres. The highest producing ecological site is R035XB275AZ in RMU 4, R035XB016NM in RMU 9, and R035XC325AZ in Teec Nos Pos 2. The lowest average available forage is in the Shiprock 2 analysis unit (0.68 pound per acre).

A table in the results section for each analysis unit presents available forage values and the number of transects for each ecological site, as well as the total grazeable acres, stocking rate, and carrying capacity.

5.1.4 Ground Cover

Ground cover values provide a baseline for determining the trend in future studies. An average of all ground cover data for areas sampled in Districts 9 and 12 is included for comparison (Figure 5-1). For clarity, the RMUs are displayed separately (Figure 5-2). The most represented ground cover category across the project area is bare ground. The highest percentage of bare ground was found in areas near the town of Shiprock, New Mexico, and west of the Highway 491 corridor in the project area. Soils in this area are derived from Mancos Shale, which inherently support little vegetative cover. The least amount of bare ground was found on the summit and along the north slope of the Carrizo Mountains in Teec Nos Pos 2. Higher elevations here bring more precipitation throughout the year, thus supporting more plant and litter cover.

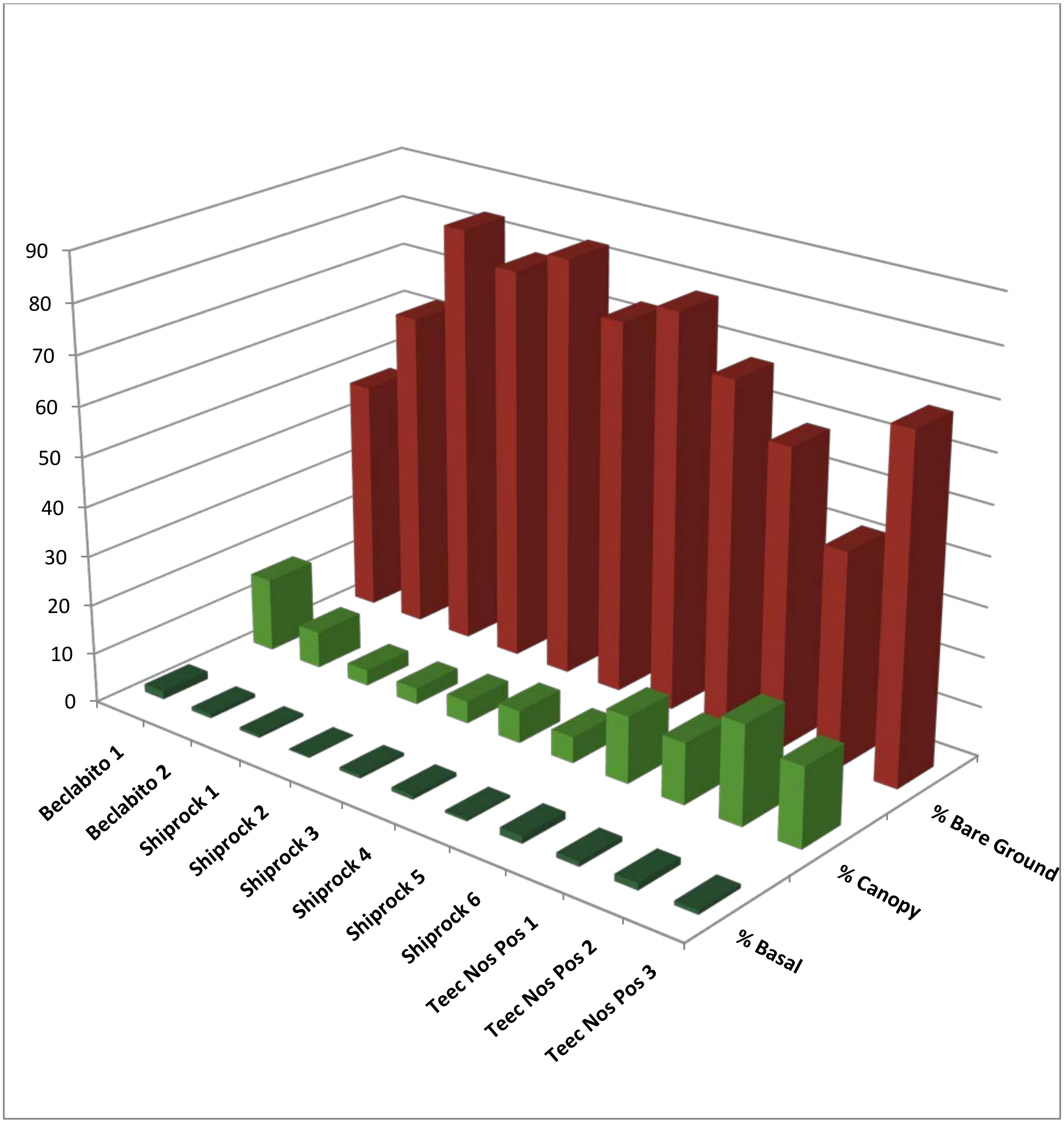


Figure 5-1. Ground Cover in Beclabito, Shiprock, and Teec Nos Pos

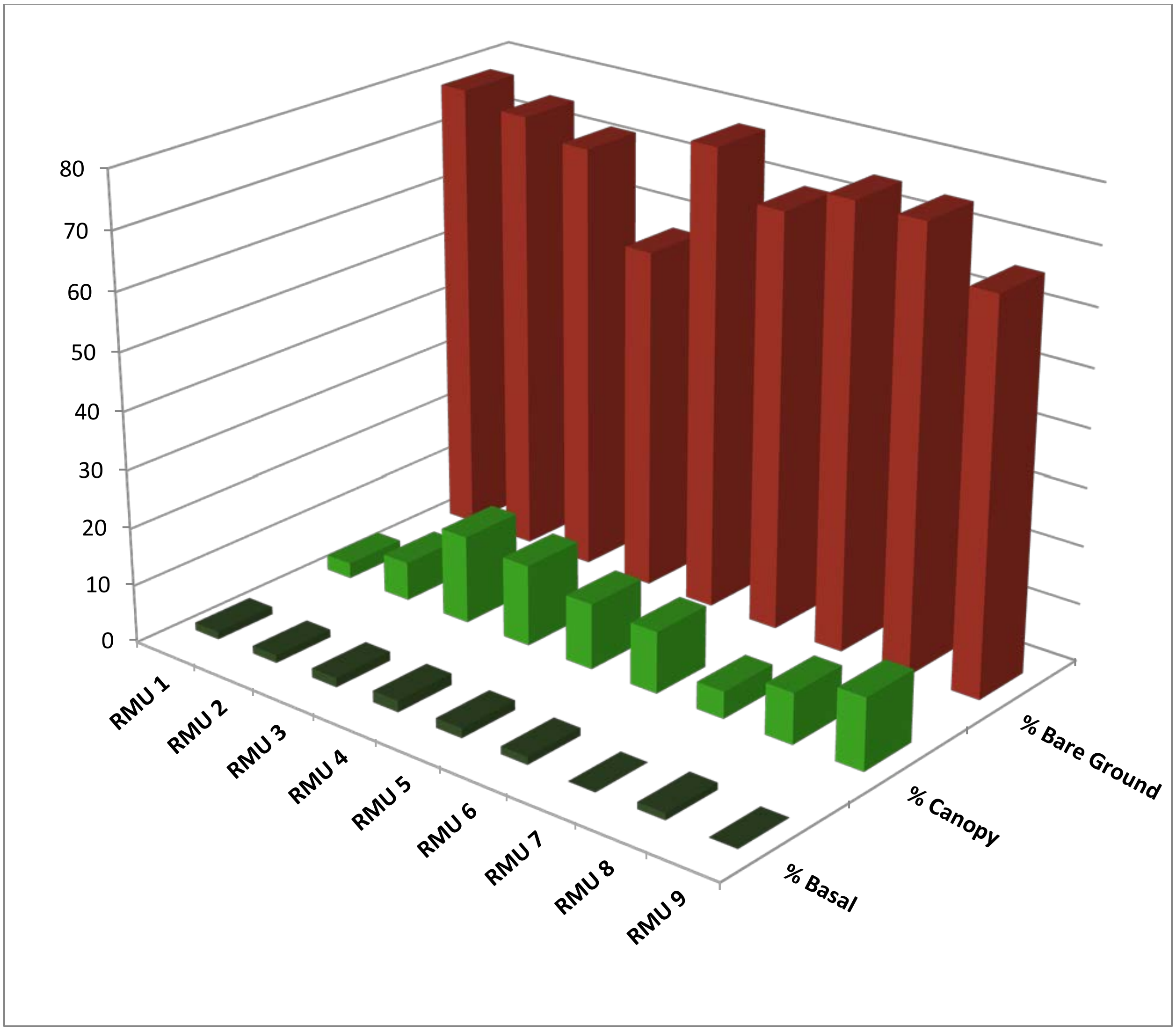


Figure 5-2. Ground Cover in RMUs

5.1.5 Frequency and Composition

The most commonly encountered species by transect are listed in the second to last table in the results section of each analysis unit along with forage value information (an explanation of forage values is found in Section 4.2.5). The individual species frequency data (by the ten plots within each transect) are included in the electronic data with this report. The species composition table presents the top contributors of biomass production. Several species are repeatedly found in these two tables for most of the analysis units. These include Russian thistle, saltlover (*Halogeton glomeratus*), alkali sacaton, galleta grass, Indian ricegrass, and shadscale.

5.2 Beclabito 1

There are 64 transects located in the Beclabito 1 analysis unit. Table 5-2 presents the total acreage for the unit, total analyzed acreage, number of analyzed ecological sites, and carrying capacity. Adjusted carrying capacity represents the carrying capacity after adjusting for slope and distance to water. There are 38 ecological sites in this unit, but only 23 contain transects. The remaining 15 unanalyzed ecological sites make up 6 percent of the total unit acreage; these were excluded from analysis as they do not contain any transects. There are no ecological site correlations for areas identified as Badland or Rock Outcrop, but as they do have transects, the resulting data were analyzed and included in this report.

Table 5-2. Beclabito 1 Carrying Capacity

Total Acres	Total Analyzed Acres	# of Analyzed Ecological Sites	Initial Carrying Capacity (SUYL)	Adjusted Carrying Capacity (SUYL)
39,822.40	35,017.80	23	263.75	113.68

Note: SUYL = sheep unit year long.

Table 5-3 shows the minimum and maximum stocking rates, and the associated ecological sites. The highest stocking rate occurs in the F035XH005NM site; however, this site has only one transect and makes up a little less than 5 percent of the total unit area. The lowest stocking rate occurs in the R035XB279AZ site, which has two transects and makes up 1 percent of the Beclabito 1 analysis area.

Table 5-3. Beclabito 1 Stocking Rate

Stocking Rate Minimum (Acres/SUYL)	Ecological Site with Minimum Stocking Rate	Stocking Rate Maximum (Acres/SUYL)	Ecological Site with Maximum Stocking Rate
3,950.00	R035XB279AZ	30.02	F035XH005NM

Note: SUYL = sheep unit year long.

Table 5-4 displays the ecological sites found within the unit and the number of transects, acreage, available forage, stocking rate, and annual carrying capacity within each ecological site. The largest ecological site, F035XG134NM, makes up 27 percent of the total unit area and has the best carrying capacity.

Table 5-4. Beclabito 1 Results by Ecological Site

Ecological Site	# of Transects	Total Acres	Average Available Forage (Pounds)	Stocking Rate (Acres/SUYL)	Initial Annual Carrying Capacity (SUYL)
Badland	2	1,096.70	17.46	135.74	8.08
F035XG134NM	17	9,884.00	13.80	171.74	57.55
F035XH005NM	1	1,143.50	78.95	30.02	38.09
F036XA001NM	3	284.70	29.69	79.82	3.57
R035XA113NM	4	1,221.20	61.79	38.36	31.84
R035XA117AZ	0	282.40	N/A	N/A	N/A
R035XB016NM	1	776.20	1.21	1,958.68	0.40
R035XB017NM	0	161.40	N/A	N/A	N/A
R035XB021NM	0	102.50	N/A	N/A	N/A
R035XB022NM	2	1,707.30	14.80	160.14	10.66
R035XB028NM	0	9.10	N/A	N/A	N/A
R035XB030NM	0	38.00	N/A	N/A	N/A
R035XB034NM	0	42.60	N/A	N/A	N/A
R035XB204AZ	0	541.10	N/A	N/A	N/A
R035XB216AZ	0	76.50	N/A	N/A	N/A
R035XB267AZ	0	451.80	N/A	N/A	N/A
R035XB271AZ	2	833.60	12.00	197.50	4.22
R035XB274AZ	5	1,863.70	3.66	647.54	2.88
R035XB275AZ	0	101.90	N/A	N/A	N/A
R035XB276AZ	2	1,789.90	8.27	286.58	6.25
R035XB277AZ	2	1,129.20	7.47	317.27	3.56
R035XB279AZ	2	413.70	0.60	3,950.00	0.10
R035XC302AZ	1	19.20	35.12	67.48	0.28
R035XC314AZ	2	1,014.60	7.81	303.46	3.34
R035XC315AZ	1	224.40	7.49	316.42	0.71
R035XC316AZ	1	504.90	67.72	35.00	14.43
R035XC324AZ	1	1,020.60	10.37	228.54	4.47
R035XC325AZ	3	893.00	31.72	74.72	11.95
R035XC326AZ	3	972.70	21.46	110.44	8.81
R035XC327AZ	3	2,435.00	29.27	80.97	30.07
R035XC328AZ	0	376.00	N/A	N/A	N/A
R035XC329AZ	2	1,378.00	21.55	109.98	12.53
R035XC330AZ	1	61.80	25.56	92.72	0.67
R035XC335AZ	0	10.00	N/A	N/A	N/A
R035XH813AZ	0	47.60	N/A	N/A	N/A
R035XH814AZ	0	67.90	N/A	N/A	N/A
Riverwash	0	85.70	N/A	N/A	N/A
Rock Outcrop	3	4,349.80	5.06	468.38	9.29

Note: SUYL = sheep unit year long.

Table 5-5 shows the maximum, minimum, and median similarity indices. Similarity indices are low throughout the Beclabito 1 analysis unit with the highest numbers found within the R035XC325AZ and R035XC327AZ ecological sites. The Historical Climax Plant Community (HCPC) for the R035X325AZ site consists of grassland mixed with low-growing shrubs. Dominant grasses include Indian ricegrass *(Achnatherum hymenoides*), galleta grass (*Pleuraphis jamesii*), alkali sacaton (*Sporobolus airoides*), and blue grama (*Bouteloua gracilis*). Common shrubs include Bigelow sagebrush (*Artemisia bigelovii*), shadscale (*Atriplex confertifolia*), and broom snakeweed (*Gutierrezia sarothrae*). Unmanaged grazing and drought can cause shrub species to increase, leading to a reduction of perennial grass species and introduction of non-native species such as red brome (*Bromus rubens*), cheatgrass (*Bromus tectorum*), and Russian thistle (*Salsola tragus*). Currently, certain members of the HCPC are still present, but overall production is low and invasive; forbs, such as Russian thistle and saltlover (*Halogeton glomeratus*), are prevalent.

The HCPC for the R035XC327AZ site also is characterized by grassland with an overstory of low shrubs, but the soils are more sodic and the average production is lower. Dominant plant species include galleta grass, alkali sacaton, sand dropseed (*Sporobolus cryptandrus*), shadscale, mound saltbush (*Atriplex obovata*), and desert seepweed (*Suaeda suffrutescens*). Forage typically is available throughout the year, but continuous grazing in the winter and spring will cause perennial, cool-season grasses to disappear allowing for less palatable grasses and forbs to increase, along with shrubs like broom snakeweed. The plant communities encountered on transects are dominated by shrub species and overall production is low; however, certain species found in the HCPC also are present including mound saltbush, shadscale, galleta grass, and sand dropseed.

Table 5-5. Beclabito 1 Similarity Index

Maximum Similarity Index	Minimum Similarity Index	Median Similarity Index
37.01	0.18	10.21

Table 5-6 contains ground cover information. The percentage of bare ground in the Beclabito 1 analysis unit is well below the project area average and the percentage of canopy cover, while still low, is well above average. Moderate erosion was observed on about half of the transects, but more advanced erosion was found on only two transects.

Table 5-6. Beclabito 1 Ground Cover

Canopy (%)	Bare Ground (%)	Basal (%)
15.0	47.0	2.0

The final two tables (Table 5-7 and Table 5-8) show the most frequently occurring species and the species contributing the most biomass, respectively. The percent frequency of occurrence is an important number as it gives mangers an idea of the distribution of species across a given area.

Table 5-7 displays the most frequently occurring species in the Beclabito 1 analysis unit. Galleta grass and the low shrub broom snakeweed occur in over 60 percent of all transects. Although not as prevalent, a valuable forage grass, Indian ricegrass, is still a fairly common species in the analysis unit.

Table 5-7. Beclabito 1 Frequently Encountered Species

Species		Frequency of Total Transects	Growth Form	Duration	Native (N) or Introduced (I)	Sheep Forage Value
Common Name	Scientific Name					
Galleta grass	*Pleuraphis jamesii*	66%	Graminoid	Perennial	N	Emergency
Broom snakeweed	*Gutierrezia sarothrae*	62%	Shrub	Perennial	N	Emergency[t]
Indian ricegrass	*Achnatherum hymenoides*	45%	Graminoid	Perennial	N	Desirable
Russian thistle	*Salsola tragus*	39%	Forb	Annual	I	Emergency[i]
Bigelow sagebrush	*Artemisia bigelovii*	30%	Shrub/ Subshrub	Perennial	N	Emergency

Notes: [i] = Injurious, [t] = Toxic.

In addition to species frequency, it also is useful to know how much biomass or weight is being produced by a given plant species. For example, a desirable grass may occur frequently, but may produce only a small amount of forage. In the Beclabito 1 analysis unit, the top producers are a mix of perennial grasses and shrubs along with the invasive forb, Russian thistle. Galleta grass, broom snakeweed, and Russian thistle are frequently occurring and top producers of biomass.

Table 5-8. Beclabito 1 Composition by Weight

Species		Composition of Total Weight	Growth Form	Duration	Native (N) or Introduced (I)	Sheep Forage Value
Common Name	Scientific Name					
Russian thistle	*Salsola tragus*	19%	Forb	Annual	I	Emergency[i]
Galleta grass	*Pleuraphis jamesii*	16%	Graminoid	Perennial	N	Emergency
Big sagebrush	*Artemisia tridentata*	11%	Shrub	Perennial	N	Emergency
Broom snakeweed	*Gutierrezia sarothrae*	6%	Shrub	Perennial	N	Emergency[t]
Muttongrass	*Poa fendleriana*	4%	Graminoid	Perennial	N	Desirable

Notes: [i] = Injurious, [t] = Toxic.

5.3 Beclabito 2

The Beclabito 2 analysis unit contains 80 transects. Table 5-9 presents the total acreage for the unit, total analyzed acreage, number of analyzed ecological sites, and carrying capacity. Adjusted carrying capacity represents the carrying capacity after adjusting for slope and distance to water. There are 39 ecological sites in this unit, but only 22 contain transects. The remaining 17 unanalyzed ecological sites make up 10 percent of the total analysis unit area.

Table 5-9. Beclabito 2 Carrying Capacity

Total Acres	Total Analyzed Acres	# of Analyzed Ecological Sites	Initial Carrying Capacity (SUYL)	Adjusted Carrying Capacity (SUYL)
53,925.0	45,060.10	22	345.19	91.58

Note: SUYL = sheep unit year long.

Table 5-10 shows the minimum and maximum stocking rates, and the associated ecological sites. The highest stocking rate occurs in the R035XB028NM site; however, this site makes up only a very small portion of the unit and contains only one transect. The lowest stocking rate comes from the R035XB267AZ site, which has less than 1 pound per acre of available forage.

Table 5-10. Beclabito 2 Stocking Rate

Stocking Rate Minimum (Acres/SUYL)	Ecological Site with Minimum Stocking Rate	Stocking Rate Maximum (Acres/SUYL)	Ecological Site with Maximum Stocking Rate
4,232.14	R035XB267AZ	14.54	R035XB028NM

Note: SUYL = sheep unit year long.

Table 5-11 displays the ecological sites found within the unit and the number of transects, acreage, available forage, stocking rate, and annual carrying capacity within each ecological site. The R035XB274AZ site is the most represented site in the analysis unit and contains the most transects. The stocking rate and carrying capacity in R035XB274AZ are about average for the unit. Carrying capacity is currently highest in the R035XB030NM and lowest in the R035XB275AZ site.

Table 5-11. Beclabito 2 Results by Ecological Site

Ecological Site	# of Transects	Total Acres	Average Available Forage (Pounds)	Stocking Rate (Acres/SUYL)	Initial Annual Carrying Capacity (SUYL)
Badland	1	3,724.40	15.32	154.70	23.22
F035XG134NM	1	2,831.50	5.68	417.25	6.79
Gullied	0	191.80	N/A	N/A	N/A
R035XA113NM	0	379.00	N/A	N/A	N/A
R035XB016NM	10	1,956.40	38.79	61.10	31.99
R035XB017NM	14	5,885.60	15.12	156.75	37.09
R035XB020NM	1	238.40	13.89	170.63	1.40
R035XB021NM	10	3,364.80	9.56	247.91	13.57
R035XB022NM	3	2,392.60	10.70	221.50	10.80
R035XB028NM	1	551.10	163.05	14.54	37.89
R035XB030NM	4	1,985.60	140.33	16.89	117.56
R035XB034NM	0	772.70	N/A	N/A	N/A
R035XB035NM	0	134.70	N/A	N/A	N/A
R035XB204AZ	0	129.70	N/A	N/A	N/A
R035XB217AZ	0	12.10	N/A	N/A	N/A
R035XB224AZ	0	3.00	N/A	N/A	N/A
R035XB227AZ	0	36.30	N/A	N/A	N/A
R035XB228AZ	0	24.20	N/A	N/A	N/A
R035XB267AZ	2	2,725.90	0.56	4,232.14	0.64
R035XB269AZ	0	700.20	N/A	N/A	N/A
R035XB271AZ	0	1,258.60	N/A	N/A	N/A
R035XB272AZ	0	394.10	N/A	N/A	N/A
R035XB273AZ	1	1,680.50	0.77	3,077.92	0.55
R035XB274AZ	15	7,568.20	11.33	209.18	35.85
R035XB275AZ	2	707.40	0.75	3,160.00	0.22
R035XB276AZ	1	1,490.20	5.03	471.17	3.16
R035XB277AZ	3	1,998.80	0.58	4,086.21	0.49
R035XB278AZ	0	208.40	N/A	N/A	N/A
R035XB279AZ	2	1,883.30	2.17	1,092.17	1.72
R035XC314AZ	1	336.90	10.72	221.08	1.52
R035XC324AZ	1	406.40	5.32	445.49	0.91
R035XC325AZ	1	355.60	35.29	67.16	5.28
R035XC326AZ	2	900.30	5.65	419.47	2.15
R035XC327AZ	2	808.60	23.75	99.79	8.10
R035XC328AZ	0	164.90	N/A	N/A	N/A
R035XC329AZ	0	604.80	N/A	N/A	N/A
R035XC330AZ	0	100.00	N/A	N/A	N/A
Riverwash	0	59.70	N/A	N/A	N/A
Rock Outcrop	2	1,585.50	6.50	364.62	4.29

Note: SUYL = sheep unit year long.

Table 5-12 shows the maximum, minimum, and median similarity indices. Similarity index values are variable across most ecological sites, but most of the highest values are associated with the R035XB017NM, R035XC325AZ, and R035XC327AZ ecological sites. The R035XB017NM site is characterized by cool- and warm-season grasses and shrub species. As the site begins to deteriorate, annual forbs and grasses are likely to invade, and shrubs like shadscale (*Atriplex confertifolia*) and valley saltbush (*Atriplex cuneata*) will increase. Common species include galleta grass (*Pleuraphis jamesii*), alkali sacaton (*Sporobolus airoides*), sand dropseed (*Sporobolus cryptandrus*), valley saltbush (*Atriplex cuneata*), shadscale, and bud sagebrush (*Picrothamnus desertorum*). Grazing is more likely to have a negative impact if it occurs during the winter and spring, when herbaceous plants begin to emerge. The contemporary plant communities tend to be dominated by several native species such as galleta grass, alkali sacaton, mound saltbush (*Atriplex obovata*), and shadscale saltbush (*Atriplex confertifolia*); however, the non-native Russian thistle (*Salsola tragus*) and saltlover (*Halogeton glomeratus*) are quite prevalent as well.

The HCPC for the R035X325AZ site consists of grassland mixed with low-growing shrubs. Only one transect occurs within this particular site. The species found on this transect are native grasses and shrubs that all have some degree of palatability for livestock. The HCPC for the R035XC327AZ site is similar to that of the R035X325AZ site, but tends have a greater proportion of salt-tolerant plants. At this time, assemblage of plant species includes a mix of perennial grasses, shrubs, and non-native, undesirable forbs.

Table 5-12. Beclabito 2 Similarity Index

Maximum Similarity Index	Minimum Similarity Index	Median Similarity Index
70.39	0.0	8.54

Table 5-13 contains ground cover information. The percentage of bare ground in the Beclabito 2 analysis unit is slightly below the project area average. Moderate erosion is occurring on about half of the transects. More severe erosion was encountered in the vicinity of several tributary washes that empty into the San Juan River. This region is prone to water erosion due to the presence of soils with a high clay content and relatively scarce ground cover.

Table 5-13. Beclabito 2 Ground Cover

Canopy (%)	Bare Ground (%)	Basal (%)
7.0	64.0	1.0

The final two tables (Table 5-14 and Table 5-15) show the most frequently occurring species and the species contributing the most biomass, respectively. The two top-producing and most frequently occurring species in the Beclabito 2 analysis unit are invasive, non-native forbs. Saltlover is of particular concern due to its toxic nature. This plant invades, and usually dominates, depleted rangeland. It is not readily consumed by livestock, but when more preferred forage is absent, it will be utilized. Heavy sheep losses have been attributed to this species in overgrazed rangeland in Utah, Nevada, and Idaho. Soil around individual plants tends to become more acidic and salty over time, which makes it difficult for other species to become established. With the exception of galleta grass, the remaining most common species are shrub species. Broom snakeweed (*Gutierrezia sarothrae*) also is toxic to livestock. This species, like saltlover, is not very palatable to livestock, but is occasionally browsed when no other forage is available.

Table 5-14. Beclabito 2 Frequently Encountered Species

Species		Frequency of Total Transects	Growth Habit	Duration	Nativity (I=Introduced, N=Native)	Sheep Forage Value
Common Name	Scientific Name					
Russian thistle	*Salsola tragus*	69%	Forb	Annual	I	Emergency[i]
Saltlover	*Halogeton glomeratus*	64%	Forb	Annual	I	Not Consumed[t]
Galleta grass	*Pleuraphis jamesii*	57%	Graminoid	Perennial	N	Emergency
Shadscale	*Atriplex confertifolia*	32%	Shrub	Perennial	N	Not Consumed
Broom snakeweed	*Gutierrezia sarothrae*	28%	Shrub	Perennial	N	Emergency[t]

Notes: [i] = Injurious, [t] = Toxic.

Table 5-15. Beclabito 2 Composition by Weight

Species		Composition of Total Weight	Growth Habit	Duration	Nativity (I=Introduced, N=Native)	Sheep Forage Value
Common Name	Scientific Name					
Russian thistle	*Salsola tragus*	43%	Forb	Annual	I	Emergency[i]
Saltlover	*Halogeton glomeratus*	11%	Forb	Annual	I	Not Consumed[t]
Greasewood	*Sarcobatus vermiculatus*	10%	Shrub	Perennial	N	Not Consumed
Galleta grass	*Pleuraphis jamesii*	10%	Graminoid	Perennial	N	Emergency
Fourwing saltbush	*Atriplex canescens*	10%	Shrub	Perennial	N	Desirable

Notes: [i] = Injurious, [t] = Toxic.

5.4 RMU 1

Range Management Unit 1 contains three transects. All RMUs in the project area are located within the northwest corner of the Shiprock analysis unit. Table 5-16 presents the total acreage for the RMU, total analyzed acreage, number of analyzed ecological sites, and carrying capacity. Adjusted carrying capacity represents the carrying capacity after adjusting for slope and distance to water. There are six ecological sites in this unit, but only two contain transects. The remaining four unanalyzed ecological sites make up half of the total unit area.

Table 5-16. RMU 1 Carrying Capacity

Total Acres	Total Analyzed Acres	# of Analyzed Ecological Sites	Initial Carrying Capacity (SUYL)	Adjusted Carrying Capacity (SUYL)
1,241.3	612.95	2	2.38	2.32

Note: SUYL = sheep unit year long.

Table 5-17 shows the minimum and maximum stocking rates, and the associated ecological sites. Stocking rates are about the same for the two analyzed ecological sites, but slightly better for the R035XB030NM site.

Table 5-17. RMU 1 Stocking Rate

Stocking Rate Minimum (Acres/SUYL)	Ecological Site with Minimum Stocking Rate	Stocking Rate Maximum (Acres/SUYL)	Ecological Site with Maximum Stocking Rate
379.20	R035XB204AZ	241.34	R035XB030NM

Note: SUYL = sheep unit year long.

Table 5-18 displays the ecological sites found within the RMU and the number of transects, acreage, available forage, stocking rate, and annual carrying capacity within each ecological site. This is one of the smallest RMUs in the project area and the carrying capacity is less than three animals per year. The most representative ecological site is the R035XB030NM site.

Table 5-18. RMU 1 Results by Ecological Site

Ecological Site	# of Transects	Total Acres	Average Available Forage (Pounds)	Stocking Rate (Acres/SUYL)	Initial Annual Carrying Capacity (SUYL)
R035XB030NM	2	504.80	9.82	241.34	2.09
R035XB204AZ	1	108.20	6.25	379.20	0.29
R035XB271AZ	0	2.60	N/A	N/A	N/A
R035XB274AZ	0	622.10	N/A	N/A	N/A
R035XB277AZ	0	2.20	N/A	N/A	N/A
R035XB278AZ	0	1.50	N/A	N/A	N/A

Note: SUYL = sheep unit year long.

Table 5-19 shows the maximum, minimum, and median similarity indices. The few transacts in RMU 1 have low similarity indices. The HCPC for the R035XB030NM site consists of perennial grasses, a few shrubs, and a small component of forb species. Common species include Indian ricegrass (*Achnatherum hymenoides*), galleta grass (*Pleuraphis jamesii*), blue grama (*Bouteloua gracilis*), fourwing saltbush (*Atriplex canescens*), and broom snakeweed (*Gutierrezia sarothrae*). Continuous grazing during the winter and spring will decrease desirable cool-season grasses and lead to an increase in less desirable herbaceous plants and shrubs. Currently, a number of native, fairly desirable species are still present, but production is very low. Russian thistle (*Salsola tragus*) also is prevalent.

The R035XB204AZ site is a traditionally low-producing site characterized by scattered grasses and shrubs. The more common grasses include Indian ricegrass, galleta grass, and blue grama. The dominant shrub species is Bigelow sagebrush (*Artemisia bigelovii*). The single transect in this ecological site contains Indian ricegrass, Bigelow sagebrush, fourwing saltbush, broom snakeweed, galleta grass, and Russian thistle. Although most of these species match the potential natural community, they are currently producing only a small amount of biomass.

Table 5-19. RMU 1 Similarity Index

Maximum Similarity Index	Minimum Similarity Index	Median Similarity Index
21.19	8.08	15.53

Table 5-20 contains ground cover information. The percentage of bare ground recorded on the transects in RMU 1 is very high and canopy cover is virtually nonexistent. This area consists of cold desert shrubland, which tends to naturally consist of bare ground and relatively scarce vegetation. However, the current percentages are a reflection of active rangeland deterioration. Erosion is not excessive at this time, but the large amount of bare ground means that this RMU is at risk for both wind and water erosion.

Table 5-20. RMU 1 Ground Cover

Canopy (%)	Bare Ground (%)	Basal (%)
1.0	80.0	2.0

The final two tables (Table 5-21 and Table 5-22) show the most frequently occurring species and the species contributing the most biomass, respectively. The most abundant and top-producing species in RMU 1 is Russian thistle followed by galleta grass. The remaining species are a mix of shrubs, perennial grasses, and forbs. Although not particularly common, the subshrub winterfat (*Krascheninnikovia lanata*) is an extremely valuable forage species, especially during the fall and winter.

Table 5-21. RMU 1 Frequently Encountered Species

Species		Frequency of Total Transects	Growth Habit	Duration	Nativity (I=Introduced, N=Native)	Sheep Forage Value
Common Name	Scientific Name					
Russian thistle	*Salsola tragus*	100%	Forb	Annual	I	Emergency[i]
Galleta grass	*Pleuraphis jamesii*	100%	Graminoid	Perennial	N	Emergency
Fourwing saltbush	*Atriplex canescens*	100%	Shrub	Perennial	N	Desirable
Broom snakeweed	*Gutierrezia sarothrae*	67%	Shrub	Perennial	N	Emergency[t]
Indian ricegrass	*Achnatherum hymenoides*	67%	Graminoid	Perennial	N	Desirable

Notes: [i] = Injurious, [t] = Toxic.

Table 5-22. RMU 1 Composition by Weight

Species		Composition of Total Weight	Growth Habit	Duration	Nativity (I=Introduced, N=Native)	Sheep Forage Value
Common Name	Scientific Name					
Russian thistle	*Salsola tragus*	53%	Forb	Annual	I	Emergency[i]
Galleta grass	*Pleuraphis jamesii*	18%	Graminoid	Perennial	N	Emergency
Broom snakeweed	*Gutierrezia sarothrae*	13%	Shrub	Perennial	N	Emergency[t]
Fourwing saltbush	*Atriplex canescens*	7%	Shrub	Perennial	N	Desirable
Desert globemallow	*Sphaeralcea ambigua*	2%	Subshrub/ Forb	Perennial	N	Not Consumed
Winterfat	*Krascheninnikovia lanata*	3%	Subshrub/ Shrub	Perennial	N	Desirable
Bigelow sagebrush	*Artemisia bigelovii*	2%	Shrub/ Subshrub	Perennial	N	Emergency

Notes: [i] = Injurious, [t] = Toxic.

5.5 RMU 2

Range Management Unit 2 contains three transects. All RMUs in the project area are located within the northwest corner of the Shiprock analysis unit. Table 5-23 presents the total acreage for the RMU, total analyzed acreage, number of analyzed ecological sites, and carrying capacity. Adjusted carrying capacity represents the carrying capacity after adjusting for slope and distance to water. There are nine ecological sites in RMU2, but only three have transects. The remaining six unanalyzed ecological sites make up 18 percent of the total unit area.

Table 5-23. RMU 2 Carrying Capacity

Total Acres	Total Analyzed Acres	# of Analyzed Ecological Sites	Initial Carrying Capacity (SUYL)	Adjusted Carrying Capacity (SUYL)
1,016.9	834.29	3	4.41	4.39

Note: SUYL = sheep unit year long.

Table 5-24 shows the minimum and maximum stocking rates, and the associated ecological sites. The site with the best stocking rate, R035XB274AZ, has only 15 pounds per acre of available forage. The lowest stocking rate, found in the R035XB276AZ site, has about 2 pounds per acre of available forage.

Table 5-24. RMU 2 Stocking Rate

Stocking Rate Minimum (Acres/SUYL)	Ecological Site with Minimum Stocking Rate	Stocking Rate Maximum (Acres/SUYL)	Ecological Site with Maximum Stocking Rate
1,025.97	R035XB276AZ	158.32	R035XB274AZ

Note: SUYL = sheep unit year long.

Table 5-25 displays the ecological sites found within the RMU and the number of transects, acreage, available forage, stocking rate, and annual carrying capacity within each ecological site. The most common ecological site is the R035XB274AZ site, which makes up 65 percent of the total unit area and has the highest carrying capacity and the best stocking rate. Overall though, available forage, stocking rates, and carrying capacities are very low throughout this unit

Table 5-25. RMU 2 Results by Ecological Site

Ecological Site	# of Transects	Total Acres	Average Available Forage (Pounds)	Stocking Rate (Acres/SUYL)	Initial Annual Carrying Capacity (SUYL)
Badland	0	0.01	N/A	N/A	N/A
R035XB030NM	1	54.15	6.20	382.26	0.14
R035XB204AZ	0	11.60	N/A	N/A	N/A
R035XB271AZ	0	70.40	N/A	N/A	N/A
R035XB274AZ	1	656.99	14.97	158.32	4.15
R035XB276AZ	1	123.15	2.31	1,025.97	0.12
R035XB277AZ	0	60.30	N/A	N/A	N/A
R035XB278AZ	0	40.20	N/A	N/A	N/A
Rock Outcrop	0	0.02	N/A	N/A	N/A

Table 5-26 shows the maximum, minimum, and median similarity indices. Similarity indices are very low in RMU 2. The highest value is reported from the single transect located in the R035XB274AZ ecological site. This is an upland site typified by grass species such as alkali sacaton (*Sporobolus airoides*), galleta grass (*Pleuraphis jamesii*), Indian ricegrass (*Achnatherum hymenoides*), and shrub species like shadscale (*Atriplex confertifolia*) and winterfat (*Krascheninnikovia lanata*). Production is currently very low and vegetation is sparse.

The HCPC for the R035XB030NM site consists of perennial grasses, a few shrubs, and a small component of forb species. Common species include Indian ricegrass, galleta grass, blue grama (*Bouteloua gracilis*), fourwing saltbush (*Atriplex canescens*), and broom snakeweed (*Gutierrezia sarothrae*). Continuous grazing during the winter and spring will decrease desirable cool-season grasses and lead to an increase in less desirable herbaceous plants and shrubs. Currently, some native, fairly desirable species are still present, but production is very low. Russian thistle (*Salsola tragus*) and shadscale are the dominant species at this time.

The final transect is in the R035XB276AZ ecological site, which is similar to the R035XB274 site but with a higher sodium content. Typical plants include yellow beeplant (*Cleome lutea*), globemallow species (*Sphaeralcea* spp.), alkali sacaton, galleta grass, Indian ricegrass, and various species of saltbush (*Atriplex* spp.). The only species found on the transect are alkali sacaton and Russian thistle.

Table 5-26. RMU 2 Similarity Index

Maximum Similarity Index	Minimum Similarity Index	Median Similarity Index
21.19	8.08	9.75

Table 5-27 contains ground cover information. Erosion is light to non-existent on the three transects found in RMU 2, but the high percentage of bare ground and low percentage of canopy cover suggests that the area is at risk of becoming more eroded in the future.

Table 5-27. RMU 2 Ground Cover

Canopy (%)	Bare Ground (%)	Basal (%)
7.0	76.0	1.0

The final two tables (Table 5-28 and Table 5-29) show the most frequently occurring species and the species contributing the most biomass, respectively. The top-producing and most frequently occurring species in RMU 2 represent the majority of species found on the three transects in this unit. All species, with the exception of Russian thistle, are native plants associated with the salt-desert habitat found in this region. The main issue with this unit is that production of native plants is very low. For example, shadscale is currently producing the most biomass of all encountered species, but its total reconstructed weight is only slightly over 200 pounds per acre.

Table 5-28. RMU 2 Frequently Encountered Species

Species		Frequency of Total Transects	Growth Form	Duration	Native (N) or Introduced (I)	Sheep Forage Value
Common Name	Scientific Name					
Russian thistle	*Salsola tragus*	100%	Forb	Annual	I	Emergency[i]
Alkali sacaton	*Sporobolus airoides*	67%	Graminoid	Perennial	N	Emergency
Indian ricegrass	*Achnatherum hymenoides*	67%	Graminoid	Perennial	N	Desirable
Galleta grass	*Pleuraphis jamesii*	33%	Graminoid	Perennial	N	Emergency
Broom snakeweed	*Gutierrezia sarothrae*	33%	Shrub	Perennial	N	Emergency[t]
Shadscale	*Atriplex confertifolia*	33%	Shrub	Perennial	N	Not Consumed

Notes: [i] = Injurious, [t] = Toxic.

Table 5-29. RMU 2 Composition by Weight

Species		Composition of Total Weight	Growth Form	Duration	Native (N) or Introduced (I)	Sheep Forage Value
Common Name	Scientific Name					
Shadscale	*Atriplex confertifolia*	47%	Shrub	Perennial	N	Not Consumed
Russian thistle	*Salsola tragus*	21%	Forb	Annual	I	Emergency[i]
Alkali sacaton	*Sporobolus airoides*	20%	Graminoid	Perennial	N	Emergency
Galleta grass	*Pleuraphis jamesii*	6%	Graminoid	Perennial	N	Emergency
Indian ricegrass	*Achnatherum hymenoides*	5%	Graminoid	Perennial	N	Desirable

Note: [i] = Injurious.

5.6 RMU 3

Range Management Unit 3 contains five transects. All RMUs in the project area are located within the northwest corner of the Shiprock analysis unit. Table 5-30 presents the total acreage for the RMU, total analyzed acreage, number of analyzed ecological sites, and carrying capacity. Adjusted carrying capacity represents the carrying capacity after adjusting for slope and distance to water. There are nine ecological sites in RMU 3, but only three contain transects. The remaining six unanalyzed ecological sites make up 28 percent of the total unit area. As with all of the RMUs in the project area, production is scarce, thus making the stocking rate and carrying capacity quite low.

Table 5-30. RMU 3 Carrying Capacity

Total Acres	Total Analyzed Acres	# of Analyzed Ecological Sites	Initial Carrying Capacity (SUYL)	Adjusted Carrying Capacity (SUYL)
2,051.2	1,470.4	3	4.82	4.61

Note: SUYL = sheep unit year long.

Table 5-31 shows the minimum and maximum stocking rates, and the associated ecological sites. The stocking rates in all three analyzed ecological sites are fairly uniform in RMU 3. The lowest rate is associated with the R035XB276AZ site and the highest comes from the R035XB274AZ site.

Table 5-31. RMU 3 Stocking Rate

Stocking Rate Minimum (Acres/SUYL)	Ecological Site with Minimum Stocking Rate	Stocking Rate Maximum (Acres/SUYL)	Ecological Site with Maximum Stocking Rate
524.34	R035XB276AZ	264.21	R035XB274AZ

Note: SUYL = sheep unit year long.

Table 5-32 displays the ecological sites found within the RMU and the number of transects, acreage, available forage, stocking rate, and annual carrying capacity within each ecological site. The largest ecological site, R035XB274AZ contains three of the five transects and has the highest carrying capacity, highest stocking rate, and most available forage.

Table 5-32. RMU 3 Results by Ecological Site

Ecological Site	# of Transects	Total Acres	Average Available Forage (Pounds)	Stocking Rate (Acres/SUYL)	Initial Annual Carrying Capacity (SUYL)
Badland	1	69.30	6.63	357.47	0.19
R035XB028NM	0	40.90	N/A	N/A	N/A
R035XB030NM	0	2.50	N/A	N/A	N/A
R035XB034NM	0	190.90	N/A	N/A	N/A
R035XB204AZ	0	230.90	N/A	N/A	N/A
R035XB274AZ	3	1,044.20	8.97	264.21	3.95
R035XB275AZ	0	0.20	N/A	N/A	N/A
R035XB276AZ	1	357.00	4.52	524.34	0.68
Rock Outcrop	0	115.40	N/A	N/A	N/A

Table 5-33 shows the maximum, minimum, and median similarity indices. The R035XB274AZ site has the highest similarity index values. This site has fairly saline soils and is characterized by salt-tolerant species such as alkali sacaton (*Sporobolus airoides*), shadscale (*Atriplex confertifolia*), valley saltbush (*Atriplex cuneata*), wheelscale saltbush (*Atriplex fasciculate*), mound saltbush (*Atriplex obovata*), and winterfat (*Krascheninnikovia lanata*). Average production on this site is 450 pounds per acre. The vegetation community found on the transects consists primarily of shadscale, Russian thistle (*Salsola tragus*), Indian ricegrass (*Achnatherum hymenoides*), fourwing saltbush (*Atriplex canescens*), and alkali sacaton. The R035XB276AZ site has only one transect, and contains just three species: saltlover (*Halogeton glomeratus*), Gardner's saltbush (*Atriplex gardneri*), and alkali sacaton.

Table 5-33. RMU 3 Similarity Index

Maximum Similarity Index	Minimum Similarity Index	Median Similarity Index
17.99	5.45	11.11

Table 5-34 contains ground cover information. Erosion is light to non-existent on the three transects found in RMU 3, but the high percentage of bare ground and low percentage of canopy cover suggests that the area is at risk of becoming more eroded in the future. The percentage of canopy cover, however, is one of the highest of all the RMUs.

Table 5-34. RMU 3 Ground Cover

Canopy (%)	Bare Ground (%)	Basal (%)
18.0	72.0	2.0

The final two tables (Table 5-35 and Table 5-36) show the most frequently occurring species and the species contributing the most biomass, respectively. The most frequently occurring species include two non-native forbs, a native shrub, and two native grasses. One of the non-native forbs is the toxic saltlover. The highest amount of biomass is produced from shadscale, followed by Russian thistle.

Table 5-35. RMU 3 Frequently Encountered Species

Species		Frequency of Total Transects	Growth Form	Duration	Native (N) or Introduced (I)	Sheep Forage Value
Common Name	Scientific Name					
Russian thistle	*Salsola tragus*	66%	Forb	Annual	I	Emergency[i]
Galleta grass	*Pleuraphis jamesii*	66%	Graminoid	Perennial	N	Emergency
Saltlover	*Halogeton glomeratus*	66%	Forb	Annual	I	Not Consumed[t]
Broom snakeweed	*Gutierrezia sarothrae*	66%	Shrub	Perennial	N	Emergency[t]
Indian ricegrass	*Achnatherum hymenoides*	66%	Graminoid	Perennial	N	Desirable

Notes: [i] = Injurious, [t] = Toxic.

Table 5-36. RMU 3 Composition by Weight

Species		Composition of Total Weight	Growth Form	Duration	Native (N) or Introduced (I)	Sheep Forage Value
Common Name	Scientific Name					
Shadscale	*Atriplex confertifolia*	23%	Shrub	Perennial	N	Not Consumed
Russian thistle	*Salsola tragus*	19%	Forb	Annual	I	Emergency[i]
Indian ricegrass	*Achnatherum hymenoides*	10%	Graminoid	Perennial	N	Desirable
Saltlover	*Halogeton glomeratus*	10%	Forb	Annual	I	Not Consumed[t]
Garner's saltbush	*Atriplex gardneri*	10%	Subshrub	Perennial	N	Desirable

Notes: [i] = Injurious, [t] = Toxic.

5.7 RMU 4

Range Management Unit 4 contains four transects. All RMUs in the project area are located within the northwest corner of the Shiprock analysis unit. Table 5-37 presents the total acreage for the RMU, total analyzed acreage, number of analyzed ecological sites, and carrying capacity. Adjusted carrying capacity represents the carrying capacity after adjusting for slope and distance to water. There are ten ecological sites in RMU 4, but only four contain transects. The remaining six unanalyzed ecological sites make up 17 percent of the total unit area.

Table 5-37. RMU 4 Carrying Capacity

Total Acres	Total Analyzed Acres	# of Analyzed Ecological Sites	Initial Carrying Capacity (SUYL)	Adjusted Carrying Capacity (SUYL)
844.8	702.9	4	15.39	14.45

Note: SUYL = sheep unit year long.

Table 5-38 shows the minimum and maximum stocking rates, and the associated ecological sites. Currently, the R035XB279AZ site is considered non-stockable, while the R035XB275AZ site has nearly 70 pounds per acre of available forage.

Table 5-38. RMU 4 Stocking Rate

Stocking Rate Minimum (Acres/SUYL)	Ecological Site with Minimum Stocking Rate	Stocking Rate Maximum (Acres/SUYL)	Ecological Site with Maximum Stocking Rate
Not stockable	R035XB279AZ	34.78	R035XB275AZ

Note: SUYL = sheep unit year long.

Table 5-39 displays the ecological sites found within the RMU and the number of transects, acreage, available forage, stocking rate, and annual carrying capacity within each ecological site. As with all of the RMUs in the project area, production is scarce, thus making the stocking rates and carrying capacity quite low. R035XB274AZ is the largest ecological site and has the highest carrying capacity.

Table 5-39. RMU 4 Results by Ecological Site

Ecological Site	# of Transects	Total Acres	Average Available Forage (Pounds)	Stocking Rate (Acres/SUYL)	Initial Annual Carrying Capacity (SUYL)
Badland	1	10.70	3.83	618.80	0.02
R035XB028NM	0	2.40	N/A	N/A	N/A
R035XB034NM	0	11.20	N/A	N/A	N/A
R035XB204AZ	0	35.60	N/A	N/A	N/A
R035XB271AZ	0	31.00	N/A	N/A	N/A
R035XB274AZ	1	532.90	59.66	39.73	13.41
R035XB275AZ	1	68.20	68.15	34.78	1.96
R035XB276AZ	0	43.90	N/A	N/A	N/A
R035XB279AZ	1	91.10	0	Not Stockable	Not Stockable
Rock Outcrop	0	17.80	N/A	N/A	N/A

Table 5-40 shows the maximum, minimum, and median similarity indices. Each of the four transects in RMU 4 is in a different ecological site. The highest value is reported from the R035XB275AZ site. This ecological site typically contains mostly grasses with a scattering of forbs and shrubs. Dominant species include globemallow (*Sphaeralcea* spp.), alkali sacaton (*Sporobolus airoides*), galleta grass (*Pleuraphis jamesii*), Indian ricegrass (*Achnatherum hymenoides*), wheelscale saltbush (*Atriplex elegans*), mound saltbush (*Atriplex obovata*), and shadscale (*Atriplex confertifolia*). The main species found on the transect include only alkali sacaton and mound saltbush. The other transects in this unit contain vegetation that matched fairly well with their corresponding ESDs, with the exception of the transect in R035XB279AZ, which is dominated by saltlover (*Halogeton glomeratus*).

Table 5-40. RMU 4 Similarity Index

Maximum Similarity Index	Minimum Similarity Index	Median Similarity Index
38.8	2.04	21.98

Table 5-41 contains ground cover information. The percentage of bare ground is one of the lowest in the project area and the percentage of canopy cover is one of the highest in all of the RMUs. Erosion is not evident at the various transects and the relatively high production of shrubs and native grasses accounts for the lower percentage of bare ground. Canopy cover may be higher in this unit due to the numerous drainage channels, which tend to increase overall soil moisture.

Table 5-41. RMU 4 Ground Cover

Canopy (%)	Bare Ground (%)	Basal (%)
18.0	48.0	3.0

The final two tables (Table 5-42 and Table 5-43) show the most frequently occurring species and the species contributing the most biomass, respectively. The most frequently occurring species and those contributing the most weight are consistent with salt-desert shrubland that has undergone a moderate amount of deterioration. Many native species are still present, especially alkali sacaton, mound saltbush, and Indian ricegrass; however, non-native, invasive species are prevalent as well, particularly saltlover and Russian thistle (*Salsola tragus*).

Table 5-42. RMU 4 Frequently Encountered Species

Species		Frequency of Total Transects	Growth Form	Duration	Native (N) or Introduced (I)	Sheep Forage Value
Common Name	Scientific Name					
Alkali sacaton	*Sporobolus airoides*	50%	Graminoid	Perennial	N	Emergency
Saltlover	*Halogeton glomeratus*	50%	Forb	Annual	I	Not Consumed[t]
Galleta grass	*Pleuraphis jamesii*	50%	Graminoid	Perennial	N	Emergency
Mound saltbush	*Atriplex obovata*	25%	Subshrub/ Shrub	Perennial	N	Emergency
Indian ricegrass	*Achnatherum hymenoides*	25%	Graminoid	Perennial	N	Desirable
Winterfat	*Krascheninnikovia lanata*	25%	Subshrub/ Shrub	Perennial	N	Desirable
Globemallow	*Sphaeralcea spp.*	25%	Forb	Perennial	N	Not Consumed
Mat saltbush	*Atriplex corrugata*	25%	Subshrub	Perennial	N	Emergency
Gardner's saltbush	*Atriplex gardneri*	25%	Subshrub	Perennial	N	Desirable
Annual wheatgrass	*Eremopyrum triticeum*	25%	Graminoid	Annual	I	Unknown
Russian thistle	*Salsola tragus*	25%	Forb	Annual	I	Emergency[i]

Notes: [i] = Injurious, [t] = Toxic.

Table 5-43. RMU 4 Composition by Weight

Species		Composition of Total Weight	Growth Form	Duration	Native (N) or Introduced (I)	Sheep Forage Value
Common Name	Scientific Name					
Alkali sacaton	*Sporobolus airoides*	34%	Graminoid	Perennial	N	Emergency
Mound saltbush	*Atriplex obovata*	20%	Subshrub/ Shrub	Perennial	N	Emergency
Indian ricegrass	*Achnatherum hymenoides*	19%	Graminoid	Perennial	N	Desirable
Saltlover	*Halogeton glomeratus*	14%	Forb	Annual	I	Not Consumed[t]
Winterfat	*Krascheninnikovia lanata*	6%	Subshrub/ Shrub	Perennial	N	Desirable

Note: [t] = Toxic.

5.8 RMU 5

Range Management Unit 5 contains six transects and is the largest RMU. All RMUs in the project area are located within the northwest corner of the Shiprock analysis unit. Table 5-44 presents the total acreage for the RMU, total analyzed acreage, number of analyzed ecological sites, and carrying capacity. Adjusted carrying capacity represents the carrying capacity after adjusting for slope and distance to water. There are 11 ecological sites in RMU 5, but only three contain transects. The remaining eight unanalyzed ecological sites make up 40 percent of the total unit area.

Table 5-44. RMU 5 Carrying Capacity

Total Acres	Total Analyzed Acres	# of Analyzed Ecological Sites	Initial Carrying Capacity (SUYL)	Adjusted Carrying Capacity (SUYL)
5,154.7	3,080.8	3	19.4	16.66

Note: SUYL = sheep unit year long.

Table 5-45 shows the minimum and maximum stocking rates, and the associated ecological sites. Available forage is extremely low in the R035XB275AZ site, and at this time, it would require nearly 40,000 acres to support one sheep unit for a year.

Table 5-45. RMU 5 Stocking Rate

Stocking Rate Minimum (Acres/SUYL)	Ecological Site with Minimum Stocking Rate	Stocking Rate Maximum (Acres/SUYL)	Ecological Site with Maximum Stocking Rate
39,500	R035XB275AZ	99	R035XB204AZ

Note: SUYL = sheep unit year long.

Table 5-46 displays the ecological sites found within the RMU and the number of transects, acreage, available forage, stocking rate, and annual carrying capacity within each ecological site. The R035XB274AZ is the largest ecological site and contains four transects. Carrying capacity is quite low in all three analyzed ecological sites with the best value being found in the R035XB274AZ site.

Table 5-46. RMU 5 Results by Ecological Site

Ecological Site	# of Transects	Total Acres	Average Available Forage (Pounds)	Stocking Rate (Acres/SUYL)	Initial Annual Carrying Capacity (SUYL)
Badland	0	142.40	N/A	N/A	N/A
R035XB028NM	0	35.90	N/A	N/A	N/A
R035XB034NM	0	167.70	N/A	N/A	N/A
R035XB204AZ	1	474.80	23.94	99.00	4.79
R035XB271AZ	0	9.10	N/A	N/A	N/A
R035XB274AZ	4	2,406.90	14.38	164.81	14.60
R035XB275AZ	1	199.20	0.06	39,500.00	0.01
R035XB276AZ	0	1,468.50	N/A	N/A	N/A
R035XB277AZ	0	7.80	N/A	N/A	N/A
R035XB278AZ	0	5.20	N/A	N/A	N/A
Rock Outcrop	0	237.40	N/A	N/A	N/A

Table 5-47 shows the maximum, minimum, and median similarity indices. The highest similarity index value is reported for the R035XB204AZ site. This site is characterized by a mix of shrubs and grasses. Common species include Indian ricegrass (*Achnatherum hymenoides*), galleta grass (*Pleuraphis jamesii*), blue grama (*Bouteloua gracilis*), Bigelow sagebrush (*Artemisia bigelovii*), fourwing saltbush (*Atriplex canescens*), and broom snakeweed (*Gutierrezia sarothrae*). Currently, alkali sacaton (*Sporobolus airoides*) is the most abundant species, followed by galleta grass, and shadscale (*Atriplex confertifolia*).

The lowest value is found in the R035XB275AZ site. Nearly all of the biomass associated with this site is being produced by saltlover (*Halogeton glomeratus*). The only native species found on location is alkali sacaton, but its occurrence is very infrequent.

Table 5-47. RMU 5 Similarity Index

Maximum Similarity Index	Minimum Similarity Index	Median Similarity Index
38.63	0.34	20.35

Table 5-48 contains ground cover information. The percentage of bare ground in RMU 5 is very high and half of the transects show moderate to severe signs of erosion. This trend will continue unless vegetation can be restored and bare ground is reduced.

Table 5-48. RMU 5 Ground Cover

Canopy (%)	Bare Ground (%)	Basal (%)
11.0	79.0	2.0

The final two tables (Table 5-49 and Table 5-50) show the most frequently occurring species and the species contributing the most biomass, respectively. Biomass production is highest for alkali sacaton, which also is the most frequently occurring species. Two forage grasses, Indian ricegrass and galleta grass, also are abundant, but so too are the non-native Russian thistle (*Salsola tragus*) and saltlover.

Table 5-49. RMU 5 Frequently Encountered Species

Species		Frequency of Total Transects	Growth Form	Duration	Native (N) or Introduced (I)	Sheep Forage Value
Common Name	Scientific Name					
Alkali sacaton	*Sporobolus airoides*	83%	Graminoid	Perennial	N	Emergency
Indian ricegrass	*Achnatherum hymenoides*	83%	Graminoid	Perennial	N	Desirable
Galleta grass	*Pleuraphis jamesii*	67%	Graminoid	Perennial	N	Emergency
Shadscale	*Atriplex confertifolia*	67%	Shrub	Perennial	N	Not Consumed
Saltlover	*Halogeton glomeratus*	50%	Forb	Annual	I	Not Consumed[t]
Russian thistle	*Salsola tragus*	50%	Forb	Annual	I	Emergency[i]

Notes: [i] = Injurious, [t] = Toxic.

Table 5-50. RMU 5 Composition by Weight

Species		Composition of Total Weight	Growth Form	Duration	Native (N) or Introduced (I)	Sheep Forage Value
Common Name	Scientific Name					
Alkali sacaton	*Sporobolus airoides*	53%	Graminoid	Perennial	N	Emergency
Saltlover	*Halogeton glomeratus*	14%	Forb	Annual	I	Not Consumed[t]
Galleta grass	*Pleuraphis jamesii*	8%	Graminoid	Perennial	N	Emergency
Indian ricegrass	*Achnatherum hymenoides*	6%	Graminoid	Perennial	N	Desirable
Shadscale	*Atriplex confertifolia*	5%	Shrub	Perennial	N	Not Consumed

Note: [t] = Toxic.

5.9 RMU 6

Range Management Unit 6 contains three transects. All RMUs in the project area are located within the northwest corner of the Shiprock analysis unit. Table 5-51 presents the total acreage for the RMU, total analyzed acreage, number of analyzed ecological sites, and carrying capacity. Adjusted carrying capacity represents the carrying capacity after adjusting for slope and distance to water. There are 12 ecological sites in RMU 6, but only one contains transects. The remaining 11 unanalyzed ecological sites make up 65 percent of the total unit area.

Table 5-51. RMU 6 Carrying Capacity

Total Acres	Total Analyzed Acres	# of Analyzed Ecological Sites	Initial Carrying Capacity (SUYL)	Adjusted Carrying Capacity (SUYL)
2,011.9	699.5	1	1.52	1.46

Note: SUYL = sheep unit year long.

Table 5-52 shows the minimum and maximum stocking rates, and the associated ecological sites. The stocking rate minimum and maximum is the same in this RMU, as only one ecological site was analyzed.

Table 5-52. RMU 6 Stocking Rate

Stocking Rate Minimum (Acres/SUYL)	Ecological Site with Minimum Stocking Rate	Stocking Rate Maximum (Acres/SUYL)	Ecological Site with Maximum Stocking Rate
461.09	R035XB274AZ	461.09	R035XB274AZ

Note: SUYL = sheep unit year long.

Table 5-53 displays the ecological sites found within the RMU and the number of transects, acreage, available forage, stocking rate, and annual carrying capacity within each ecological site. RMU 6 is a small unit and contains only three transects, all within a single ecological site (R035XB274AZ). This site makes up 35 percent of the total area, has a carrying capacity of less than two animals per year, and has a stocking rate of 461.

Table 5-53. RMU 6 Results by Ecological Site

Ecological Site	# of Transects	Total Acres	Average Available Forage (Pounds)	Stocking Rate (Acres/SUYL)	Initial Annual Carrying Capacity (SUYL)
Badland	0	29.10	N/A	N/A	N/A
R035XB028NM	0	0.90	N/A	N/A	N/A
R035XB034NM	0	4.30	N/A	N/A	N/A
R035XB204AZ	0	11.50	N/A	N/A	N/A
R035XB271AZ	0	265.40	N/A	N/A	N/A
R035XB274AZ	3	699.50	5.14	461.09	1.52
R035XB275AZ	0	90.30	N/A	N/A	N/A
R035XB276AZ	0	356.60	N/A	N/A	N/A
R035XB277AZ	0	236.00	N/A	N/A	N/A
R035XB278AZ	0	117.40	N/A	N/A	N/A
R035XB279AZ	0	195.10	N/A	N/A	N/A
Rock Outcrop	0	5.70	N/A	N/A	N/A

Table 5-54 shows the maximum, minimum, and median similarity indices. All transects in RMU 6 are in the R035XB274AZ ecological site. This site is typically dominated by alkali sacaton (*Sporobolus airoides*), winterfat (*Krascheninnikovia lanata*), and various species of saltbush (*Atriplex* spp.). Once this site begins to deteriorate, shrubs, warm-season grasses and species like Russian thistle (*Salsola tragus*) and blazing star (*Mentzelia* spp.) will increase. The main species found on the transects are shadscale (*Atriplex confertifolia*), Russian thistle, and galleta grass (*Pleuraphis jamesii*).

Table 5-54. RMU 6 Similarity Index

Maximum Similarity Index	Minimum Similarity Index	Median Similarity Index
30.24	1.38	5.74

Table 5-55 contains ground cover information. The percentage of bare ground in RMU 6 is high and all of the transects show signs of moderate erosion. More advanced erosion is likely to occur unless vegetation can be restored, which would increase canopy cover and reduce the amount of bare ground.

Table 5-55. RMU 6 Ground Cover

Canopy (%)	Bare Ground (%)	Basal (%)
11	71	1

The final two tables (Table 5-56 and Table 5-57) show the most frequently occurring species and the species contributing the most biomass, respectively. The most commonly encountered species, and those producing the most biomass, are consistent with salt-desert communities that have undergone at least a moderate amount of deterioration. Native shrubs and perennial grasses are present to various degrees, but so are invasive forbs, particularly Russian thistle and saltlover (*Halogeton glomeratus*). Shrubs also have increased, especially shadscale.

Table 5-56. RMU 6 Frequently Encountered Species

Species		Frequency of Total Transects	Growth Form	Duration	Native (N) or Introduced (I)	Sheep Forage Value
Common Name	Scientific Name					
Alkali sacaton	*Sporobolus airoides*	100%	Graminoid	Perennial	N	Emergency
Russian thistle	*Salsola tragus*	100%	Forb	Annual	I	Emergency[i]
Shadscale	*Atriplex confertifolia*	100%	Shrub	Perennial	N	Not Consumed
Galleta grass	*Pleuraphis jamesii*	67%	Graminoid	Perennial	N	Emergency
Saltlover	*Halogeton glomeratus*	67%	Forb	Annual	I	Not Consumed[t]
Indian ricegrass	*Achnatherum hymenoides*	67%	Graminoid	Perennial	N	Desirable

Notes: [i] = Injurious, [t] = Toxic.

Table 5-57. RMU 6 Composition by Weight

Species		Composition of Total Weight	Growth Form	Duration	Native (N) or Introduced (I)	Sheep Forage Value
Common Name	Scientific Name					
Shadscale	*Atriplex confertifolia*	50%	Shrub	Perennial	N	Not Consumed
Russian thistle	*Salsola tragus*	26%	Forb	Annual	I	Emergency[i]
Galleta grass	*Pleuraphis jamesii*	11%	Graminoid	Perennial	N	Emergency
Alkali sacaton	*Sporobolus airoides*	5%	Graminoid	Perennial	N	Emergency
Saltlover	*Halogeton glomeratus*	4%	Forb	Annual	I	Not Consumed[t]

Notes: [i] = Injurious, [t] = Toxic.

5.10 RMU 7

Range Management Unit 7 contains three transects. All RMUs in the project area are located within the northwest corner of the Shiprock analysis unit. Table 5-58 presents the total acreage for the RMU, total analyzed acreage, number of analyzed ecological sites, and carrying capacity. Adjusted carrying capacity represents the carrying capacity after adjusting for slope and distance to water. There are 12 ecological sites in RMU 7, but only three contain transects. The remaining nine unanalyzed ecological sites make up about half percent of the total unit area. As with most of the RMUs, the small number of transects made it difficult to capture data in all of the ecological sites within the RMU. Additional transects in selected areas would allow for increased data and carrying capacities.

Table 5-58. RMU 7 Carrying Capacity

Total Acres	Total Analyzed Acres	# of Analyzed Ecological Sites	Initial Carrying Capacity (SUYL)	Adjusted Carrying Capacity (SUYL)
2,962.7	1,360.1	3	1.84	1.49

Note: SUYL = sheep unit year long.

Table 5-59 shows the minimum and maximum stocking rates, and the associated ecological sites.

Table 5-59. RMU 7 Stocking Rate

Stocking Rate Minimum (Acres/SUYL)	Ecological Site with Minimum Stocking Rate	Stocking Rate Maximum (Acres/SUYL)	Ecological Site with Maximum Stocking Rate
Not Stockable	R035XB271AZ	298.49	R035XB274AZ

Note: SUYL = sheep unit year long.

Table 5-60 displays the ecological sites found within the RMU and the number of transects, acreage, available forage, stocking rate, and annual carrying capacity within each ecological site. The largest ecological site is the R035XB271AZ site, but despite its size, contains only one transect. No available forage was found on this transect, which makes the entire area non-stockable. Additional transects should be installed within this unit to better access how much actual forage exists. The best stocking rate occurs in the R035XB274AZ site, but as it only contains 54 acres, its carrying capacity is lower than that reported for the final ecological site, R035XB275AZ, which has a far lower stocking rate.

Table 5-60. RMU 7 Results by Ecological Site

Ecological Site	# of Transects	Total Acres	Average Available Forage (Pounds)	Stocking Rate (Acres/SUYL)	Initial Annual Carrying Capacity (SUYL)
Badland	0	317.40	N/A	N/A	N/A
R035XB028NM	0	31.90	N/A	N/A	N/A
R035XB034NM	0	148.60	N/A	N/A	N/A
R035XB204AZ	0	15.40	N/A	N/A	N/A
R035XB271AZ	1	912.30	0.0	Not Stockable	Not Stockable
R035XB274AZ	1	54.00	7.94	298.49	1.32
R035XB275AZ	1	393.90	3.85	615.58	0.52
R035XB276AZ	0	85.90	N/A	N/A	N/A
R035XB277AZ	0	886.20	N/A	N/A	N/A
R035XB278AZ	0	104.30	N/A	N/A	N/A
R035XB279AZ	0	5.20	N/A	N/A	N/A
Rock Outcrop	0	7.70	N/A	N/A	N/A

Table 5-61 shows the maximum, minimum, and median similarity indices. Each of the three transects in RMU 7 is located within a unique ecological site and each similarity index value is quite low. The plant communities that should be present at these sites are largely non-existent and represent degraded rangeland. Individual plants tend to be separated by large expanses of bare ground and, with the exception of alkali sacaton (*Sporobolus airoides*), most plants are annual forbs.

Table 5-61. RMU 7 Similarity Index

Maximum Similarity Index	Minimum Similarity Index	Median Similarity Index
14.81	0.0	5.58

Table 5-62 contains ground cover information. The percentage of bare ground in RMU 7 is high while canopy cover is low; no basal counts were recorded. Erosion is light to moderate at each of the transects. Most of this unit encompasses a highly dissected landscape composed of primarily Mancos Shale. This formation is made up of marine deposits; when weathered, these deposits form clay soils containing high amounts of salt and selenium. Managing for vegetation and grazing in this environment is difficult. Forage production typically is low even in areas that have undergone little to no disturbance; however, valuable grazing plants such as winterfat (*Krascheninnikovia lanata*), galleta grass (*Pleuraphis jamesii*), and western wheatgrass (*Pascopyrum smithii*) may become abundant with proper management. Aside from erosion, a major concern associated with improper grazing in these areas is the advent of non-desirable, invasive species such as saltlover (*Halogeton glomeratus*), Russian thistle (*Salsola tragus*), and cheatgrass (*Bromus tectorum*).

Table 5-62. RMU 7 Ground Cover

Canopy (%)	Bare Ground (%)	Basal (%)
5.0	76.0	0.0

The final two tables (Table 5-63 and Table 5-64) show the most frequently occurring species and the species contributing the most biomass, respectively. The most frequently encountered species in RMU 7 are mostly annual species. Russian thistle and saltlover are two problematic forbs that occur throughout the various RMUs. However, RMU 7 also contains cheatgrass. Although this grass can provide forage for livestock when it is green, it is not a suitable replacement for the native contingent of forage plants. It can easily out-compete most native, perennial species and is able to quickly colonize areas of bare ground. These aspects are particularly troublesome in RMU 7 and adjacent RMUs, as the percentage of bare ground is high and native species production is low. The species currently supplying the most forage is alkali sacaton. Aside from this grass, biomass is mostly being produced by the non-desirable forbs, Russian thistle and saltlover.

Table 5-63. RMU 7 Frequently Encountered Species

Species		Frequency of Total Transects	Growth Form	Duration	Native (N) or Introduced (I)	Sheep Forage Value
Common Name	Scientific Name					
Russian thistle	*Salsola tragus*	100%	Forb	Annual	I	Emergency[i]
Alkali sacaton	*Sporobolus airoides*	67%	Graminoid	Perennial	N	Emergency
Sand dropseed	*Sporobolus cryptandrus*	33%	Graminoid	Perennial	N	Not Consumed
Woolly plantain	*Plantago patagonica*	33%	Forb	Annual	N	Not Consumed
Saltlover	*Halogeton glomeratus*	33%	Forb	Annual	I	Not Consumed[t]
Tansy mustard	*Descurainia spp.*	33%	Forb	Annual	I	Not Consumed
Cheatgrass	*Bromus tectorum*	33%	Graminoid	Annual	I	Emergency[i]
Gardner's saltbush	*Atriplex gardneri*	33%	Subshrub	Perennial	N	Desirable
Shadscale	*Atriplex confertifolia*	33%	Shrub	Perennial	N	Not Consumed

Notes: [i] = Injurious, [t] = Toxic.

Table 5-64. RMU 7 Composition by Weight

Species		Composition of Total Weight	Growth Form	Duration	Native (N) or Introduced (I)	Sheep Forage Value
Common Name	Scientific Name					
Alkali sacaton	*Sporobolus airoides*	39%	Graminoid	Perennial	N	Emergency
Russian thistle	*Salsola tragus*	38%	Forb	Annual	I	Emergency[i]
Saltlover	*Halogeton glomeratus*	14%	Forb	Annual	I	Not Consumed[t]
Shadscale	*Atriplex confertifolia*	6%	Shrub	Perennial	N	Not Consumed
Cheatgrass	*Bromus tectorum*	1%	Graminoid	Annual	I	Emergency[i]

Notes: [i] = Injurious, [t] = Toxic.

5.11 RMU 8

There are five transects located within RMU 8. All RMUs in the project area are located within the northwest corner of the Shiprock analysis unit. Table 5-65 presents the total acreage for the RMU, total analyzed acreage, number of analyzed ecological sites, and carrying capacity. Adjusted carrying capacity represents the carrying capacity after adjusting for slope and distance to water. There are 12 ecological sites in RMU 8, but only three contain transects. The remaining eight unanalyzed ecological sites make up nearly half of the total unit area. Carrying capacities could be calculated for the unreported 50 percent of acreage with the addition of transects in selected areas.

Table 5-65. RMU 8 Carrying Capacity

Total Acres	Total Analyzed Acres	# of Analyzed Ecological Sites	Initial Carrying Capacity (SUYL)	Adjusted Carrying Capacity (SUYL)
3,238.1	1,625.1	3	16.67	5.98

Note: SUYL = sheep unit year long.

Table 5-66 shows the minimum and maximum stocking rates, and the associated ecological sites. Stocking rates are variable with the highest coming from the R035XB275AZ site and the lowest from the R035XB271AZ site.

Table 5-66. RMU 8 Stocking Rate

Stocking Rate Minimum (Acres/SUYL)	Ecological Site with Minimum Stocking Rate	Stocking Rate Maximum (Acres/SUYL)	Ecological Site with Maximum Stocking Rate
1,362.07	R035XB271AZ	46.14	R035XB275AZ

Note: SUYL = sheep unit year long.

Table 5-67 displays the ecological sites found within the RMU and the number of transects, acreage, available forage, stocking rate, and annual carrying capacity within each ecological site. Carrying capacities are extremely low with the best rate being associated with the R035XB275AZ site.

Table 5-67. RMU 8 Results by Ecological Site

Ecological Site	# of Transects	Total Acres	Average Available Forage (Pounds)	Stocking Rate (Acres/SUYL)	Initial Annual Carrying Capacity (SUYL)
Badland	0	131.10	N/A	N/A	N/A
R035XB016NM	0	0.01	N/A	N/A	N/A
R035XB017NM	0	6.70	N/A	N/A	N/A
R035XB030NM	0	4.00	N/A	N/A	N/A
R035XB204AZ	0	0.90	N/A	N/A	N/A
R035XB271AZ	2	393.86	1.74	1,362.07	0.29
R035XB274AZ	2	910.95	20.46	115.84	7.86
R035XB275AZ	1	393.08	51.36	46.14	8.52
R035XB276AZ	0	148.30	N/A	N/A	N/A
R035XB277AZ	0	823.50	N/A	N/A	N/A
R035XB278AZ	0	349.60	N/A	N/A	N/A
R035XB279AZ	0	148.80	N/A	N/A	N/A

Table 5-68 shows the maximum, minimum, and median similarity indices. The highest similarity index value in RMU 8 is associated with the R035XB274AZ ecological site. The HCPC primarily consists of perennial grasses such as alkali sacaton (*Sporobolus airoides*), galleta grass (*Pleuraphis jamesii*), and Indian ricegrass (*Achnatherum hymenoides*). Shrubs often are numerous as well, especially shadscale (*Atriplex confertifolia*), wheelscale saltbush (*Atriplex elegans*), and winterfat (*Krascheninnikovia lanata*). At the time of this survey, native forage species such as alkali sacaton, mound saltbush (*Atriplex obovata*), and Indian ricegrass are dominant. Two undesirable species, saltlover (*Halogeton glomeratus*) and Russian thistle (*Salsola tragus*), also are fairly abundant.

Table 5-68. RMU 8 Similarity Index

Maximum Similarity Index	Minimum Similarity Index	Median Similarity Index
36.62	2.02	4.25

Table 5-69 contains ground cover information. Ground cover and the overall landscape in RMU 8 are similar to that found in RMU 7. The percentage of bare ground is high, and canopy and basal counts are low. Soils derived from Mancos Shale are common, and non-native species have invaded the site. Cheatgrass (*Bromus tectorum*) is not yet evident in this unit, but the amount of bare ground increases the likelihood of colonization from populations in neighboring RMU 7.

Table 5-69. RMU 8 Ground Cover

Canopy (%)	Bare Ground (%)	Basal (%)
9.0	76.0	1.0

The final two tables (Table 5-70 and Table 5-71) show the most frequently occurring species and the species contributing the most biomass, respectively. The most frequently encountered species are a mix of annual forbs, perennial grasses, and shrubs. Some species provide forage for livestock while others like saltlover and tansymustard (*Descurainia* spp.) are of no value for grazing animals and, in the case of saltlover, potentially dangerous to livestock. The primary contributor of biomass in this unit is alkali sacaton, followed by mound saltbush.

Table 5-70. RMU 8 Frequently Encountered Species

Species		Frequency of Total Transects	Growth Form	Duration	Native (N) or Introduced (I)	Sheep Forage Value
Common Name	Scientific Name					
Alkali sacaton	*Sporobolus airoides*	40%	Graminoid	Perennial	N	Emergency
Russian thistle	*Salsola tragus*	40%	Forb	Annual	I	Emergency[i]
Saltlover	*Halogeton glomeratus*	40%	Forb	Annual	I	Not Consumed[t]
Tansymustard	*Descurainia spp.*	40%	Forb	Annual	I	Not Consumed
Gardner's saltbush	*Atriplex gardneri*	40%	Subshrub	Perennial	N	Desirable
Mat saltbush	*Atriplex corrugata*	40%	Subshrub	Perennial	N	Emergency
Indian ricegrass	*Achnatherum hymenoides*	40%	Graminoid	Perennial	N	Desirable

Notes: [i] = Injurious, [t] = Toxic.

Table 5-71. RMU 8 Composition by Weight

Species		Composition of Total Weight	Growth Form	Duration	Native (N) or Introduced (I)	Sheep Forage Value
Common Name	Scientific Name					
Alkali sacaton	*Sporobolus airoides*	70%	Graminoid	Perennial	N	Emergency
Mound saltbush	*Atriplex obovata*	7%	Subshrub/ Shrub	Perennial	N	Emergency
Indian ricegrass	*Achnatherum hymenoides*	6%	Graminoid	Perennial	N	Desirable
Russian thistle	*Salsola tragus*	4%	Forb	Annual	I	Emergency[i]
Saltlover	*Halogeton glomeratus*	4%	Forb	Annual	I	Not Consumed[t]

Notes: [i] = Injurious, [t] = Toxic.

5.12 RMU 9

There are six transects located within RMU 9. All RMUs in the project area are located within the northwest corner of the Shiprock analysis unit. Table 5-72 presents the total acreage for the RMU, total analyzed acreage, number of analyzed ecological sites, and carrying capacity. There are 13 ecological sites in RMU 9, but only three contain transects. The remaining ten unanalyzed ecological sites make up 37 percent of the total unit area. Additional transects in selected areas would allow for calculation of carrying capacity on more acreage.

Table 5-72. RMU 9 Carrying Capacity

Total Acres	Total Analyzed Acres	# of Analyzed Ecological Sites	Initial Carrying Capacity (SUYL)	Adjusted Carrying Capacity (SUYL)
1,758.4	1,102.4	3	10.8	0.0

Note: SUYL = sheep unit year long.

Table 5-73 shows the minimum and maximum stocking rates, and the associated ecological sites. The site with the lowest stocking rate, R035XB271AZ, is virtually not stockable while the R035XB016NM site has an exponentially higher stocking rate.

Table 5-73. RMU 9 Stocking Rate

Stocking Rate Minimum (Acres/SUYL)	Ecological Site with Minimum Stocking Rate	Stocking Rate Maximum (Acres/SUYL)	Ecological Site with Maximum Stocking Rate
47,400	R035XB271AZ	33.42	R035XB016NM

Note: SUYL = sheep unit year long.

Table 5-74 displays the ecological sites found within the RMU and the number of transects, acreage, available forage, stocking rate, and annual carrying capacity within each ecological site. Carrying capacity and stocking rate are highest in the R035XB016NM site and lowest in the R035XB271AZ site. Although results are low for all analyzed sites, the numbers for the R035XB016NM site are well above those recorded for the other two sites.

Table 5-74. RMU 9 Results by Ecological Site

Ecological Site	# of Transects	Total Acres	Average Available Forage (Pounds)	Stocking Rate (Acres/SUYL)	Initial Annual Carrying Capacity (SUYL)
Badland	0	236.50	N/A	N/A	N/A
R035XB016NM	3	347.50	70.91	33.42	10.40
R035XB017NM	0	21.60	N/A	N/A	N/A
R035XB267AZ	0	59.40	N/A	N/A	N/A
R035XB269AZ	0	24.10	N/A	N/A	N/A
R035XB271AZ	2	400.10	0.05	47,400.00	0.01
R035XB272AZ	0	24.80	N/A	N/A	N/A
R035XB273AZ	0	57.70	N/A	N/A	N/A
R035XB274AZ	0	0.60	N/A	N/A	N/A
R035XB275AZ	0	109.50	N/A	N/A	N/A
R035XB277AZ	1	354.70	2.59	915.06	0.39
R035XB278AZ	0	78.70	N/A	N/A	N/A
Rock Outcrop	0	43.20	N/A	N/A	N/A

Table 5-75 shows the maximum, minimum, and median similarity indices. The R035XB016NM site contains the highest similarity index values for RMU 9. This site occurs on fan terraces found below mesas and on valley floors. The typical plant community is comprised mainly of alkali sacaton (*Sporobolus airoides*), galleta grass (*Pleuraphis jamesii*), bottlebrush squirreltail (*Elymus elymoides*), Powell's saltweed (*Atriplex powellii*), mound saltbush (*Atriplex obovata*), greasewood (*Sarcobatus vermiculatus*), fourwing saltbush (*Atriplex canescens*), and Mojave seablite (*Suaeda moquinii*). Average annual production is around 420 pounds per acre and species likely to increase or invade following disturbance include greasewood, Powell's saltweed, and various annual forbs. The dominant plants on the transects are mound saltbush and saltlover (*Halogeton glomeratus*).

Table 5-75. RMU 9 Similarity Index

Maximum Similarity Index	Minimum Similarity Index	Median Similarity Index
27.44	1.52	2.45

Table 5-76 contains ground cover information. The percentages of bare ground and basal counts are slightly below average for the project area, while canopy cover is a little above average. Soils in RMU 9 are susceptible to both water and wind erosion. Currently, areas surrounding the transects are experiencing light to moderate erosion.

Table 5-76. RMU 9 Ground Cover

Canopy (%)	Bare Ground (%)	Basal (%)
12.0	67.0	0.0

The final two tables (Table 5-77 and Table 5-78) show the most frequently occurring species and the species contributing the most biomass, respectively. At this time, the primary species found within RMU 9 are various types of saltbush (*Atriplex* spp.); the toxic forb, saltlover; Russian thistle (*Salsola tragus*); and buckwheat (*Eriogonum* spp.). Saltbush does provide browse for livestock, but suitable grasses and forbs are very scarce.

Table 5-77. RMU 9 Frequently Occurring Species

Species		Frequency of Total Transects	Growth Form	Duration	Native (N) or Introduced (I)	Sheep Forage Value
Common Name	Scientific Name					
Saltlover	*Halogeton glomeratus*	67%	Forb	Annual	I	Not Consumed[t]
Mound saltbush	*Atriplex obovata*	67%	Subshrub/ Shrub	Perennial	N	Emergency
Russian thistle	*Salsola tragus*	33%	Forb	Annual	I	Emergency[i]
Sixweeks fescue	*Vulpia octoflora*	17%	Graminoid	Annual	N	Not Consumed
Buckwheat	*Eriogonum spp.*	17%	Forb	N/A	X	Unknown
Saltbush	*Atriplex spp.*	17%	Shrub	N/A	X	Unknown
Gardner's saltbush	*Atriplex gardneri*	17%	Subshrub	Perennial	N	Desirable
Mat saltbush	*Atriplex corrugata*	17%	Subshrub	Perennial	N	Emergency

Notes: [i] = Injurious, [t] = Toxic.

Table 5-78. RMU 9 Composition by Weight

Species		Composition of Total Weight	Growth Form	Duration	Native (N) or Introduced (I)	Sheep Forage Value
Common Name	Scientific Name					
Mound saltbush	*Atriplex obovata*	88%	Subshrub/ Shrub	Perennial	N	Emergency
Saltlover	*Halogeton glomeratus*	8%	Forb	Annual	I	Not Consumed[t]
Saltbush	*Atriplex spp.*	1%	Shrub	N/A	X	Unknown
Russian thistle	*Salsola tragus*	1%	Forb	Annual	I	Emergency[i]
Buckwheat	*Eriogonum spp.*	1%	Forb	N/A	X	Unknown

Notes: [i] = Injurious, [t] = Toxic.

5.13 Shiprock 1

The Shiprock 1 analysis unit contains seven transects. Table 5-79 presents the total acreage for the unit, total analyzed acreage, number of analyzed ecological sites, and carrying capacity. Adjusted carrying capacity represents the carrying capacity after adjusting for slope and distance to water. There are 16 ecological sites in this unit, but only three contain transects. The remaining 13 unanalyzed ecological sites make up 56 percent of the total unit area.

Table 5-79. Shiprock 1 Carrying Capacity

Total Acres	Total Analyzed Acres	# of Analyzed Ecological Sites	Initial Carrying Capacity	Adjusted Carrying Capacity
6,479.6	2,869.4	3	3.6	1.41

Note: SUYL = sheep unit year long.

Table 5-80 shows the minimum and maximum stocking rates, and the associated ecological sites. There is no available forage associated with the R035XB279AZ site, which makes it non-stockable. The best stocking rate comes from the R035XB274AZ site.

Table 5-80. Shiprock 1 Stocking Rate

Stocking Rate Minimum (Acres/SUYL)	Ecological Site with Minimum Stocking Rate	Stocking Rate Maximum (Acres/SUYL)	Ecological Site with Maximum Stocking Rate
R035XB279AZ	Not stockable	R035XB274AZ	143.9

Note: SUYL = sheep unit year long.

Table 5-81 displays the ecological sites found within the unit and the number of transects, acreage, available forage, stocking rate, and annual carrying capacity within each ecological site. The R035XB277AZ site is the largest analyzed site in the unit and has the most transects, but the carrying capacity is higher in the much smaller R035XB274AZ site.

Table 5-81. Shiprock 1 Results by Ecological Site

Ecological Site	# of Transects	Total Acres	Average Available Forage (Pounds)	Stocking Rate (Acres/SUYL)	Initial Annual Carrying Capacity (SUYL)
Badland	0	764.50	N/A	N/A	N/A
Gullied	0	4.80	N/A	N/A	N/A
R035XB016NM	0	175.80	N/A	N/A	N/A
R035XB017NM	0	475.90	N/A	N/A	N/A
R035XB028NM	0	71.50	N/A	N/A	N/A
R035XB267AZ	0	29.10	N/A	N/A	N/A
R035XB269AZ	0	0.10	N/A	N/A	N/A
R035XB271AZ	0	1,517.60	N/A	N/A	N/A
R035XB273AZ	0	0.10	N/A	N/A	N/A
R035XB274AZ	1	465.40	16.47	143.90	2.46
R035XB275AZ	0	413.50	N/A	N/A	N/A
R035XB277AZ	5	1,489.10	5.81	407.92	1.14
R035XB278AZ	0	113.80	N/A	N/A	N/A
R035XB279AZ	1	914.90	0.0	Not Stockable	Not Stockable
Riverwash	0	35.70	N/A	N/A	N/A
Rock Outcrop	0	7.90	N/A	N/A	N/A

Table 5-82 shows the maximum, minimum, and median similarity indices. All transects in the Shiprock 1 analysis unit have extremely low similarity index values. The maximum value occurs in the R035XB277AZ site. The HCPC for this site consists of perennial grasses, low shrubs, and only a minimal amount of forbs. Dominant plants include Indian ricegrass (*Achnatherum hymenoides*), galleta grass (*Pleuraphis jamesii*), bottlebrush squirreltail (*Elymus elymoides*), valley saltbush (*Atriplex cuneata*), bud sagebrush (*Picrothamnus desertorum*), and winterfat (*Krascheninnikovia lanata*). Species likely to increase or invade following prolonged disturbance are cheatgrass (*Bromus tectorum*) and various annual forbs. The dominant plant species encountered at the transects include saltlover (*Halogeton glomeratus*), alkali sacaton (*Sporobolus airoides*), mat saltbush (*Atriplex corrugata*), and Russian thistle (*Salsola tragus*).

Table 5-82. Shiprock 1 Similarity Index

Maximum Similarity Index	Minimum Similarity Index	Median Similarity Index
4.07	0.0	1.81

Table 5-83 contains ground cover information. The Shiprock 1 analysis unit has the highest percentage of bare ground of any unit in the project area and one of the lowest percentages of canopy cover. At each of the transects, erosion ranged from moderate to advanced. Along with erosion, deterioration of the ecological sites within this unit often leads to invasion of non-desirable, invasive species such as saltlover, Russian thistle, and cheatgrass.

Table 5-83. Shiprock 1 Ground Cover

Canopy (%)	Bare Ground (%)	Basal (%)
3.0	85.0	1.0

The final two tables (Table 5-84 and Table 5-85) show the most frequently occurring species and the species contributing the most biomass, respectively. The top species in both tables is the invasive, toxic forb, salt lover (*Halogeton glomeratus*). Other species associated with degraded rangeland include Russian thistle and sixweeks fescue (*Vulpia octoflora*). Sixweeks fescue is a native, annual grass that is not a problematic plant, but would be much less abundant on rangeland in better condition.

Table 5-84. Shiprock 1 Frequently Encountered Species

Species		Frequency of Total Transects	Growth Habit	Duration	Nativity (I=Introduced, N=Native)	Sheep Forage Value
Common Name	Scientific Name					
Saltlover	*Halogeton glomeratus*	100%	Forb	Annual	I	Not Consumed[t]
Gardner's saltbush	*Atriplex gardneri*	71%	Subshrub	Perennial	N	Desirable
Russian thistle	*Salsola tragus*	71%	Forb	Annual	I	Emergency[i]
Alkali sacaton	*Sporobolus airoides*	43%	Graminoid	Perennial	N	Emergency
Mat saltbush	*Atriplex corrugata*	43%	Subshrub	Perennial	N	Emergency
Western wheatgrass	*Pascopyrum smithii*	14%	Graminoid	Perennial	N	Desirable
Shadscale	*Atriplex confertifolia*	14%	Shrub	Perennial	N	Not Consumed
Sixweeks fescue	*Vulpia octoflora*	14%	Graminoid	Annual	N	Not Consumed
Mound saltbush	*Atriplex obovata*	14%	Subshrub/ Shrub	Perennial	N	Emergency

Notes: [i] = Injurious, [t] = Toxic.

Table 5-85. Shiprock 1 Composition by Weight

Species		Composition of Total Weight	Growth Habit	Duration	Nativity (I=Introduced, N=Native)	Sheep Forage Value
Common Name	Scientific Name					
Saltlover	*Halogeton glomeratus*	56%	Forb	Annual	I	Not Consumed[t]
Gardner's saltbush	*Atriplex gardneri*	17%	Subshrub	Perennial	N	Desirable
Alkali sacaton	*Sporobolus airoides*	10%	Graminoid	Perennial	N	Emergency
Russian thistle	*Salsola tragus*	9%	Forb	Annual	I	Emergency[i]
Mat saltbush	*Atriplex corrugata*	5%	Subshrub	Perennial	N	Emergency

Notes: [i] = Injurious, [t] = Toxic.

5.14 Shiprock 2

The Shiprock 2 analysis unit contains 18 transects. Table 5-86 presents the total acreage for the unit, total analyzed acreage, number of analyzed ecological sites, and carrying capacity. Adjusted carrying capacity represents the carrying capacity after adjusting for slope and distance to water. This unit has ten ecological sites; five contain transects. The remaining unanalyzed sites make up 6 percent of the total unit area.

Table 5-86. Shiprock 2 Carrying Capacity

Total Acres	Total Analyzed Acres	# of Analyzed Ecological Sites	Initial Carrying Capacity	Adjusted Carrying Capacity
9,287.9	8,729.9	5	2.83	1.98

Note: SUYL = sheep unit year long.

Table 5-87 shows the minimum and maximum stocking rates, and the associated ecological sites. Available forage is so limiting in the R035XB279AZ site that it would take almost 17, 000 acres to support one sheep unit for a year. The best stocking rate occurs in the R035XB278AZ site, but available forage is still quite low.

Table 5-87. Shiprock 2 Stocking Rate

Stocking Rate Minimum (Acres/SUYL)	Ecological Site with Minimum Stocking Rate	Stocking Rate Maximum (Acres/SUYL)	Ecological Site with Maximum Stocking Rate
16,928.57	R035XB279AZ	1,338.98	R035XB278AZ

Note: SUYL = sheep unit year long.

Table 5-88 displays the ecological sites found within the unit and the number of transects, acreage, available forage, stocking rate, and annual carrying capacity within each ecological site. Carrying capacities are very low for all of the analyzed ecological sites found in the Shiprock 2 analysis unit. The highest rate belongs to the R035XB278AZ site while the lowest occurs in the R035XB279AZ site. The largest site, making up 27 percent of the total area, is the R035XB271AZ site.

Table 5-88. Shiprock 2 Results by Ecological Site

Ecological Site	# of Transects	Total Acres	Average Available Forage (Pounds)	Stocking Rate (Acres/SUYL)	Initial Annual Carrying Capacity (SUYL)
Badland	0	302.50	N/A	N/A	N/A
R035XB016NM	0	236.70	N/A	N/A	N/A
R035XB268AZ	0	11.20	N/A	N/A	N/A
R035XB270AZ	0	4.80	N/A	N/A	N/A
R035XB271AZ	3	2,497.00	0.54	4,388.89	0.21
R035XB275AZ	4	1,805.70	0.32	7,406.25	0.34
R035XB277AZ	5	2,237.90	0.72	3,291.67	0.55
R035XB278AZ	3	1,036.30	1.77	1,338.98	1.67
R035XB279AZ	3	1,153.00	0.14	16,928.57	0.06
Water	0	2.80	N/A	N/A	N/A

Table 5-89 shows the maximum, minimum, and median similarity indices. Similarity index values are very low for all transects in the Shiprock 2 analysis unit. The higher values occur in several ecological sites, but most of the lowest values are in the R035XB275AZ site. The HCPC for this site consists mostly of grassland with some shrubs and forbs. Common species include alkali sacaton (*Sporobolus airoides*), galleta grass (*Pleuraphis jamesii*), Indian ricegrass (*Achnatherum hymenoides*), wheelscale saltbush (*Atriplex elegans*), mound saltbush (*Atriplex obovata*), and valley saltbush (*Atriplex cuneata*). Disturbance tends to lead to an increase in annual grasses and forbs. The current plant community is in a much degraded condition. The two most common species are Russian thistle (*Salsola tragus*) and saltlover (*Halogeton glomeratus*). Native, perennial species are scarce and producing little biomass.

Table 5-89. Shiprock 2 Similarity Index

Maximum Similarity Index	Minimum Similarity Index	Median Similarity Index
4.55	0.0	1.01

Table 5-90 contains ground cover information. The Shiprock 2 analysis unit has a high percentage of bare ground, minimal canopy cover, and no basal counts. Most transects show signs of moderate erosion, but the scarcity of vegetation indicates that the unit as at risk for more destructive erosion in the future.

Table 5-90. Shiprock 2 Ground Cover

Canopy (%)	Bare Ground (%)	Basal (%)
3.0	79.0	0.0

The final two tables (Table 5-91 and Table 5-92) show the most frequently occurring species and the species contributing the most biomass, respectively. Two annual, invasive forbs occupy the top two positions in both tables. Each of the other species have some degree of forage value, but their frequency of occurrence and overall production are far below the numbers reported for the invasive, non-desirable species.

Table 5-91. Shiprock 2 Frequently Encountered Species

Species		Frequency of Total Transects	Growth Form	Duration	Native (N) or Introduced (I)	Sheep Forage Value
Common Name	Scientific Name					
Saltlover	*Halogeton glomeratus*	94%	Forb	Annual	I	Not Consumed[t]
Russian thistle	*Salsola tragus*	61%	Forb	Annual	I	Emergency[i]
Gardner's saltbush	*Atriplex gardneri*	50%	Subshrub	Perennial	N	Desirable
Alkali sacaton	*Sporobolus airoides*	11%	Graminoid	Perennial	N	Emergency
Shadscale	*Atriplex confertifolia*	11%	Shrub	Perennial	N	Not Consumed
Crested wheatgrass	*Agropyron cristatum*	11%	Graminoid	Perennial	I	Desirable

Notes: [i] = Injurious, [t] = Toxic.

Table 5-92. Shiprock 2 Composition by Weight

Species		Composition of Total Weight	Growth Form	Duration	Native (N) or Introduced (I)	Sheep Forage Value
Common Name						
Saltlover	*Halogeton glomeratus*	60%	Forb	Annual	I	Not Consumed[t]
Russian thistle	*Salsola tragus*	35%	Forb	Annual	I	Emergency[i]
Gardner's saltbush	*Atriplex gardneri*	2%	Subshrub	Perennial	N	Desirable
Shadscale	*Atriplex confertifolia*	1%	Shrub	Perennial	N	Not Consumed
Alkali sacaton	*Sporobolus airoides*	1%	Graminoid	Perennial	N	Emergency

Notes: [i] = Injurious, [t] = Toxic.

5.15 Shiprock 3

There are 25 transects in the Shiprock 3 analysis unit. Table 5-93 presents the total acreage for the unit, total analyzed acreage, number of analyzed ecological sites, and carrying capacity. Adjusted carrying capacity represents the carrying capacity after adjusting for slope and distance to water. This unit has 13 ecological sites; eight contain transects. The remaining unanalyzed sites make up less than 1 percent of the total unit area.

Table 5-93. Shiprock 3 Carrying Capacity

Total Acres	Total Analyzed Acres	# of Analyzed Ecological Sites	Initial Carrying Capacity	Adjusted Carrying Capacity
17,224.2	17,163.4	8	32.74	7.28

Note: SUYL = sheep unit year long.

Table 5-94 shows the minimum and maximum stocking rates, and the associated ecological sites. Available forage averages about 5 pounds per acre in the Shiprock 3 analysis unit. The best stocking rate is found in the R035XB016NM site which has 13 pounds per acre of available forage and the lowest rate is associated with the R035XB275AZ site, which contains 1.5 pounds per acre of available forage.

Table 5-94. Shiprock 3 Stocking Rate

Stocking Rate Minimum (Acres/SUYL)	Ecological Site with Minimum Stocking Rate	Stocking Rate Maximum (Acres/SUYL)	Ecological Site with Maximum Stocking Rate
1,580.0	R035XB275AZ	183.15	R035XB016NM

Note: SUYL = sheep unit year long.

Table 5-95 displays the ecological sites found within the unit and the number of transects, acreage, available forage, stocking rate, and annual carrying capacity within each ecological site. The highest carrying capacity occurs in the R035XB016NM site, which also is the largest site in the unit. The second highest carrying capacity is associated with the smallest ecological site, R035XB016NM.

Table 5-95. Shiprock 3 Results by Ecological Site

Ecological Site	# of Transects	Total Acres	Average Available Forage (Pounds)	Stocking Rate (Acres/SUYL)	Initial Annual Carrying Capacity (SUYL)
Badland	0	6.10	N/A	N/A	N/A
R035XB016NM	2	1,389.70	12.94	183.15	7.59
R035XB020NM	0	8.90	N/A	N/A	N/A
R035XB024NM	0	35.70	N/A	N/A	N/A
R035XB268AZ	0	7.10	N/A	N/A	N/A
R035XB270AZ	0	3.00	N/A	N/A	N/A
R035XB271AZ	1	2,161.80	5.58	424.73	5.09
R035XB274AZ	3	1,696.80	3.20	740.62	2.29
R035XB275AZ	4	4,243.00	1.50	1,580.00	2.69
R035XB276AZ	4	3,110.70	5.38	440.52	7.06
R035XB277AZ	6	1,853.00	2.88	822.92	2.25
R035XB278AZ	3	1,777.10	5.08	466.54	3.81
R035XB279AZ	2	931.20	5.00	474.00	1.96

Table 5-96 shows the maximum, minimum, and median similarity indices. Similarity scores are consistently higher in the R035XB016NM and R035XB276NM ecological sites. The R035XB016NM site is typically made up of warm-season grasses like alkali sacaton (*Sporobolus airoides*) and galleta grass (*Pleuraphis jamesii*). The primary shrub species is mound saltbush (*Atriplex obovata*); this shrub, along with alkali sacaton, are the two main species found on transects within this site.

The R035XB276NM site tends to have soils with a high salinity and sodium content. The main grass species include alkali sacaton, Indian ricegrass (*Achnatherum hymenoides*), and galleta grass. Dominant shrubs include numerous species of saltbush (*Atriplex* spp.), bud sagebrush (*Picrothamnus desertorum*), and winterfat (*Krascheninnikovia lanata*). The current vegetation community consists largely of Russian thistle (*Salsola tragus*) and alkali sacaton.

Table 5-96. Shiprock 3 Similarity Index

Maximum Similarity Index	Minimum Similarity Index	Median Similarity Index
24.01	0.47	2.97

Table 5-97 contains ground cover information. The percentage of bare ground is well above average, while the percentage of canopy cover and basal counts are below average. Most transects exhibit signs of moderate erosion. Soils in this unit are loams and clay loams suggesting that they are susceptible to water erosion.

Table 5-97. Shiprock 3 Ground Cover

Canopy (%)	Bare Ground (%)	Basal (%)
4.0	84.0	1.0

The final two tables (Table 5-98 and Table 5-99) show the most frequently occurring species and the species contributing the most biomass, respectively. Annual forbs, especially saltlover (*Halogeton glomeratus*), are among the most frequently occurring and highest producers of biomass in the Shiprock 3 analysis unit. More desirable species are present, but are much less abundant.

Table 5-98. Shiprock 3 Frequently Encountered Species

Species		Frequency of Total Transects	Growth Habit	Duration	Nativity (I=Introduced, N=Native)	Sheep Forage Value
Common Name	Scientific Name					
Saltlover	*Halogeton glomeratus*	92%	Forb	Annual	I	Not Consumed[t]
Alkali sacaton	*Sporobolus airoides*	68%	Graminoid	Perennial	N	Emergency
Gardner's saltbush	*Atriplex gardneri*	64%	Subshrub	Perennial	N	Desirable
Russian thistle	*Salsola tragus*	60%	Forb	Annual	I	Emergency[i]
Annual forb	N/A	32%	Forb	Annual	N/A	Not Consumed

Notes: [i] = Injurious, [t] = Toxic.

Table 5-99. Shiprock 3 Composition by Weight

Species		Composition of Total Weight	Growth Habit	Duration	Nativity (I=Introduced, N=Native)	Sheep Forage Value
Common Name	Scientific Name					
Saltlover	*Halogeton glomeratus*	57%	Forb	Annual	I	Not Consumed[t]
Russian thistle	*Salsola tragus*	19%	Forb	Annual	I	Emergency[i]
Alkali sacaton	*Sporobolus airoides*	10%	Graminoid	Perennial	N	Emergency
Gardner's saltbush	*Atriplex gardneri*	6%	Subshrub	Perennial	N	Desirable
Mound saltbush	*Atriplex obovata*	5%	Subshrub/ Shrub	Perennial	N	Emergency

Notes: [i] = Injurious, [t] = Toxic.

5.16 Shiprock 4

The Shiprock 4 analysis unit contains 64 transects. Table 5-100 presents the total acreage for the unit, total analyzed acreage, the number of analyzed ecological sites, and carrying capacity. Adjusted carrying capacity represents the carrying capacity after adjusting for slope and distance to water. This unit has 17 ecological sites; 11 contain transects. The remaining unanalyzed sites make up 6 percent of the total unit area.

Table 5-100. Shiprock 4 Carrying Capacity

Total Acres	Total Analyzed Acres	# of Analyzed Ecological Sites	Initial Carrying Capacity	Adjusted Carrying Capacity
43,831.4	41,078.2	11	170.36	64.20

Note: SUYL = sheep unit year long.

Table 5-101 shows the minimum and maximum stocking rates, and the associated ecological sites. The R035XB028NM site has no available forage, which makes it non-stockable at this time. The best stocking rate is associated with the R035XB030NM site.

Table 5-101. Shiprock 4 Stocking Rate

Stocking Rate Minimum (Acres/SUYL)	Ecological Site with Minimum Stocking Rate	Stocking Rate Maximum (Acres/SUYL)	Ecological Site with Maximum Stocking Rate
Not Stockable	R035XB028NM	105.33	R035XB030NM

Note: SUYL = sheep unit year long.

Table 5-102 displays the ecological sites found within the unit and the number of transects, acreage, available forage, stocking rate, and annual carrying capacity within each ecological site. The largest ecological site, R035XB274AZ, also has the highest carrying capacity and the most transects. The R035XB028NM site is considered to be non-stockable, but this is the smallest of the analyzed sites, making up less than 1 percent of the total unit area.

Table 5-102. Shiprock 4 Results by Ecological Site

Ecological Site	# of Transects	Total Acres	Average Available Forage (Pounds)	Stocking Rate (Acres/SUYL)	Initial Annual Carrying Capacity (SUYL)
Badland	0	816.60	N/A	N/A	N/A
R035XB016NM	0	563.40	N/A	N/A	N/A
R035XB020NM	0	11.30	N/A	N/A	N/A
R035XB022NM	2	227.30	11.40	207.89	1.09
R035XB024NM	0	53.30	N/A	N/A	N/A
R035XB028NM	1	138.10	0.0	0	0
R035XB030NM	4	2,969.60	22.50	105.33	28.19
R035XB034NM	0	644.30	N/A	N/A	N/A
R035XB204AZ	2	861.10	5.70	414.34	2.08
R035XB271AZ	5	5,265.90	8.20	289.73	18.18
R035XB274AZ	23	9,753.00	10.60	224.01	43.54
R035XB275AZ	9	6,293.60	11.60	204.49	30.78
R035XB276AZ	6	6,527.30	3.80	617.19	10.58
R035XB277AZ	6	4,608.80	9.70	245.09	18.80
R035XB278AZ	5	3,099.30	11.80	201.36	15.39
R035XB279AZ	1	1,334.20	3.10	769.48	1.73
Rock Outcrop	0	664.30	N/A	N/A	N/A

Table 5-103 shows the maximum, minimum, and median similarity indices. The highest similarity index values are in the R035XB274AZ and R035XB275AZ ecological sites. Soils are deep and well drained in the R035XB274AZ site and the plant community is made up mostly of grass species if the site is not unduly disturbed. When shrubs are present, shadscale (*Atriplex confertifolia*) tends to be the most commonly encountered. Annual species, especially Russian thistle (*Salsola tragus*), will invade or increase following prolonged disturbance. At this time, alkali sacaton (*Sporobolus airoides*) and Russian thistle are dominant components of the plant community.

The HCPC for the R035XB275AZ site is similar to that of the R035XB274AZ site. The plant community is primarily grassland with few forbs or shrubs. Common species include galleta grass (*Pleuraphis jamesii*), alkali sacaton, wheelscale saltbush (*Atriplex elegans*), and mound saltbush (*Atriplex obovata*). Transects within this site encountered mostly alkali sacaton and saltlover (*Halogeton glomeratus*).

Table 5-103. Shiprock 4 Similarity Index

Maximum Similarity Index	Minimum Similarity Index	Median Similarity Index
35.99	0.0	9.22

Table 5-104 contains ground cover information. The amount of bare ground is high in the Shiprock 4 analysis unit, and canopy cover and basal counts are low; however, most transects show little to no signs of erosion at this time. The few that are actively losing soil, primarily to water erosion, are located along the southern boundary of the unit.

Table 5-104. Shiprock 4 Ground Cover

Canopy (%)	Bare Ground (%)	Basal (%)
7.0	75.0	1.0

The final two tables (Table 5-105 and Table 5-106) show the most frequently occurring species and the species contributing the most biomass, respectively. The plants found in the following table are indicative of at least moderately degraded rangeland. Forage species like alkali sacaton and Indian ricegrass (*Achnatherum hymenoides*) are present, but invasive, non-desirable species like Russian thistle and saltlover are abundant as well.

Table 5-105. Shiprock 4 Frequently Encountered Species

Species		Frequency of Total Transects	Growth Habit	Duration	Nativity (I=Introduced, N=Native)	Sheep Forage Value
Common Name	Scientific Name					
Alkali sacaton	*Sporobolus airoides*	69%	Graminoid	Perennial	N	Emergency
Russian thistle	*Salsola tragus*	69%	Forb	Annual	I	Emergency[i]
Shadscale	*Atriplex confertifolia*	44%	Shrub	Perennial	N	Not Consumed
Saltlover	*Halogeton glomeratus*	41%	Forb	Annual	I	Not Consumed[t]
Indian ricegrass	*Achnatherum hymenoides*	34%	Graminoid	Perennial	N	Desirable

Notes: [i] = Injurious, [t] = Toxic.

Table 5-106. Shiprock 4 Composition by Weight

Species		Composition of Total Weight	Growth Form	Duration	Native (N) or Introduced (I)	Sheep Forage Value
Common Name	Scientific Name					
Russian thistle	*Salsola tragus*	42%	Forb	Annual	I	Emergency[i]
Alkali sacaton	*Sporobolus airoides*	19%	Graminoid	Perennial	N	Emergency
Prickly pear	*Opuntia spp.*	7%	Cactus	Perennial	N	Not Consumed
Saltlover	*Halogeton glomeratus*	7%	Forb	Annual	I	Not Consumed[t]
Shadscale	*Atriplex confertifolia*	6%	Shrub	Perennial	N	Not Consumed

Notes: [i] = Injurious, [t] = Toxic.

5.17 Shiprock 5

There are 8 transects in the Shiprock 5 analysis unit. Table 5-107 presents the total acreage for the unit, total analyzed acreage, number of analyzed ecological sites, and carrying capacity. Adjusted carrying capacity represents the carrying capacity after adjusting for slope and distance to water. This unit has 16 ecological sites; four contain transects. The remaining unanalyzed sites make up 37 percent of the total unit area.

Table 5-107. Shiprock 5 Carrying Capacity

Total Acres	Total Analyzed Acres	# of Analyzed Ecological Sites	Initial Carrying Capacity	Adjusted Carrying Capacity
4,752.1	3,002.1	4	6.27	1.84

Note: SUYL = sheep unit year long.

Table 5-108 shows the minimum and maximum stocking rates, and the associated ecological sites. The Badland site has less than 1 pound per acre of available forage and as result, has the lowest stocking rate in the Shiprock 5 analysis unit. The best stocking rate is associated with the R035XB271AZ site.

Table 5-108. Shiprock 5 Stocking Rate

Stocking Rate Minimum (Acres/SUYL)	Ecological Site with Minimum Stocking Rate	Stocking Rate Maximum (Acres/SUYL)	Ecological Site with Maximum Stocking Rate
3,077.92	Badland	265.10	R035XB271AZ

Note: SUYL = sheep unit year long.

Table 5-109 displays the ecological sites found within the unit and the number of transects, acreage, available forage, stocking rate, and annual carrying capacity within each ecological site. Carrying capacity is highest in the R035XB271AZ site, but the largest site, and the one with the most transects, is the R035XB274AZ site.

Table 5-109. Shiprock 5 Results by Ecological Site

Ecological Site	# of Transects	Total Acres	Average Available Forage (Pounds)	Stocking Rate (Acres/SUYL)	Initial Annual Carrying Capacity (SUYL)
Badland	1	534.10	0.77	3,077.92	0.17
R035XB016NM	0	38.10	N/A	N/A	N/A
R035XB017NM	0	365.60	N/A	N/A	N/A
R035XB021NM	0	1.30	N/A	N/A	N/A
R035XB028NM	0	6.40	N/A	N/A	N/A
R035XB034NM	0	29.90	N/A	N/A	N/A
R035XB204AZ	0	3.90	N/A	N/A	N/A
R035XB267AZ	0	0.10	N/A	N/A	N/A
R035XB271AZ	2	1,040.90	8.94	265.10	3.93
R035XB274AZ	4	1,117.00	2.46	963.41	1.16
R035XB275AZ	0	122.30	N/A	N/A	N/A
R035XB276AZ	1	310.10	7.72	306.99	1.01
R035XB277AZ	0	1,017.70	N/A	N/A	N/A
R035XB278AZ	0	93.20	N/A	N/A	N/A
R035XB279AZ	0	69.60	N/A	N/A	N/A
Rock Outcrop	0	1.90	N/A	N/A	N/A

Table 5-110 shows the maximum, minimum, and median similarity indices. Only one transect is located within the R035XB276AZ ecological site, but its similarity index value is well above the values reported for other sites. The vegetation community for this site is characterized by grasses and low shrubs. One species, sickle saltbush (*Atriplex falcata*), is well adapted to the high levels of soil salinity and sodium, and often is the last species to disappear from the HCPC as the site deteriorates. Replacement species invading this site are most often native and non-native annual forbs. Vegetation is scarce at the only transect in the R035XB276AZ site. The two most abundant species are alkali sacaton (*Sporobolus airoides*) and Russian thistle (*Salsola tragus*).

Table 5-110. Shiprock 5 Similarity Index

Maximum Similarity Index	Minimum Similarity Index	Median Similarity Index
28.88	0.09	3.56

Table 5-111 contains ground cover information. Erosion ranges from light to severe on the transects located in the Shiprock analysis unit. The high percentage of bare ground and low percentage of canopy cover suggests that the area is at risk of becoming more eroded in the future.

Table 5-111. Shiprock 5 Ground Cover

Canopy (%)	Bare Ground (%)	Basal (%)
5.0	80.0	1.0

The final two tables (Table 5-112 and Table 5-113) show the most frequently occurring species and the species contributing the most biomass, respectively. The Shiprock 5 analysis unit appears to be in a fairly degraded condition. The vast majority of the biomass is coming from two invasive, annual forbs, Russian thistle and saltlover (*Halogeton glomeratus*). Remnants of a more intact plant community, such as Gardner's saltbush (*Atriplex gardneri*) and galleta grass (*Pleuraphis jamesii*), are still present but in a limited capacity.

Table 5-112. Shiprock 5 Frequently Encountered Species

Species		Frequency of Total Transects	Growth Habit	Duration	Nativity (I=Introduced, N=Native)	Sheep Forage Value
Common Name	Scientific Name					
Russian thistle	*Salsola tragus*	75%	Forb	Annual	I	Emergency[i]
Alkali sacaton	*Sporobolus airoides*	75%	Graminoid	Perennial	N	Emergency
Saltlover	*Halogeton glomeratus*	50%	Forb	Annual	I	Not Consumed[t]
Gardner's saltbush	*Atriplex gardneri*	50%	Subshrub	Perennial	N	Desirable
Globemallow	*Sphaeralcea spp.*	38%	Forb	Perennial	N	Not Consumed

Notes: [i] = Injurious, [t] = Toxic.

Table 5-113. Shiprock 5 Composition by Weight

Species		Composition of Total Weight	Growth Habit	Duration	Nativity (I=Introduced, N=Native)	Sheep Forage Value
Common Name	Scientific Name					
Saltlover	*Halogeton glomeratus*	47%	Forb	Annual	I	Not Consumed[t]
Russian thistle	*Salsola tragus*	30%	Forb	Annual	I	Emergency[i]
Alkali sacaton	*Sporobolus airoides*	9%	Graminoid	Perennial	N	Emergency
Gardner's saltbush	*Atriplex gardneri*	6%	Subshrub	Perennial	N	Desirable
Galleta grass	*Pleuraphis jamesii*	3%	Graminoid	Perennial	N	Emergency

Notes: [i] = Injurious, [t] = Toxic.

5.18 Shiprock 6

There are 4 transects in the Shiprock 6 analysis unit. Table 5-114 presents the total acreage for the unit, the total analyzed acreage, number of analyzed ecological sites, and carrying capacity. Adjusted carrying capacity represents the carrying capacity after adjusting for slope and distance to water. This unit has 14 ecological sites; two contain transects. The remaining unanalyzed sites make up 51 percent of the total unit area.

Table 5-114. Shiprock 6 Carrying Capacity

Total Acres	Total Analyzed Acres	# of Analyzed Ecological Sites	Initial Carrying Capacity	Adjusted Carrying Capacity
3,434.1	1,674.2	2	12.63	0.0

Note: SUYL = sheep unit year long.

Table 5-115 shows the minimum and maximum stocking rates, and the associated ecological sites. There are only two analyzed ecological sites in this unit. The best stocking rate is associated with the R035XB030NM site, which has almost four times the amount of available forage as the R035XB271AZ site.

Table 5-115. Shiprock 6 Stocking Rate

Stocking Rate Minimum (Acres/SUYL)	Ecological Site with Minimum Stocking Rate	Stocking Rate Maximum (Acres/SUYL)	Ecological Site with Maximum Stocking Rate
371.47	R035XB271AZ	101.59	R035XB030NM

Note: SUYL = sheep unit year long.

Table 5-116 displays the ecological sites found within the unit and the number of transects, acreage, available forage, stocking rate, and annual carrying capacity within each ecological site. The R035XB030NM site is about twice the size of the R035XB271AZ site and has a much higher carrying capacity.

Table 5-116. Shiprock 6 Results by Ecological Site

Ecological Site	# of Transects	Total Acres	Average Available Forage (Pounds)	Stocking Rate (Acres/SUYL)	Initial Annual Carrying Capacity (SUYL)
Badland	0	259.60	N/A	N/A	N/A
Gullied	0	10.60	N/A	N/A	N/A
R035XB016NM	0	19.50	N/A	N/A	N/A
R035XB017NM	0	172.90	N/A	N/A	N/A
R035XB028NM	0	21.30	N/A	N/A	N/A
R035XB030NM	3	1,135.40	23.33	101.59	11.18
R035XB034NM	0	99.30	N/A	N/A	N/A
R035XB035NM	0	186.60	N/A	N/A	N/A
R035XB271AZ	1	538.70	6.38	371.47	1.45
R035XB274AZ	0	246.30	N/A	N/A	N/A
R035XB275AZ	0	25.10	N/A	N/A	N/A
R035XB276AZ	0	134.60	N/A	N/A	N/A
R035XB277AZ	0	523.60	N/A	N/A	N/A
R035XB278AZ	0	60.50	N/A	N/A	N/A

Table 5-117 shows the maximum, minimum, and median similarity indices. Three of the four transects in the Shiprock 6 analysis unit are located in the R035XB039NM site. This site has both the lowest and highest similarity index values. The HCPC is comprised of primarily grasses with only a small forb and shrub component. Common species include Indian ricegrass (*Achnatherum hymenoides*), galleta grass (*Pleuraphis jamesii*), blue grama (*Bouteloua gracilis*), species of globemallow (*Sphaeralcea* spp.), fourwing saltbush (*Atriplex canescens*), winterfat (*Krascheninnikovia lanata*), and broom snakeweed (*Gutierrezia sarothrae*). Deterioration of this site leads to increases in native and non-native annual species. The most prevalent annual found on the transects is Russian thistle (*Salsola tragus*). The invasive annual grass, cheatgrass (*Bromus tectorum*), was found on two of the transects, but at this time, it is not very abundant. The most common forage species are alkali sacaton (*Sporobolus airoides*) and galleta grass.

Table 5-117. Shiprock 6 Similarity Index

Maximum Similarity Index	Minimum Similarity Index	Median Similarity Index
18.11	10.1	13.66

Table 5-118 contains ground cover information. The Shiprock 6 analysis unit has the lowest amount of bare ground and the highest percentage of canopy cover of all units in the Shiprock Chapter. Transects show light to moderate amounts of erosion.

Table 5-118. Shiprock 6 Ground Cover

Canopy (%)	Bare Ground (%)	Basal (%)
14.0	70.0	2.0

The final two tables (Table 5-119 and Table 5-120) show the most frequently occurring species and the species contributing the most biomass, respectively. The main contributor of biomass in the Shiprock 6 analysis unit is Russian thistle, followed by the perennial grass, alkali sacaton. The invasive grass, cheatgrass, is present on 50 percent of the transects, but is producing less than 1 percent of the total biomass.

Table 5-119. Shiprock 6 Frequently Encountered Species

Species		Frequency of Total Transects	Growth Form	Duration	Native (N) or Introduced (I)	Sheep Forage Value
Common Name	Scientific Name					
Alkali sacaton	*Sporobolus airoides*	100%	Graminoid	Perennial	N	Emergency
Russian thistle	*Salsola tragus*	100%	Forb	Annual	I	Emergency[i]
Galleta grass	*Pleuraphis jamesii*	75%	Graminoid	Perennial	N	Emergency
Cheatgrass	*Bromus tectorum*	50%	Graminoid	Annual	I	Emergency[i]
Indian ricegrass	*Achnatherum hymenoides*	50%	Graminoid	Perennial	N	Desirable

Note: [i] = Injurious.

Table 5-120. Shiprock 6 Composition by Weight

Species		Composition of Total Weight	Growth Form	Duration	Native (N) or Introduced (I)	Sheep Forage Value
Common Name	Scientific Name					
Russian thistle	*Salsola tragus*	79%	Forb	Annual	I	Emergency[i]
Alkali sacaton	*Sporobolus airoides*	13%	Graminoid	Perennial	N	Emergency
Galleta grass	*Pleuraphis jamesii*	5%	Graminoid	Perennial	N	Emergency
Canaigre dock	*Rumex hymenosepalus*	1%	Forb	Perennial	N	Not Consumed
Sand verbena	*Abronia fragrans*	1%	Forb	Perennial	N	Not Consumed

Note: [i] = Injurious.

5.19 Teec Nos Pos 1

There are 36 transects in the Teec Nos Pos 1 analysis unit. Table 5-121 presents the total acreage for the unit, total analyzed acreage, number of analyzed ecological sites, and carrying capacity. Adjusted carrying capacity represents the carrying capacity after adjusting for slope and distance to water. This unit has 33 ecological sites; 18 contain transects. The remaining unanalyzed sites make up 18 percent of the total unit area.

Table 5-121. Teec Nos Pos 1 Carrying Capacity

Total Acres	Total Analyzed Acres	# of Analyzed Ecological Sites	Initial Carrying Capacity	Adjusted Carrying Capacity
21,132.9	18,072.3	19	104.25	62.84

Note: SUYL = sheep unit year long.

Table 5-122 shows the minimum and maximum stocking rates, and the associated ecological sites. The site with lowest stocking rate (R035XB217AZ) also is the smallest ecological site in the Teec Nos Pos 1 analysis unit. The R035XA113NM site has the best stocking rate, which is well above the average for the unit.

Table 5-122. Teec Nos Pos 1 Stocking Rate

Stocking Rate Minimum (Acres/SUYL)	Ecological Site with Minimum Stocking Rate	Stocking Rate Maximum (Acres/SUYL)	Ecological Site with Maximum Stocking Rate
3,160.0	R035XB217AZ	15.14	R035XA113NM

Note: SUYL = sheep unit year long.

Table 5-123 displays the ecological sites found within the unit and the number of transects, acreage, available forage, stocking rate, and annual carrying capacity within each ecological site. The largest ecological site, R035XB225AZ, has one of the better carrying capacities and a stocking rate that is slightly above average. The second largest ecological site, R035XB134NM, has the highest carrying capacity. In addition to having the lowest stocking rate, the R035XB217AZ site also has the lowest stocking rate.

Table 5-123. Teec Nos Pos 1 Results by Ecological Site

Ecological Site	# of Transects	Total Acres	Average Available Forage (Pounds)	Stocking Rate (Acres/SUYL)	Initial Annual Carrying Capacity (SUYL)
Badland	0	517.90	N/A	N/A	N/A
F035XG134NM	1	2,958.10	28.59	82.90	35.68
R035XA113NM	1	279.10	156.58	15.14	18.43
R035XA117AZ	0	441.60	N/A	N/A	N/A
R035XB017NM	1	505.00	6.20	382.26	1.32
R035XB021NM	2	455.30	8.93	265.40	1.72
R035XB022NM	0	373.40	N/A	N/A	N/A
R035XB028NM	0	10.00	N/A	N/A	N/A
R035XB030NM	0	244.40	N/A	N/A	N/A
R035XB204AZ	5	1,495.00	13.52	175.30	8.53
R035XB217AZ	1	94.70	0.75	3,160.00	0.03
R035XB219AZ	2	1,080.90	8.04	294.78	3.67
R035XB224AZ	3	1,967.90	3.07	771.99	2.55
R035XB225AZ	5	3,737.50	6.96	340.52	10.98
R035XB227AZ	1	284.10	16.44	144.16	1.97
R035XB228AZ	1	189.40	11.88	199.49	0.95
R035XB229AZ	2	332.60	17.66	134.20	2.48
R035XB267AZ	0	781.70	3.85	615.58	1.27
R035XB269AZ	0	134.90	N/A	N/A	N/A
R035XB272AZ	0	27.20	N/A	N/A	N/A
R035XB273AZ	0	323.80	N/A	N/A	N/A
R035XB274AZ	1	288.90	16.37	144.78	2.00
R035XC314AZ	0	50.70	N/A	N/A	N/A
R035XC315AZ	0	353.30	N/A	N/A	N/A
R035XC316AZ	3	794.80	2.30	1,030.43	0.77
R035XC324AZ	2	267.20	30.18	78.53	3.40
R035XC325AZ	0	233.80	N/A	N/A	N/A
R035XC326AZ	3	986.00	12.66	187.20	5.27
R035XC327AZ	0	121.60	N/A	N/A	N/A
R035XC328AZ	0	209.40	N/A	N/A	N/A
R035XC329AZ	1	767.60	6.18	383.50	2.00
Riverwash	0	4.20	N/A	N/A	N/A
Rock Outcrop	1	806.40	3.61	656.51	1.23

Table 5-124 shows the maximum, minimum, and median similarity indices. The highest similarity index value occurs in the R035XB225AZ site, but the R035XB204AZ site has the highest values overall. The R035XB204AZ site occupies structural benches, mesa summits, and cuestas. Average production is low (150 pounds per acre) and the plant community tends to be comprised of perennial grasses and shrubs. Dominant species include Indian ricegrass (*Achnatherum hymenoides*), galleta grass (*Pleuraphis jamesii*), and Bigelow sagebrush (*Artemisia bigelovii*). The two most abundant species at the transects are Russian thistle (*Salsola tragus*) and galleta grass.

The R035XB225AZ site is characterized by warm- and cool-season grasses with a scattering of forbs and low-growing shrubs. Species that invade or increase following disturbance are mound saltbush (*Atriplex obovata*), shadscale (*Atriplex confertifolia*), broom snakeweed (*Gutierrezia sarothrae*), Greene's rabbitbrush (*Chrysothamnus greenei*), and various annual forbs. The highest scoring transect in this ecological site contains mostly galleta grass and a smaller amount of alkali sacaton (Sporobolus airoides). Transects with lower scores are dominated by Russian thistle and saltlover (*Halogeton glomeratus*). Forage species like galleta grass and Gardner's saltbush (*Atriplex gardneri*) are present, but not as prevalent.

Table 5-124. Teec Nos Pos 1 Similarity Index

Maximum Similarity Index	Minimum Similarity Index	Median Similarity Index
41.25	1.38	16.54

Table 5-125 contains ground cover information. The percentage of canopy cover is slightly above average in the Teec Nos Pos analysis unit. The percentage of bare ground is below average and erosion is slight at most transects. Soils range from clay to loamy sand, suggesting that the area could experience both wind and water erosion in the future.

Table 5-125. Teec Nos Pos 1 Ground Cover

Canopy (%)	Bare Ground (%)	Basal (%)
12.0	60.0	1.0

The final two tables (Table 5-126 and Table 5-127) show the most frequently occurring species and the species contributing the most biomass, respectively. The perennial forage grass, galleta grass is the most frequently occurring species in this unit and contributes about 20 percent of the total biomass. Aside from alkali sacaton, the remaining species are rarely consumed and some can be injurious or toxic when consumed.

Table 5-126. Teec Nos Pos 1 Frequently Encountered Species

Species		Frequency of Total Transects	Growth Form	Duration	Native (N) or Introduced (I)	Sheep Forage Value
Common Name	Scientific Name					
Galleta grass	*Pleuraphis jamesii*	92%	Graminoid	Perennial	N	Emergency
Russian thistle	*Salsola tragus*	84%	Forb	Annual	I	Emergency[i]
Shadscale	*Atriplex confertifolia*	61%	Shrub	Perennial	N	Not Consumed
Broom snakeweed	*Gutierrezia sarothrae*	58%	Shrub	Perennial	N	Emergency[t]
Saltlover	*Halogeton glomeratus*	39%	Forb	Annual	I	Not Consumed[t]

Notes: [i] = Injurious, [t] = Toxic.

Table 5-127. Teec Nos Pos 1 Composition by Weight

Species		Composition of Total Weight	Growth Form	Duration	Native (N) or Introduced (I)	Sheep Forage Value
Common Name	Scientific Name					
Russian thistle	*Salsola tragus*	58%	Forb	Annual	I	Emergency[i]
Galleta grass	*Pleuraphis jamesii*	21%	Graminoid	Perennial	N	Emergency
Saltlover	*Halogeton glomeratus*	9%	Forb	Annual	I	Not Consumed[t]
Alkali sacaton	*Sporobolus airoides*	3%	Graminoid	Perennial	N	Emergency
Rubber rabbitbrush	*Ericameria nauseosa*	2%	Shrub	Perennial	N	Not Consumed

Notes: [i] = Injurious, [t] = Toxic.

5.20 Teec Nos Pos 2

There are 110 transects in the Teec Nos Pos 2 analysis unit. Table 5-128 presents the total acreage for the unit, total analyzed acreage, number of analyzed ecological sites, and carrying capacity. Adjusted carrying capacity represents the carrying capacity after adjusting for slope and distance to water. This unit has 37 ecological sites; 20 contain transects. The remaining unanalyzed sites make up 8 percent of the total unit area. This unit has the highest initial carrying capacity of any unit in the project area, although the adjusted carrying capacity is slightly higher in the Teec Nos Pos 3 analysis unit.

Table 5-128. Teec Nos Pos 2 Carrying Capacity

Total Acres	Total Analyzed Acres	# of Analyzed Ecological Sites	Initial Carrying Capacity	Adjusted Carrying Capacity
65,996.0	60,914.6	20	721.19	253.80

Note: SUYL = sheep unit year long.

Table 5-129 shows the minimum and maximum stocking rates, and the associated ecological sites. The lowest stocking rate occurs in the Rock Outcrop site, which is not surprising as this site tends to produce only minimal forage. The best stocking rate comes from the R035XC325AZ site, which has a little over 100 pounds per acre of available forage.

Table 5-129. Teec Nos Pos 2 Stocking Rate

Stocking Rate Minimum (Acres/SUYL)	Ecological Site with Minimum Stocking Rate	Stocking Rate Maximum (Acres/SUYL)	Ecological Site with Maximum Stocking Rate
454.02	Rock Outcrop	22.74	R035XC325AZ

Note: SUYL = sheep unit year long.

Table 5-130 displays the ecological sites found within the unit and the number of transects, acreage, available forage, stocking rate, and annual carrying capacity within each ecological site. The majority of the transects in the Teec Nos Pos 2 analysis unit are in the F035XG134NM ecological site. This also is the largest site and has the highest carrying capacity. The second largest site, R035XC329AZ, has the second highest carrying capacity, but is roughly half the size of F035XG134NM and the carrying capacity is about one-third that of F035XG134NM.

Table 5-130. Teec Nos Pos 2 Results by Ecological Site

Ecological Site	# of Transects	Total Acres	Average Available Forage (Pounds)	Stocking Rate (Acres/SUYL)	Initial Annual Carrying Capacity (SUYL)
F035XG134NM	30	15,757.50	30.28	78.27	201.32
F035XH005NM	1	4,557.20	19.27	122.99	37.05
F036XA001NM	8	3,961.30	36.22	65.43	60.54
R035XA101AZ	0	459.70	N/A	N/A	N/A
R035XA113NM	4	2,547.10	41.12	57.64	44.19
R035XA117AZ	2	1,031.00	53.75	44.09	23.38
R035XB021NM	3	2,698.10	30.46	77.81	34.68
R035XB030NM	11	4,782.10	27.63	85.78	55.75
R035XB201AZ	0	14.20	N/A	N/A	N/A
R035XB204AZ	0	13.60	N/A	N/A	N/A
R035XB217AZ	5	2,760.70	9.35	253.48	10.89
R035XB219AZ	1	1,159.40	14.75	160.68	7.22
R035XB222AZ	4	1,247.60	7.47	317.27	3.93
R035XB224AZ	0	10.20	N/A	N/A	N/A
R035XB225AZ	0	33.90	N/A	N/A	N/A
R035XB227AZ	0	572.90	N/A	N/A	N/A
R035XB228AZ	0	381.90	N/A	N/A	N/A
R035XB229AZ	0	285.50	N/A	N/A	N/A
R035XB238AZ	0	70.70	N/A	N/A	N/A
R035XC302AZ	0	75.70	N/A	N/A	N/A
R035XC313AZ	0	105.70	N/A	N/A	N/A
R035XC314AZ	0	87.30	N/A	N/A	N/A
R035XC315AZ	6	2,001.60	18.88	125.53	15.95
R035XC316AZ	2	1,391.70	21.67	109.37	12.73
R035XC317AZ	1	290.00	52.05	45.53	6.37
R035XC324AZ	3	887.60	11.95	198.33	4.48
R035XC325AZ	2	652.60	104.24	22.74	28.70
R035XC326AZ	0	55.10	N/A	N/A	N/A
R035XC327AZ	0	209.40	N/A	N/A	N/A
R035XC328AZ	4	2,310.60	38.50	61.56	37.53
R035XC329AZ	15	6,839.20	22.15	107.00	63.92
R035XC330AZ	1	1,279.80	13.85	171.12	7.48
R035XC335AZ	0	37.90	N/A	N/A	N/A
R035XH813AZ	5	1,611.40	85.54	27.71	58.15
R035XH814AZ	0	2,302.10	N/A	N/A	N/A
Riverwash	0	365.70	N/A	N/A	N/A
Rock Outcrop	2	3,147.90	5.22	454.02	6.93

Table 5-131 shows the maximum, minimum, and median similarity indices. The ecological site with the most consistently high similarity index values is the R035XC329AZ site. The HCPC for this site is dominated by perennial grasses such as needle and thread (*Hesperostipa comata*), New Mexico feathergrass (*Hesperostipa neomexicana*), Indian ricegrass (*Achnatherum hymenoides*), and galleta grass (*Pleuraphis jamesii*). Common shrubs, when present, include big sagebrush (*Artemisia tridentata*) and broom snakeweed (*Gutierrezia sarothrae*). The main species found in the current plant community are Russian thistle (*Salsola tragus*), galleta grass, big sagebrush, and broom snakeweed.

Table 5-131. Teec Nos Pos 2 Similarity Index

Maximum Similarity Index	Minimum Similarity Index	Median Similarity Index
39.21	1.93	18.34

Table 5-132 contains ground cover information. The Teec Nos Pos 2 analysis unit has the highest percentage of canopy cover and lowest percentage of bare ground in the project area. This is due in part to geography. This unit encompasses the southern end of the Carrizo Mountains and benefits from higher amounts of precipitation. Slopes tend to be steeper, which reduces the amount of land available to grazing animals. A few transects show signs of advanced erosion, but most show light to moderate erosion.

Table 5-132. Teec Nos Pos 2 Ground Cover

Canopy (%)	Bare Ground (%)	Basal (%)
20	43	1

The final two tables (Table 5-133 and Table 5-134) show the most frequently occurring species and the species contributing the most biomass, respectively. All species, with the exception of Russian thistle, are native. The largely montane aspect of this analysis unit is reflected by the prevalence of species like banana yucca (*Yucca baccata*), big sagebrush, and black sagebrush (*Artemisia nova*).

Table 5-133. Teec Nos Pos 2 Frequently Encountered Species

Species		Frequency of Total Transects	Growth Form	Duration	Native (N) or Introduced (I)	Sheep Forage Value
Common Name	Scientific Name					
Broom snakeweed	*Gutierrezia sarothrae*	56%	Shrub	Perennial	N	Emergency[t]
Galleta grass	*Pleuraphis jamesii*	55%	Graminoid	Perennial	N	Emergency
Indian ricegrass	*Achnatherum hymenoides*	50%	Graminoid	Perennial	N	Desirable
Russian thistle	*Salsola tragus*	39%	Forb	Annual	I	Emergency[i]
Rose heath	*Chaetopappa ericoides*	28%	Forb	Perennial	N	Not Consumed

Notes: [i] = Injurious, [t] = Toxic.

Table 5-134. Teec Nos Pos 2 Composition by Weight

Species		Composition of Total Weight	Growth Form	Duration	Native (N) or Introduced (I)	Sheep Forage Value
Common Name	Scientific Name					
Russian thistle	*Salsola tragus*	45%	Forb	Annual	I	Emergency[i]
Galleta grass	*Pleuraphis jamesii*	11%	Graminoid	Perennial	N	Emergency
Banana yucca	*Yucca baccata*	5%	Subshrub/Shrub	Perennial	N	Injurious
Black sagebrush	*Artemisia nova*	4%	Shrub	Perennial	N	Desirable
Big sagebrush	*Artemisia tridentata*	4%	Shrub	Perennial	N	Emergency

Note: [i] = Injurious.

5.21 Teec Nos Pos 3

There are 183 transects in the Teec Nos Pos 3 analysis unit. Table 5-135 presents the total acreage for the unit, total analyzed acreage, number of analyzed ecological sites, and carrying capacity. Adjusted carrying capacity represents the carrying capacity after adjusting for slope and distance to water. This unit has 39 ecological sites; 27 contain transects. The remaining unanalyzed sites make up 5 percent of the total unit area. An additional 3 percent of the unit contains areas without any classified ecological sites.

Table 5-135. Teec Nos Pos 3 Carrying Capacity

Total Acres	Total Analyzed Acres	# of Analyzed Ecological Sites	Initial Carrying Capacity	Adjusted Carrying Capacity
128,361.6	117,797.9	20	707.97	268.75

Note: SUYL = sheep unit year long.

Table 5-136 shows the minimum and maximum stocking rates, and the associated ecological sites. Two sites (R035XY012UT and Rock Outcrop) are currently considered non-stockable due to a lack of available forage. The best stocking rate is associated with the moderately sized R035XB030NM site.

Table 5-136. Teec Nos Pos 3 Carrying Capacity

Stocking Rate Minimum (Acres/SUYL)	Ecological Site with Minimum Stocking Rate	Stocking Rate Maximum (Acres/SUYL)	Ecological Site with Maximum Stocking Rate
Not stockable	R035XY012UT and Rock Outcrop	54.75	R035XB030NM

Note: SUYL = sheep unit year long.

Table 5-137 displays the ecological sites found within the unit and the number of transects, acreage, available forage, stocking rate, and annual carrying capacity within each ecological site. The largest site in the Teec Nos Pos 3 analysis unit is Badland. Available forage is low in this site, but due to its large size, it has one of the highest carrying capacities. The highest carrying capacity occurs in the R035XY118UT site; this site also has the most transects and is the second largest site in the unit.

Table 5-137. Teec Nos Pos 3 Results by Ecological Site

Ecological Site	# of Transects	Total Acres	Average Available Forage (Pounds)	Stocking Rate (Acres/SUYL)	Initial Annual Carrying Capacity (SUYL)
Badland	18	27,784.60	3.60	665.73	41.74
F035XG134NM	0	174.00	N/A	N/A	N/A
R035XA101AZ	0	547.00	N/A	N/A	N/A
R035XA117AZ	2	1,815.80	16.60	142.69	12.73
R035XB021NM	6	3,596.50	8.90	265.99	13.52
R035XB022NM	0	7.60	N/A	N/A	N/A
R035XB030NM	14	7,135.30	43.30	54.75	130.32
R035XB035NM	0	190.50	N/A	N/A	N/A
R035XB201AZ	5	1,479.20	12.00	197.99	7.47
R035XB204AZ	1	188.30	8.20	290.09	0.65
R035XB215AZ	0	51.60	N/A	N/A	N/A
R035XB216AZ	2	170.80	4.00	598.48	0.29
R035XB217AZ	14	5,528.10	8.70	273.67	20.20
R035XB219AZ	6	2,702.70	25.10	94.46	28.61
R035XB222AZ	5	2,567.00	16.40	144.69	17.74
R035XB224AZ	0	1,213.70	N/A	N/A	N/A
R035XB225AZ	0	470.90	N/A	N/A	N/A
R035XB227AZ	0	2,768.10	N/A	N/A	N/A
R035XB228AZ	4	1,845.40	11.10	214.09	8.62
R035XB229AZ	2	461.50	15.06	157.37	2.93
R035XB230AZ	0	2.60	N/A	N/A	N/A
R035XB238AZ	1	165.80	16.24	145.94	1.14
R035XB239AZ	1	731.70	6.51	364.06	2.01
R035XC315AZ	6	1,452.70	10.60	223.58	6.50
R035XC316AZ	3	3,268.50	28.90	81.98	39.87
R035XC324AZ	2	462.70	13.70	173.37	2.67
R035XC325AZ	1	165.50	6.60	360.18	0.46
R035XC330AZ	0	3.20	N/A	N/A	N/A
R035XY009UT	5	2,903.40	1.30	1,768.66	1.64
R035XY012UT	4	2,621.10	0	0	0
R035XY015UT	4	2,002.50	6.20	379.81	5.27
R035XY109UT	24	9,399.80	15.35	154.40	60.88
R035XY115UT	8	3,370.20	29.51	80.31	41.96
R035XY118UT	35	27,703.70	19.88	119.22	232.37
R035XY215UT	5	2,119.10	21.38	110.85	19.12
R035XY220UT	4	1,373.00	15.98	148.31	9.26
Riverwash	0	480.40	N/A	N/A	N/A
Rock Outcrop	1	4,783.00	0	0	0
Shallow	0	817.50	N/A	N/A	N/A

Table 5-138 shows the maximum, minimum, and median similarity indices. Most of the highest similarity index values are associated with the R035XY118UT ecological site. This is a grassland/shrubland community with fourwing saltbush (*Atriplex canescens*) being the dominant shrub, and Indian ricegrass (*Achnatherum hymenoides*) and galleta grass (*Pleuraphis jamesii*) the dominant grasses. Grass species will be favored following disturbances like fire or insect herbivory on shrubs. Shrubs increase naturally, but increases will be accelerated following unmanaged grazing. Continued disturbance leads to more areas of bare ground and an increase in broom snakeweed (*Gutierrezia sarothrae*). Eventually, the areas of bare ground will become colonized by annual plants including invasives like cheatgrass (*Bromus tectorum*) and Russian thistle (*Salsola tragus*). The transects with the higher similarity values contain many forage species such as Cutler's jointfir (*Ephedra cutleri*), Indian ricegrass, galleta grass, and sand dropseed (*Sporobolus cryptandrus*). Russian thistle is dominant on transects with lower similarity values. Cheatgrass also is present, but is not especially abundant at this time.

Table 5-138. Teec Nos Pos 3 Similarity Index

Maximum Similarity Index	Minimum Similarity Index	Median Similarity Index
70.39	0.0	15.69

Table 5-139 contains ground cover information. In the Teec Nos Pos 3 analysis unit, the amount of bare ground is average and canopy cover is above average for the project area. Signs of erosion are mostly slight to moderate, but erosion is more advanced at 8 percent of the transects. Most of these transects are located in the breaks leading down to the San Juan River.

Table 5-139. Teec Nos Pos 3 Ground Cover

Canopy (%)	Bare Ground (%)	Basal (%)
16.0	69.0	1.0

The final two tables (Table 5-140 and Table 5-141) show the most frequently occurring species and the species contributing the most biomass, respectively. The Teec Nos Pos 3 unit is comprised largely of moderately deteriorated desert grassland. Forage species such as Indian ricegrass, galleta grass, and sand dropseed are abundant; however, the non-native Russian thistle is well-established and shrubs like broom snakeweed and rubber rabbitbrush (*Ericameria nauseosa*) have increased.

Table 5-140. Teec Nos Pos 3 Frequently Encountered Species

Species		Frequency of Total Transects	Growth Form	Duration	Native (N) or Introduced (I)	Sheep Forage Value
Common Name	Scientific Name					
Russian thistle	*Salsola tragus*	89%	Forb	Annual	I	Emergency[i]
Galleta grass	*Pleuraphis jamesii*	77%	Graminoid	Perennial	N	Emergency
Indian ricegrass	*Achnatherum hymenoides*	75%	Graminoid	Perennial	N	Desirable
Broom snakeweed	*Gutierrezia sarothrae*	47%	Shrub	Perennial	N	Emergency[t]
Sand dropseed	*Sporobolus cryptandrus*	44%	Graminoid	Perennial	N	Not Consumed

Notes: [i] = Injurious, [t] = Toxic.

Table 5-141. Teec Nos Pos 3 Composition by Weight

Species		Composition of Total Weight	Growth Form	Duration	Native (N) or Introduced (I)	Sheep Forage Value
Common Name	Scientific Name					
Russian thistle	*Salsola tragus*	81%	Forb	Annual	I	Emergency[i]
Galleta grass	*Pleuraphis jamesii*	4%	Graminoid	Perennial	N	Emergency
Indian ricegrass	*Achnatherum hymenoides*	2%	Graminoid	Perennial	N	Desirable
Cutler's jointfir	*Ephedra cutleri*	2%	Shrub	Perennial	N	Desirable
Rubber rabbitbrush	*Ericameria nauseosa*	2%	Shrub	Perennial	N	Not Consumed

Notes: [i] = Injurious

6. Conclusions and Recommendations

The project area encompasses portions of Land Management Districts 9 and 12. This area is roughly divided into three different geographic regions. The majority of the Shiprock Chapter consists of flat, salt-desert shrub/grasslands interspersed with large variously sized washes. The Beclabito Chapter occupies the foothills of the Carrizo Mountains and gradually slopes away to the benches found on either side of the San Juan River. The Teec Nos Pos Chapter has a similar landscape, but takes in more of the upper, mountain slopes, and the desert grasslands extending out to the west. Patterns of forage production are consistent with these geographic locations.

The Shiprock analysis units and RMUs, located in the Shiprock Chapter, have the lowest production yields in the project area. Soils tend to have high amounts of sodium and high salinity, and moisture is often extremely limiting. Even without disturbance, production in this area is low. Drought and continuous grazing have led to a decrease in native, perennial species. This has paved the way for dramatic increases in annual, invasive species.

The western portion of the Beclabito Chapter is situated above the flatlands around Shiprock and benefits from higher amounts of precipitation. Soils also are more conducive to plant growth as compared to the salty, clay soils associated with the Mancos Shale formations found at lower elevations. As a result, species diversity and forage production tend to be higher than encountered in the Shiprock Chapter. The eastern half of the Beclabito Chapter is less productive, sits at a lower elevation, and contains numerous non-native annuals such as cheatgrass (*Bromus tectorum*), Russian thistle (*Salsola tragus*), and saltlover (*Halogeton glomeratus*).

Available forage is highest in the Teec Nos Pos Chapter. Transects located within the upper reaches of the Carrizo Mountains encountered numerous desirable shrub species such as Utah serviceberry (*Amelanchier utahensis*), Mormon tea (*Ephedra viridis*), and Stansbury cliffrose (*Purshia stansburiana*). Beneficial, higher-elevation graminoids such as muttongrass (*Poa fendleriana*) and several species of sedge (*Carex* spp.) also are abundant. Lower-elevation sites are occupied by non-desirable species, but perennial forage species tend to have a stronger, overall presence than in the other two chapters.

The following sections provide some recommendations pertaining to fencing, seasonal grazing, forage availability, distribution of water sources, increasing water retention, and monitoring.

6.1 Drought

Precipitation is one of the greatest obstacles to overcome when managing and restoring rangeland, especially in the drought-prone southwest. Therefore, it is extremely important to maintain healthy plant communities, not only for forage purposes, but to reduce soil exposure and loss. To complicate matters, moisture arriving during the monsoon season often is in the form of severe thunderstorms that can produce several inches of rain at one time. As the percentage of bare ground is fairly high in much of the project area, many areas are at risk of accelerated water erosion during this type of storm event. Water retention also is limited in areas lacking vegetation and litter accumulation. Wind erosion is problematic during times of low precipitation as well, particularly in areas of loose sand found near the San Juan River. Sandy soils require a lot of plant cover to become stable and it may be necessary to initially encourage growth of less palatable species. Grasses such as sandhill muhly (*Muhlenbergia pungens*) and galleta grass (*Pleuraphis jamesii*) are excellent cover plants that do well in loose soils.

It also is very important to collect accurate precipitation data. Calculations for annual production (and resulting stocking rates) incorporate average precipitation for a given water year. Location-specific precipitation gauges allow managers to more closely monitor precipitation, giving them the opportunity to proactively implement drought management plans. Plants demonstrate rapid growth during a certain portion of the growing season; cool-season plants tend to experience this between March and the beginning of June, with a smaller growth surge in the fall, while warm-season plants grow more quickly during mid-summer. These are critical time periods for forage species and a lack of adequate moisture will compromise growth for the duration of the growing season. Moisture that arrives outside of these windows of rapid growth will help plants, but will be much less effective. Semiarid regions generally are considered to be experiencing drought conditions when the cumulative growing season precipitation is 20 to 25 percent below average during these periods of rapid growth (National Drought Mitigation Center 2013). Closely monitoring precipitation would alert managers to impending drought toward the beginning of the growing season and allow for drought mitigation plans to be put into place in a more timely fashion. This is particularly important for the lower-elevation sites in Land Management Districts 9 and 12 as the majority of forage plants are warm-season grasses like galleta grass and alkali sacaton (*Sporobolus airoides*). Monsoonal moisture arriving in mid to late July corresponds well with the period of rapid growth for these grasses. However, in years where the monsoons are delayed or largely absent, it will be necessary to adjust the grazing plan. Ultimately, it is up to the individual livestock owner to gain the most thorough knowledge possible of the area being grazed. The best way to mitigate the effects of drought is to keep or restore rangeland to a good condition with a healthy diversity of plants species.

6.2 Soil and Grazing Management

Soils are an extremely important component of rangeland ecosystems. Well-developed soils retain water and provide the substrate and nutrients necessary to produce vibrant plant communities. In areas with large patches of bare ground and/or active erosion, the best way to recover forage production is to build up the soils so they are capable of supporting viable plant populations. Rebuilding soils requires a combination of erosion control, revegetation, and periodic disturbance of the soil surface. Deeply eroded gullies and arroyos are the most difficult and cost-prohibitive features to restore. In their immature form, the sides of channels usually are very steep or even vertical, which makes it difficult for stabilizing vegetation to establish. An effective technique for decreasing slope gradient is to use earthmoving equipment to reshape or terrace the banks, thus creating substrates suitable for plant colonization. This method is particularly effective in arid regions, where work can be completed prior to seasonal flows (Valentin et al. 2005). Unfortunately, the cost and logistics involved with getting equipment into more remote locations can make this option prohibitive. Another alternative is to focus efforts upstream from deeply eroded channels. In areas where channels are just beginning to develop and the rate and volume of surface runoff is lower, effective countermeasures to erosion include simple hand-constructed rock check dams. In addition to capturing soil and preventing further loss, check dams redistribute water, especially during the monsoon season. Spreading runoff across the landscape and retaining water for longer periods leads to more plant growth and cover, which increases infiltration and soil moisture (Nichols et al. 2012). Seeding programs that utilize fast-growing, native pioneer species tend to produce better and quicker results when working to stabilize channel walls (Valentin et al. 2005). Water erosion is a potential problem for most of the project area, especially in regions containing moderate to steep slopes and high clay content in the soils.

Revegetation may require reseeding programs, particularly in areas experiencing channelization and in sandy regions with active dunes; however, elements of the native plant community are still present within portions of the project area. Especially visible are perennial grass species such as Indian ricegrass (*Achnatherum hymenoides*), galleta grass, and dropseed species (*Sporobolus* spp.). Important forb and shrub species such as globemallow (*Sphaeralcea* spp.), saltbush (*Atriplex* spp.), and Stansbury cliffrose also are abundant. This indicates that with careful and proactive management, native species production and frequency should increase naturally without much intervention. In areas that are more deteriorated, seeding with local, drought-tolerant species that can germinate early, such as scarlet globemallow (*Sphaeralcea coccinea*) and sand dropseed (*Sporobolus cryptandrus*), may speed up revegetation and increase the likelihood of success. The toughest areas to restore will be the low, dry, salty areas found in the Beclabito and Shiprock chapters. Winterfat (*Krascheninnikovia lanata*) is one species that tends to do well in these areas. It is adapted to alkaline soils, is drought tolerant, helps control erosion, and provides excellent forage for livestock and wildlife (Uncompahgre Plateau Project 2007). It is important to use fresh seed as viability is quickly lost. Planting in the winter or early spring tends to produce the best stands (Ogle et al. 2012).

Higher-elevation areas with dense shrubs may require thinning to release the native herbaceous component. Although shrub production is high throughout the study area, shrub populations are not always dense. The lack of native herbaceous diversity is due, in large part, to unmanaged continuous grazing systems. Determining forage production based upon a normal precipitation year allows managers to establish a “ceiling” or carrying capacity for their land. These determinations 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; however, this situation can be partially mitigated by allowing managers to reduce and increase 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. Expected precipitation generally falls during late summer and through the winter. If precipitation is low during the winter, then spring and early summer production also are expected to be be low and livestock numbers should be adjusted accordingly.

The final part of rebuilding soil is to make sure it undergoes periodic disturbance. This is where livestock play a very important role. The trampling effect of livestock works to incorporate manure and litter into the soil, which increases aeration and organic matter content. Hoof indentations also create microsites that encourage seedling growth and moisture retention; however, controlling the timing and duration of grazing is key to reaping these benefits. Many of the ecological site descriptions available for the project area recommend deferring grazing from late winter through early spring. This practice alone would help increase available forage. Other areas are better suited for winter/spring grazing and can be utilized to provide forage while less suitable areas are rested. Data collected from this survey can help identify these areas. A critical part of grazing management is allowing the forage to grow before being grazed and allowing it to recoup following grazing. Fences greatly facilitate the process of pasture deferment, rest, and rotation. They also are valuable tools for excluding stray livestock, especially horses. NRCS programs such as the Environmental Quality Incentives Program can aid in providing the technical and financial support needed for this to occur.

6.3 Shrub Composition

Shrubs play a valuable role in maintaining healthy, functioning rangelands, but the ratio of shrubs to forb and grass species is higher than it should be in parts of the study area. The RMUs, Shiprock analysis units, and lower-elevation portions of the Beclabito analysis units often are dominated by saltbush species. Mid-range elevations present in the Teec Nos Pos Chapter and regions of the Beclabito Chapter have large populations of big sagebrush (*Artemisia tridentata*), broom snakeweed (*Gutierrezia sarothrae*), and Greene's rabbitbrush (*Chrysothamnus greenei*). Saltbush species are concentrated in the lower, salt-desert shrublands that spread out from the community of Shiprock, New Mexico. This ecosystem is fragile and does not respond well to disturbance. Vegetation is limited in the best of conditions, and using control measures to reduce shrub species is not recommended. A better route is to employ proper grazing management to encourage the re-establishment of native forbs and grasses. As the herbaceous component begins to flourish, woody species will cease to dominate and a more balanced plant community will develop.

This approach also should be considered for other shrub ecosystems in the project area; however, in some cases, it may be necessary to reduce shrub populations either by mechanical or chemical means. A number of mechanical methods have been used to control shrubs on rangelands including roller chopping, root plowing, shredding, chaining, and bulldozing. These practices require relatively gentle terrain and the cost of operating the equipment can be expensive, which limits their practicality in the study area. There also is the danger of encouraging the spread of invasive species by removing large swaths of vegetation at one time (DiTomaso 2000). However, it should be noted that the BIA is currently developing an integrated weed management plan for the entire Navajo Indian Reservation.

Chemical control is less expensive than mechanical methods and can be more effective at thinning brush stands rather than eradicating them entirely. This is generally the more desirable route to take, as it leaves cover and browse for livestock and wildlife. Soil exposure also is much reduced, which decreases opportunities for exotic plants to invade the study area (Olsen et al. 1994; DiTomaso 2000). The use of the herbicide tebuthiuron (Spike®, Scrubmaster®, Perflan®), which inhibits photosynthetic activity, has been quite successful in thinning dense stands of big sagebrush. Low rates of this chemical effectively thin the stand, while still leaving adequate cover and browse for wildlife. Application rates ranging from

0.3 to 0.5 pound of active ingredient per acre have proven to be both cost effective and suitable for creating a mix of shrubs, grasses, and forbs (Hooley 1991; Olsen et al. 1994). Tebuthiuron and Picloram (Tordon®, Grazon®) have proven effective in controlling broom snakeweed, as well. However, most studies have found that at least 90 percent of the plants need to be killed to see significant increases in perennial forage species (Schmutz and Little 1970; Gesink et al. 1973; Sosebee et al. 1979; McDaniel and Duncan 1987). Greene's rabbitbrush is a common shrub species associated with broom snakeweed and big sagebrush. Aerial applications of Picloram often are successfully used to control this shrub and mixing Picloram with 2,4-dichlorophenoxyacetic acid (2,4-D) can effectively reduce brush stands containing both Greene's rabbitbrush and big sagebrush (Cook et al. 1965; Tueller and Evans 1969; Evans and Young 1978). Prior to implementing shrub control measures, consultation with experts is recommended to determine the best rates and timing for herbicide applications, minimize impacts to non-target plant and wildlife species, and explore alternate control methods.

6.4 Invasive Species

There are two invasive species that are particularly abundant in the project area: Russian thistle and saltlover.

Russian thistle

Russian thistle is the most widespread invasive species in the project area, occurring in all areas except for the mountainous region. This is a drought-tolerant, disturbance-loving species that does well in sandy soils (Whitson et al. 2002). Although this plant is an invasive species, it does provide forage for sheep and cattle in its immature form and when softened by snow or rain (USDA USFS 1937). Consumption of large quantities of this plant has been known to cause diarrhea, especially in lambs, which can compromise the heath of animals already in a weakened condition (Cook et al. 1954). This can be an issue in areas where little else is growing and consumption is likely to be high.

Russian thistle also can accelerate revegetation of disturbed areas by supporting the growth of soil mycorrhiza. Soil mycorrhizae are fungi that form associations with many native plant species. The fungi help the plants absorb more water and nutrients and, in return, receive carbohydrates from the plant roots. Certain mycorrhiza invade the roots of Russian thistle and do not form an association with this plant, but rather kill the infected roots and then move on to the roots of neighboring plants. In this manner, the fungi population increases while Russian thistle populations begin to die (Allen and Allen 1988; Allen et al. 1989). The dead plants provide cover for seedlings of other species that are capable of forming associations with the newly established mycorrhiza colonies (Allen and Allen 1988; Grilz et al. 1988). Typically, Russian thistle will persist on a site for about 2 years and then will be replaced by annual and biennial mustards like tall tumblemustard (*Sisymbrium altissimum*) and various species of tansymustard (*Descurainia* spp.) (Chapman et al. 1969). Tansymustard is common across much of the project area, especially where populations of Russian thistle frequently occur. The mustard species continue to build up the soil substrate by maintaining soil mycorrhiza populations and adding organic matter to the soil as the plants die.

Russian thistle also helps prepare a site by releasing oxalates into the soil. These chemicals work to change inorganic phosphorous into a soluble form that can be taken up by plants (Cannon et al. 1995). Phosphorus often is a limiting nutrient in the soil and by increasing its availability, favorable forage plants can become established more quickly. Russian thistle can be controlled or even eradicated through various mechanical and chemical treatments (Young and Whitesides 1987; Burrill et al. 1989); however, this process is time consuming and expensive. Given the potential benefits of the plant, it is generally better to leave it and focus on encouraging the establishment of desirable, perennial species through proper grazing management and seeding treatments.

Saltlover

Saltlover is summer annual that readily invades saline soils when disturbances remove the pre-existing vegetation. Once established, it can quickly spread and out-compete other species due to its ability to germinate early in the spring, produce large quantities of long-lived seed, resist predation, and withstand harsh conditions (Duda et al. 2003). There also is evidence that this species alters the soil chemistry around individual plants by increasing soil pH, electrical conductivity, and soluble sodium content. This alteration makes it difficult for native species to become re-established even if saltlover plants are removed (Eckert and Kinsinger 1960; Lancaster et al. 1987; Duda et al. 2003).

A second concern is that saltlover is highly toxic to livestock, especially sheep. Sodium oxalate, the lethal component of this species, is sequestered in the leaves and stems and the highest levels are achieved during the fall, winter, and spring when the plant reaches maturity. This also is the time frame when this plant is more likely to be consumed, since desirable forage plants are typically scarce or too dry to be palatable (Whitson et al. 2002; USDA Agricultural Research Service 2006).

Saltlover control is difficult. Seeds, which are abundant, can remain viable in the soil for up to 10 years, requiring annual applications of herbicide for many years to effectively deplete seed reserves (West 1983). In addition to being expensive, this approach is not particularly agreeable as the main herbicide that has proven to be effective is 2,4-D. This chemical, when applied at the rates necessary to control saltlover, also will have a negative impact on native species (Cook and Stoddart 1953). The best approach is to establish alternate species that can grow in saline conditions and compete with saltlover. Two species in particular have successfully become established in saltlover invaded sites: forage kochia (*Bassia prostrata*) and desert wheatgrass (*Agropyron desertorum*) (Asay and Johnson 1987; McArthur et al. 1990; Stevens and McArthur 1990). Reducing or excluding grazing pressure during the late winter/early spring is important as well to allow desirable species the opportunity to grow and develop prior to consumption. Establishing a diverse, perennial plant community that undergoes light to moderate grazing towards the end of the growing season appears to be the best strategy to prevent saltlover invasions (Keller 1979; West 1983; Blaisdell and Holmgren 1984; Whisenant and Wagstaff 1991).

6.5 Data Analysis and Monitoring

Data analysis revealed several patterns including areas with large populations of invasive species, areas lacking in ground cover, and other sites that are maintaining good populations of key forage species such as Indian ricegrass, galleta grass, alkali sacaton, muttongrass, and black sagebrush (*Artemisia nova*). The next step is to use this data to identify specific locations that would benefit most from improvement measures and then organize field visits to gain an "on-the-ground" perspective. Groups of transects that yielded low production and high counts of bare ground may be in severely eroded areas and great effort would be necessary to improve these sites. On the other hand, these groups of transects may just have a high potential for erosion and simple improvements could greatly enhance the soil and plant community. Using the data to pinpoint areas with the highest densities of shrubs would serve as a starting point for assessing whether chemical control measures are necessary. In some cases, it may be better to focus on grazing strategies and let natural succession run its course. Identifying places with high forage production can be helpful for implementing rotational grazing schemes. These areas would be able to withstand higher grazing pressures, while more fragile locations are being rested. Visits to these areas would allow managers to determine the feasibility of adding water sources if none are present. If data from certain transects show that native forage species are not present, it may be necessary to implement reseeding programs. Agriculture extension offices and the NRCS are good resources to help determine appropriate seed mixes and find seed sources.

Grazing programs should make use of available tools. When it is possible to erect fences, they should be designed to ease movement and exclusion of livestock, as dictated by the condition of the vegetation. Designating pastures where fences already exist, such as the highway fences that bisect grazing units, also would be useful for monitoring forage in those pastures. Currently, the forage on one of side the highway is applied to the carrying capacity on both sides of the highway. Separating the grazing units into pastures would allow for more site-specific data collection and monitoring, as well as livestock management. In keeping with this, water sources and salt blocks can be situated to move animals out of areas or to encourage them to use underutilized locations. In addition, the initial stocking rates and carrying capacities provided in this report should be used as a guide to be adjusted appropriately with consideration of forage value, seasonal palatability of forage, and variability of precipitation. For example, a conservative initial stocking rate is appropriate under drought conditions. If there is very little precipitation during the winter and early spring, stock numbers should not be permitted at the rate of a normal year production. The same is true when an area endures several years of precipitation below normal levels. However, placement of the previously discussed check dams and other water catchment systems such as ponding dikes can greatly offset the negative impacts associated with drought and lessen the need to cut livestock numbers.

After restoration efforts have begun, it is important to establish monitoring programs. Now that the initial baseline data have been collected, it is not necessary to sample vegetation at each transect. Instead, a smaller number of permanent transects and photo-monitoring points can be set up at locations targeted for restoration and in representative areas for each ecological site. In addition to monitoring species composition and production, it also would be valuable to assess soil stability and hydrologic function. Numerous references can be utilized to develop monitoring programs and help interpret the results, such as the *Monitoring Manual for Grassland, Shrubland, and Savanna Ecosystems* published by the Arid Lands Research Program (Herrick et al. 2005) and the Bureau of Land Management's Technical Reference 1734-6: Interpreting Indicators of Rangeland Health (Pellant et al. 2005).

7. References and Literature Cited

Allen, E. B. and M. F. Allen. 1988. Facilitation of succession by the nonmycotrophic colonizer *Salsola kali* (Chenopdiaceae) on a harsh site: effects of mycorrhizal fungi. Amer. Jour. of Botany. 75(2): 257-266.

Allen, M. F., E. B. Allen, and C. F. Friese. 1989. Responses of the non-mycotrophic plant *Salsola kali* to invasion by vesicular-arbuscular mycorrhizal fungi. New Phytologist. 111(1): 45-49.

Asay, K. H. and D. A. Johnson. 1987. Breeding for improved seedling establishment in cool-season range grasses. *In*: Frasier, G. W., R. A. Evans, eds. Proceedings of symposium: Seed and seedbed ecology of rangeland plants; 1987 April 21-23; Tucson, Arizona. Washington, DC: United States Department of Agriculture, Agriculture Research Service: 173-176.

Belnap, J., J. H. Kaltenecker, R. Rosentreter, J. Williams, S. Leonard, and D. Eldridge. 2001. Biological Soil Crusts: Ecology and Management. Interagency Technical Reference 1730-2. Bureau of Land Management. Denver, Colorado.

Blaisdell, J. P. and R. C. Holmgren. 1984. Managing Intermountain rangelands – salt-desert shrub ranges. Gen. Tech. Rep. INT-163. Ogden, Utah: United States Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station. 52 p.

Bonham, C. D. 1989. Measurements for Terrestrial Vegetation. New York, New York: John Wiley & Sons. *In* Elzinga, C. L., D. W. Salzer and J. W. Willoughby. 1998. Measuring and Monitoring Plant Populations. Interagency Technical Reference 1730-1. Bureau of Land Management. Denver, Colorado.

Burrill, L. C., W. S. Braunworth, Jr., and R. D. William (compilers). 1989. Pacific Northwest weed control handbook. Oregon State University, Extension Service, Agricultural Communications. Corvallis, Oregon. 276 p.

Cannon, J. P., E. B. Allen, M. F. Allen, L. M. Dudley, and I. J. Jirimack. 1995. The effects of oxalates produced by *Salsola tragus* on the phosphorus nutrition of *Stipa pulchra*. Oecologia. 102: 265-272.

Chapman, J. A., C. J. Henny, and H. M. Wight. 1969. The status, population dynamics, and harvest of the dusky Canada goose. Wildlife Mono. No 18. The Wildlife Soc. Washington, DC. 48 p.

Chiaretti, J. V., Jr. 2001. Soil survey of Shiprock area, parts of San Juan County, New Mexico and Apache County, Arizona. United States Department of Agriculture, Natural Resources Conservation Service, in cooperation with United States Department of the Interior, Bureau of Indian Affairs, the Navajo Nation, the Shiprock Soil and Water Conservation District, and the New Mexico and Arizona Agricultural Experiment Stations.

Cook, C. W. and L. A. Stoddart. 1953. The halogeton problem in Utah. Bulletin 364. Logan, Utah: Utah State Agricultural College, Agricultural Experiment Station. 44 p. In cooperation with United States Department of the Interior, Bureau of Land Management.

Cook, C. W., L. A. Stoddart, and L. E. Lorin. 1954. The nutritive value of winter range plants in the Great Basin as determined with digestion trials with sheep. Bulletin 372. Utah State University, Agricultural Experiment Station. 56 p.

Cook, C. W., P. D. Leonard, and C. D. Bonham. 1965. Rabbitbrush competition and control on Utah rangelands. Bulletin 454. Agricultural Experiment Station, Utah State University. Logan, Utah. 28 p.

Coulloudon, B., K. Eshelman, J. Gianola, N. Habich, L. Hughes, C. Johnson, M. Pellant, P. Podborny, A. Rasmussen, B. Robles, P. Shaver, J. Spehar, and J. Willoughby. 1999. Sampling vegetation attributes. Bureau of Land Management Technical Reference 1734-4. Bureau of Land Management National Applied Resource Sciences Center Web site, http://www.blm.gov/nstc/library/pdf/samplveg.pdf.

DiTomaso, J. M. 2000. Invasive weeds in rangelands: species, impacts, and management. Weed Science. 48:255-265.

Duda, J. J., C. D. Freeman, J. M. Emlen, J. Belnap, S. G. Kitchen, J. C. Zak, E. Sobek, M. Tracy, and J. Montante. 2003. Differences in native soil ecology associated with invasion of the exotic annual chenopod, *Halogeton glomeratus*. Biol. Fertil. Soils. 38:72-77.

Eckert, R. E. and F. E. Kinsinger. 1960. Effects of *Halogeton glomeratus* leachate on chemical and physical characteristics of soils. Ecology. 41:764-772.

Elzinga, C. L., D. W. Salzer and J. W. Willoughby. 1998. Measuring and Monitoring Plant Populations. Interagency Technical Reference 1730-1. Bureau of Land Management. Denver, Colorado.

Evans, R. A. and J. A. Young. 1978. Effectiveness of rehabilitation practices following wildfire in a degraded big sagebrush-downy brome community. Journal of Range Mgmt. 31(3): 185-188.

Gesink, H. P., H. P. Alley, and G. A. Lee. 1973. Vegetative response to chemical control of broom snakeweed on a blue grama range. Journal of Range Mgmt. 26(2): 139-143.

Goodman, J. M. 1982. The Navajo Atlas: Environments, Resources, People and History of the Dine Bikeyah. University of Oklahoma Press. Norman, Oklahoma.

Grilz, P., L. Delanoy, and G. Grismer. 1988. Site preparation, seeding, nurse crop methods tested in dune restoration (Saskatchewan). Restoration and Mgmt. Notes. 6(1): 47-48.

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

Heitschmidt, R. and J. Stuth (eds.). 1991. Grazing Management – An Ecological Perspective. Timber Press. Oregon.

Herrick, J. E., J. W. Van Zee, K. M. Havstad, L. M. Burkett and W. G. Whitford. 2005. Monitoring Manual for Grassland, Shrubland and Savanna Ecosystems, Volume I: Quick Start. USDA-ARS Jornada Experimental Range, Las Cruces, New Mexico.

Holecheck, J. L., H. Gomez, F. Molinar, and D. Galt. 1999. Grazing Studies: What We've Learned. Rangelands 21(2): 12-16.

Hooley, C. 1991. Pronghorn antelope use of tebuthiuron treated areas in northwestern New Mexico. Paper presentation, 15th Biennial Pronghorn Antelope Workshop, Rock Springs, Wyoming.

Keller, W. 1979. Species and methods for seeding in the sagebrush ecosystem. *In* The sagebrush ecosystem: a symposium: Proceedings; 1978 April; Logan, Utah. Utah State University, College of Natural Resources: 129-163.

Lancaster, D. L., J. A. Young, and R. A. Evans. 1987. Weed and brush control tactics in the sagebrush ecosystem. *In* Onsager, J. A., ed. Integrated pest management on rangeland: state of the art in the sagebrush ecosystem. ARS-50. United States Department of Agriculture, Agricultural Research Service. 11-14.

McArthur, D. E., C. A. Blauer, and R. Stevens. 1990. Forage kochia competition with cheatgrass in central Utah. *In*: McArthur, D. E., E. M. Romney, S. D. Smith, and P. T. Tueller, complires. Proceedings ; symposium on cheatgrass invasion, shrub die-off, and other aspects of shrub biology and management; 1989 April 5-7, Las Vegas, Nevada. Gen. Tech. Rep. INT-276. Odgen, Utah: United States Department of Agriculture, Forest Service, Intermountain Research Station: 56-65.

McDaniel, K. C. and K. W. Duncan. 1987. Broom snakeweed (*Gutierrezia sarothrae*) control with picloram and metsulfuron. Weed Science. 35(6): 837-841.

National Drought Mitigation Center. 2013. Available at http://drought.unl.edu/ranchplan/DroughtBasics/KnowingWhenYoureinDrought.aspx. Lincoln, Nebraska.

Nichols, M. H., K. McReynolds, and C. Reed. 2012. Short-term soil moisture response to low-tech erosion Control structures in a semiarid rangeland. Catena. 98: 104-109.

Nielson, W. and A. J. Erickson. 1980. Soil suvey of Navajo Indian Reservation San Juan County, Utah. United States Department of Agriculture, Soil Conservation Service, and United States Department of the Interior, Bureau of Indian Affairs, in cooperation with the Utah Agricultural Experiment Station.

Ogle, D. G., L. St. John, L. Holzworth, S. R. Winslow, and D. Tilley. 2012. Plant Guide for winterfat (*Krascheninnikovia lanata*). United States Department of Agriculture-Natural Resources Conservation Services, Aberdeen, Idaho Plant Materials Center. 83210-0296.

Olsen, R., J. Hansen, T. Whitson, and K. Johnson. 1994. Tebuthiuron to enhance rangeland diversity. Rangelands. 16(5): 197-201.

Pellant, M., P. Shaver, D. A. Pyke, and J. E. Herrick. 2005. Interpreting indicators of rangeland health, version 4. Technical Reference 1734-6. United States Department of the Interior, Bureau of Land Management, National Science and Technology Center, Denver, Colorado. BLM/WO/ST-00/001+1734/REV05. 122 p.

Schmutz, E. M. and D. E. Little. 1970. Effects of 2,4,5-T and picloram on broom snakeweed in Arizona. Journal of Range Mgmt. 23(5): 354-357.

Sosebee, R. E., W. E. Boyd, and C. S. Brumley. 1979. Broom snakeweed control with tebuthiuron. Journal of Range Mgmt. 32(3): 179-182.

Stevens, R. and D. E. McArthur. 1990. 'Imigrant' forage kochia competition with Halogeton following various seeding techniques. *In* McArthur, D. E., E. M. Romney, S. D. Smith, and P. T. Tueller, compilers. Proceedings; symposium on cheatgrass invasion, shrub die-off, and other aspects of shrub biology and management; 1989 April 5-7, Las Vegas, Nevada. Gen. Tech. Rep. INT-276. Odgen, Utah: United States Department of Agriculture, Forest Service, Intermountain Research Station: 175-180.

Tueller, P. T. and R. A. Evans. 1969. Control of green rabbitbrush and big sagebrush with 2,4-D and picloram. Weed Science. 17:233-235.

Uncompahgre Plateau Project (UP Project). 2007. UP Native Plant Program FY2007 Progress Report. (available from http://www.upproject.org/publications/pdfs/npreport_app7.pdf). Accessed 30 January 2014.

United States Department of Agriculture, United States Forest Service (USDA USFS). 1937. Range Plant Handbook. United States Government Printing Office, Washington, DC.

United States Department of Agriculture, Agricultural Research Service. 2006. Poisonous plants, Halogeton (*Halogeton glomeratus*). (available from http://www.ars.usda.gov/Services/docs.htm?docid=9937). Accessed 30 January 2014.

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

United States Department of Agriculture, Natural Resources Conservation Services (USDA NRCS). 2013. Plants databases. Available at http://plants.usda.gov/.

United States Department of Interior. 2012. Code of Federal Regulations, Part 167 – Navajo Grazing Regulations. Available at http://cfr.regstoday.com.

United States Department of Interior, Bureau of Indian Affairs (USDOI BIA). 2012. Range Management Handbook (Draft 3-28-2012).

Utah State University Cooperative Extension. 2013. Range Plants of Utah. Accessed online on 11 April 2013 at: http://extension.usu.edu/rangeplants/htm/sandhill-muhly.

Valentin, C., J. Poesen, and Y. Li. 2005. Gully erosion: impacts, factors and control. Catena. 63(2-3): 132-153.

West, N. E. 1983. Intermountain salt-desert shrubland. *In* Neil, E., ed. Temperate deserts and semi-deserts. Amsterdam; Oxford; New York. Elsevier Scientific Publishing Company. 1983: 375-397.

Whisenant, S. G. and F. J. Wagstaff. 1991. Successional trajectories of a grazed salt desert shrubland. Vegetatio. 94(2):133-140.

Whitson, T. D., L. C. Burrill, S. A. Dewey, D. W. Cudney, B. E. Nelson, R. D. Lee, and R. Parker. 2002. Weeds of the West, 9th Edition. Western Soc. of Weed Science, Newark, California.

Young, F. L. and R. E. Whitesides. 1987. Efficacy of postharvest herbicides on Russian thistle (*Salsola iberica*) control and seed germination. Weed Science. 35: 554-559.