Land Management District 2

2013 Vegetation Inventory

Inscription House, Navajo Mountain, Shonto Communities, Arizona

Prepared for:

Bureau of Indian Affairs
Western Navajo Agency
Branch of Natural Resources

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ACRONYMS AND ABBREVIATIONS

%ADW	percent air-dry weight
ADW	air-dry weight
AUM	animal unit months
BIA	Bureau of Indian Affairs
Ecosphere	Ecosphere Environmental Services
ESD	Ecological site description
ft²	square foot
G	grams
GIS	geographic information systems
GPS	Global Positioning System
HCPC	historic climax plant community
lbs	pounds
MLRA	Major Land Resource Area
NNDOA	Navajo Nation Department of Agriculture
NNDWR	Navajo Nation Division of Water Resources
NRCS	Natural Resource 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

ABSTRACT

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The Bureau of Indian Affairs contracted Ecosphere Environmental Services to collect and compile vegetation data on portions of Land Management District 2, of the Western Navajo Agency. Data were collected from 555 transects in 48 grazing compartments. Data collection occurred during October of 2013, and April and May of 2014. Measurements were taken for biomass production, ground cover, and species composition. The data were analyzed to determine annual production, species frequency, and condition class of the range resource and initial stocking rates for each management area. The results include the carrying capacity of the range resource, as well as the similarity to the historic climax plant community.

Data were analyzed by United States Department of Agriculture Natural Resource Conservation Service named ecological sites within each grazing compartment. Carrying capacities and recommended stocking rates were calculated by grazing community using available forage. Carrying capacity for each compartment was adjusted to account for steep, inaccessible slopes.

Results indicate that the range resource in Land Management District 2 is mostly in a moderate state of deterioration with shrubs species being substantially increased in most compartments. Invasive annual forbs and grasses are also common in many areas of Land Management District 2. However, native forage species are still part of the plant community overall, suggesting that many areas would likely recover following grazing management, range improvement efforts, and adequate moisture.

INTRODUCTION

1. INTRODUCTION

The Bureau of Indian Affairs (BIA) contracted Ecosphere Environmental Services (Ecosphere) to conduct understory rangeland vegetation inventories on a portion of Land Management District 2, Units 1, 2 and 3 of the Western Navajo Agency. Species-specific vegetation data measurements included biomass production and cover. These data were also used to calculate annual production, species frequency, and carrying capacity. 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

Baseline range condition data are critical to establishing quality range management practices. The purpose of this inventory is to provide baseline information about the existing range resource so land managers and permittees are enabled to improve and/or maintain the condition of this resource.

The results of this inventory will enable recommendations for adjusted stocking rates in Land Management District 2, as well as development of more comprehensive range management plans.

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 Branch of Natural Resources in accordance with the Navajo Grazing Regulations (25 CFR §167). This BIA Branch also maintains master livestock grazing records and issues grazing permits. All three parties (BIA, NNDOA, and Grazing Committees) coordinate their activities in an effort to utilize and manage the range resources.

1.2.1 BIA Agency Natural Resources

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 the resources on the land, including the land itself, on behalf of the Indian landowners. Protection and preservation includes conservation, highest and best use, and protection against misuse of the property for illegal purposes. The BIA will use the best scientific information available, and reasonable and prudent conservation practices, to manage trust and restricted Indian lands. Conservation practices must reflect local land management goals and objectives. Tribes, individual landowners, and BIA will manage Indian agricultural lands." A summary of the BIA Range Policy as stated in the Agricultural and Range Management Handbook (USDOI BIA 2003a) 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 and 25 CFR 167-Navajo Grazing Regulations.
- Seek tribal participation in BIA agriculture and rangeland management decision-making.
- Integrate environmental considerations into the initial stage of planning for all activities with potential impact on the quality of the land, air, water, or biological resources.

1.2.2 District Grazing Committees

Districts, formally called Land Management Districts, were established in 1936 by the Soil Conservation Service (now called Natural Resource Conservation Service, or NRCS) and adopted by the BIA.

The Navajo Nation is organized into 110 Chapters. Chapters are locally organized entities similar to counties and are the smallest political unit. 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 grazing district 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 permit. In addition, the NNDOA and the District Grazing Committees are responsible for enforcement of range management and resolving grazing disputes.

1.2.3 Grazing Management Overview

Timing of grazing, movement and dispersal of livestock, and animal numbers are all 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, composition, and location of water, shelter, and minerals (Heitschmidt and Stuth1991). The total forage production of a given pasture or grazing area does not necessarily reflect the amount of forage available to livestock; therefore, it is important to recognize specific factors that restrict forage availability, such as inaccessibility, 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 the development of additional water sources in areas rarely visited by livestock because of the long distance to water.

After likely foraging patterns have been determined, production and forage value data can be used to help determine the number of animals that could sustainably graze in a given area. 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 take into consideration the ecosystem as a whole. Maintaining long-term viable rangelands provides for the continued health of livestock and long-term financial gains for producers or permittees. 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, they each select their 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, the less valuable forage species are replaced by invaders and noxious weeds.

Plant vigor and root development can be adversely affected when grazing occurs during periods of initial plant growth or during the time of seed development. This will remain a problem for rangeland managers as long as livestock grazing permits are issued for year-round grazing; however, Holecheck (1999) argues 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 with dynamic seasonal, topographic, and behavioral factors.

RESOURCE DESCRIPTIONS

2. RESOURCE DESCRIPTIONS

Knowledge of the resource issues that affect rangeland health and productivity is essential to rangeland management plans. Stocking rates, season of use, annual precipitation, soil types, 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 Land Management District 2 area. This information can be used to document future changes on the rangelands and assist with management decisions.

2.1 Geographic Setting

The Land Management District 2 project area is located within the Colorado Plateau Major Land Resource Area (MLRA). The project area surveyed ranges from Lake Powell lake level at 3,700 feet, up to piñon-juniper woodlands on Black Mesa at 7,300 feet. Navajo Mountain, Shonto and Inscription House communities are included in the project area. Sandstone canyon lands characterize the western portion of the study area. This area is remote with exposed bedrock dominating the landscape. Navajo Mountain sits on the northeast corner of the canyon country. Most of Navajo Mountain is located in Utah, but the lower southern slopes extend into Arizona and were included as part of this inventory. Lands surveyed on the east side of the project in Shonto community consist of elevated mesas and deep, large canyons. Inscription House community has abundant rolling piñon-juniper woodlands interspersed with stabilized dunes and shallow canyons. Figure 1 shows a map of the study area.

The project area is located within Coconino and Navajo counties, Arizona. The western boundary of the project lies about 10 miles north of Page, Arizona, at the Glenn Canyon National Recreation Area boundary on the margin of Lake Powell. The Arizona/Utah State line also coincides here. This boundary follows east, passing Navajo Mountain and continuing to a remote canyon region which drains to Monument Valley. The boundary then turns south to form the eastern boundary which nearly reaches Peabody Energy leased lands on Black Mesa. From here, the boundary extends directly west to White Mesa where it bends north following Potato Canyon to Navajo Creek. This creek forms the boundary back to the starting point.

The project area covers an area of 659, 816 acres. Acreages for each compartment were extracted from shapefiles provided by the BIA Western Navajo Agency. The land area in acres of each compartment is provided in Section 5: Results.

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 to 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 and the corresponding data is managed by the Navajo Nation Division of Water Resources (NNDWR). Fifteen precipitation gauges with complete data sets located throughout the Western Agency were averaged to provide a measurement for the 2013 water year up to the time of data collection.

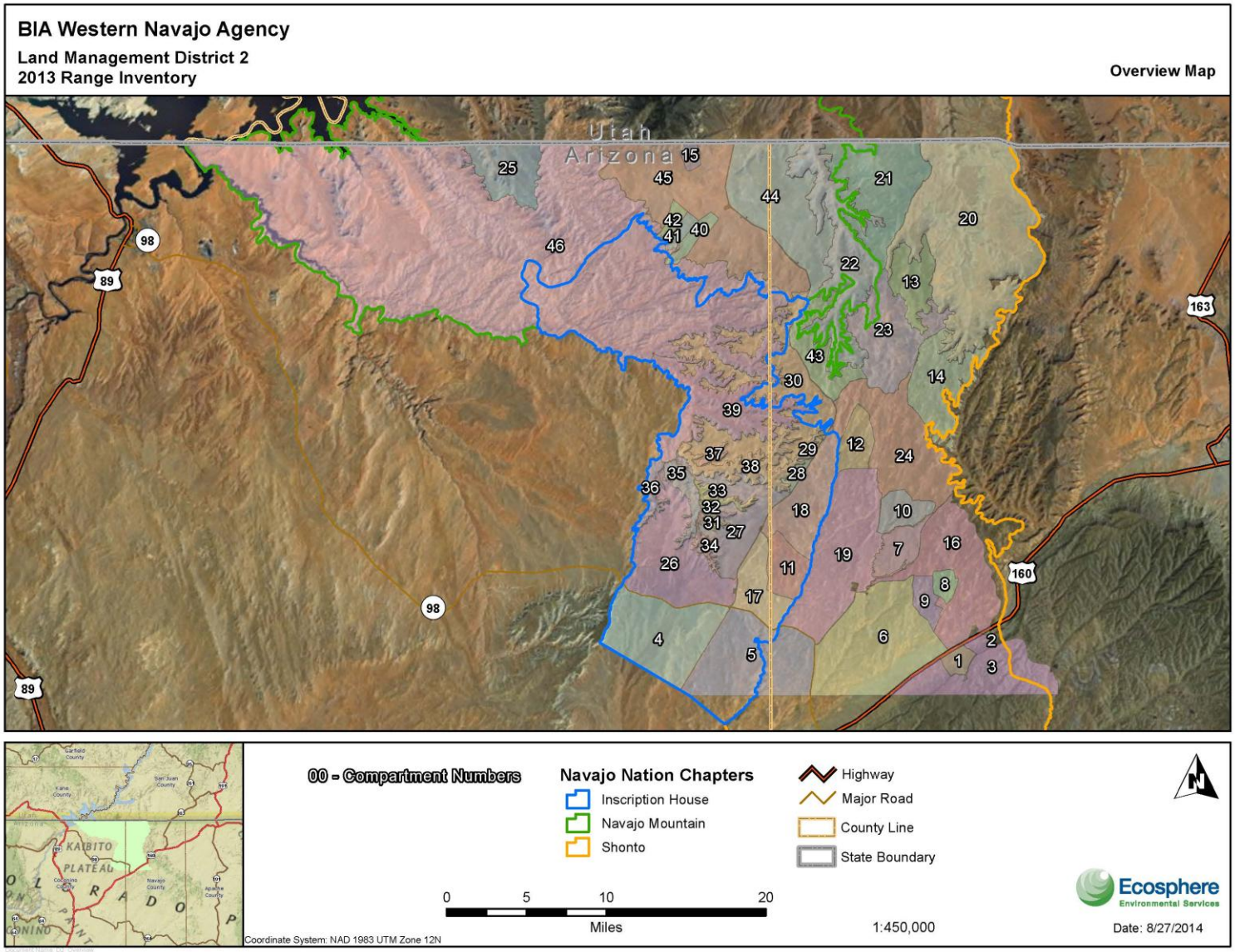


Figure 2-1. Map of Project Area

2.3 Soils

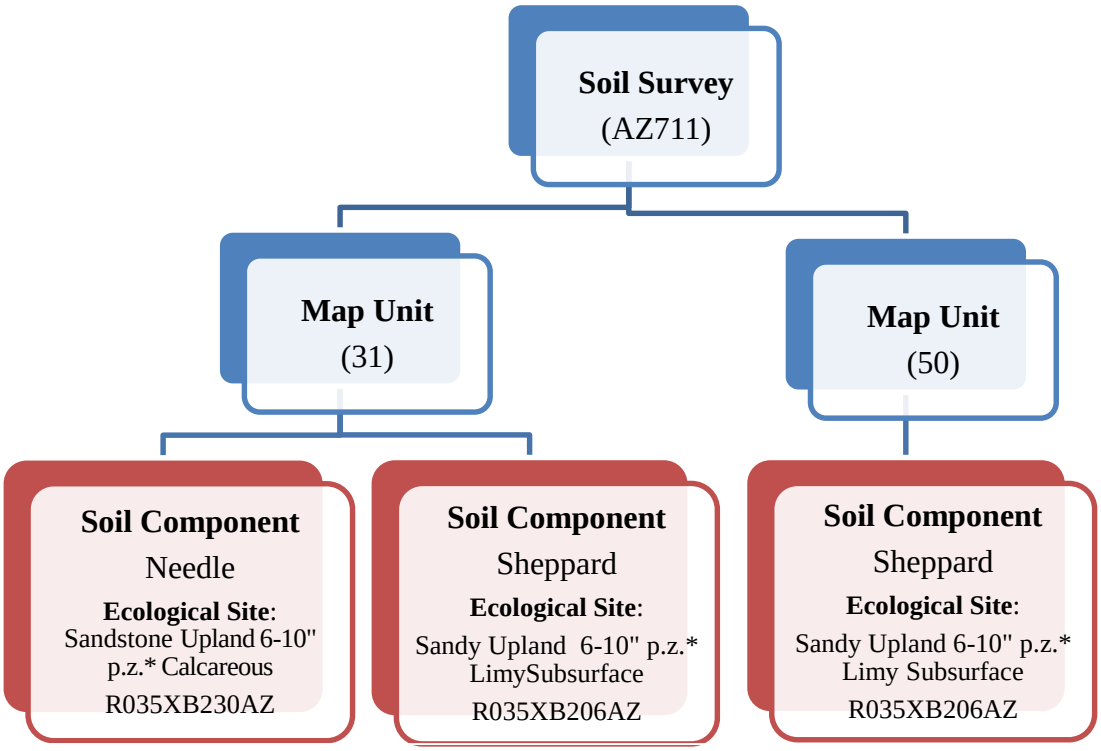
Knowledge of the soil properties in a particular area can help in predicting forage production. Soil properties such as texture, depth, moisture content, and capacity can dictate the type and amount of vegetation that will grow in that soil.

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, which occur throughout the project area, provide a vital component of healthy, functioning soils.

The application of soil survey information is what enables rangeland managers to provide estimates of forage production in a given area. The BIA Agricultural and Range Management Handbook notes, "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… [S]oil types, plant composition and production yield are representative for an area but may have significant dissimilar inclusions and/or change over time (USDOI BIA 2003a)."

Soil surveys are carried out by the United States Department of Agriculture (USDA), NRCS. These soil surveys are used to create soil map units. A soil map unit is delineated by soils, landscape position (floodplain, terrace, alluvial fan, etc.), and slope. Each unit is named for the major soil contained in the unit or for a soil complex which consists of two to three major soils. Soils found in one unit can occur in other units, but the slopes and landscape position will be different. The major soil(s) found in a map unit are referred to as a soil component. The written soil survey contains descriptions of each map unit starting with a general description that includes elevation, frost-free period, mean annual precipitation, and mean annual air temperature. This is followed by a breakdown of the proportion of each soil component found within a soil map unit. Soil component specifics are then listed and include the landscape setting, soil properties and qualities, the typical soil profile, and interpretive groups. Interpretive groups pertain to land capability, such as whether or not it is irrigated, soil hydrology, and ecological sites. The entire vegetation inventory area lies within survey AZ711, Soil Survey of Navajo Mountain Area, Arizona and parts of Apache, Coconino, and Navajo Counties (USDA NRCS 2008).

Ecological sites are directly associated with soil components and are differentiated from each other based on soils, hydrology, and the composition and production associated with the characteristic plant community. It is possible to determine the percentage of soil components or ecological sites in a soil map unit, but any mapping at this scale will only include the dominant component. The following chart illustrates the hierarchy of *unmapped* soil components and their corresponding ecological sites within a *mapped* soil unit for a given soil survey. The soil examples in the chart illustrated below are extracted from the USDA NRCS 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.



*p.z. = precipitation zone

Figure 2-2. Mapped and Unmapped Soil Hierarchy

At the time this study was undertaken, most soils in the project area were not correlated with ecological sites and the soils that did have correlated ecological sites had no written description of the ecological sites (ESD). Consequently, field crews identified only the soil component at each transect location. By the time the field study was completed, the soil survey had been updated with correlated ecological sites and published ESDs. Because the soil components had been identified, it was possible to assign ecological sites to each transect location after the fact; however, it should be noted that these ecological site assignments were not verified in the field.

ECOLOGICAL SITES

3. ECOLOGICAL SITES

According to the USDA NRCS, an Ecological Site Description (ESD) provides "land managers the information needed for evaluating the land as to suitability for various land-uses, capability to respond to different management activities or disturbance processes, and ability to sustain productivity over the long term" (2014). ESDs are continually being created and updated by the NRCS. Land managers can use the following website to check for ESD updates and additions:

http://esis.sc.egov.usda.gov/Welcome/pgReportLocation.aspx?type=ESD.

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 ESD describes the historic climax plant community (HCPC) that was present during European settlement of North America. Some ESDs go on to describe the plant communities that will likely result following various disturbance factors such as overgrazing or wildfire. 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 reference or potential natural community (PNC). PNCs may include non-native plant species and other factors, which differentiate them from an HCPC on the same site. Other information includes annual production of forbs, grasses, shrubs, and trees, plant growth curves, associated sites, recreational uses, and details pertaining to livestock grazing. Some ESDs are more complete than others.

The most valuable application of an ESD is the employment of similarity indices. Calculating a similarity index involves comparing the plant community that currently exists on the ground to the HCPC or, when available, the PNC. The similarity index is expressed as a percentage. For example, 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.

ESDs list two production values for each species found in an HCPC or PNC, one representing annual production if precipitation is high and one if precipitation is low. If managers are using a reconstruction factor on field collected data, it is recommended to average these two values as the reconstruction process essentially adjusts plant weights to represent growth in an average year. The listed production value for each species is termed "allowable production." The production from every plant species encountered in the field is compared to the allowable production for the same species in the ESD and scored accordingly. For example, assume that a sampled area had 79 pounds/acre of alkali sacaton (*Sporobolus airoides*) and that the corresponding ESD lists 50 pounds/acre as the average allowable production for this same species. In this case, no more than 50 pounds may be allowed to be counted toward the similarity index. If the ESD had listed alkali sacaton (*Sporobolus airoides*) at 200 pounds/acre, then all 79 pounds (and no more) would be counted. If an individual species is not listed in the ESD, then no production is assigned or "allowed" for that species. At the end of this process, all allowable production is added up and divided by the total production for the HCPC or PNC found in the ESD. The resulting value is the similarity index.

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 James' galleta grass (*Pleuraphis jamesii*) and alkali sacaton (*Sporobolus airoides*). 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 plant community in the ESD 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 the reference 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 that contains a mix of grasses, forbs, and shrubs.

Rangeland managers should be aware that maps of ecological sites are available on the NRCS Web Soil Survey website: http://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm. 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.

Table 3-1 lists the dominant ecological sites in Land Management District 2. Acres represent graze-able acres with non-rangeland and slopes greater than 60 percent removed.

Table 3.1. Ecological Sites

ESD Number	ESD Name	Acres	Ecological Site Description Available?
F035XF627AZ	Sandstone Upland 13-17 inches (JUOS, PIED)	39,486	Y
F035XF629AZ	Sandstone Hills 13-17 inches (PIED)	4,204	Y
R035XA106AZ	Clayey Upland 10-14 inches	70	Y
R035XA107AZ	Clay Loam Upland 10-14 inches	52	Y
R035XA113AZ	Loamy Upland 10-14 inches	244	Y
R035XA115AZ	Sandstone Upland 10-14 inches	6,970	Y

ESD Number	ESD Name	Acres	Ecological Site Description Available?
R035XA117AZ	Sandy Loam Upland 10-14 inches	57	Y
R035XA118AZ	Sandy Upland 10-14 inches	11,887	Y
R035XB204AZ	Sandstone Upland 6-10 inches	16,496	Y
R035XB206AZ	Sandy Upland 6-10 inches, Warm	19,846	Y
R035XB217AZ	Sandy Upland 6-10 inches	135	Y
R035XB226AZ	Sandstone/Shale Upland 6-10 inches, Warm	2,252	Y
R035XB230AZ	Sandstone Upland 6-10 inches Very Shallow, Warm	7,282	Y
R035XB234AZ	Sandstone Upland 6-10 inches, Warm	5,499	Y
R035XB235AZ	Sandy Loam Upland 6-10 inches, Warm	3,152	Y
R035XB251AZ	Mudstone/Sandstone Hills 6-10 inches, Warm	1,861	Y
R035XB255AZ	Sandstone Rockland 6-10 inches	32,072	Y
R035XC302AZ	Sedimentary Cliffs 10-14 inches	96,256	Y
R035XC312AZ	Loamy Wash 10-14 inches	3,631	Y
R035XC314AZ	Sandstone Upland 10-14 inches	25,992	Y
R035XC315AZ	Sandy Upland 10-14 inches	85,990	Y
R035XC317AZ	Sandy Loam Upland 10-14 inches	10,983	Y
R035XC321AZ	Sandstone Hills 10-14 inches	481	Y
R035XC328AZ	Cobbly Slopes 10-14 inches	35,005	Y
R035XC331AZ	Shallow Upland 10-14 inches, Warm	1,450	Y
R035XC333AZ	Sandstone Upland 10-14 inches, Warm	7,546	Y
R035XC337AZ	Sandstone/Shale Upland 10-14 inches	193	Y
R035XC370AZ	N/A	1,926	N
R035XC373AZ	Sandy Upland 10-14 inches, Warm	3,626	Y
R035XC377AZ	Sandy Slopes 10-14 inches	534	Y
R035XF606AZ	Sandy Loam Upland 13-17 inches	9,019	Y
R035XF607AZ	Sandy Upland 13-17 inches	69,881	Y
R035XY236UT	Semidesert Shallow Sandy Loam (Utah Juniper, Blackbrush)	1,079	Y
R035XY243UT	Semidesert Stony Loam (Blackbrush)	3,022	Y
Riverwash	N/A	1,269	N
Rock Outcrop	N/A	68,625	N
Total		**578,071**	

METHODOLOGY

4. METHODOLOGY

The methods used to collect this 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 1999a, Habich 2001, and USDA NRCS 2003). The field methodology was based on the SOW and the technical references, with modifications approved by the BIA.

4.1 Field Methodology

4.1.1 Transect Establishment

Field data collection occurred between October 16-28, 2013 in grazing compartments 1-24, 26-36, 38-46 in Inscription house, Navajo Mountain, and Shonto. The remaining transects were sampled between April 12 - May 17, 2014. The BIA provided Ecosphere with predetermined transect locations. The Universal Transverse Mercator coordinates of these 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 foot. Transects were established within one 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 taut as much 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. The plots were measured with a square 9.6-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, soil texture, and notes were also recorded. All plant species names were consistent with the NRCS Plants Database (USDA NRCS 2013a).

4.1.2 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. 1999a). 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

double sampling methodology of the USDA, the NRCS modified standards outlined in the SOW, and the modifications generated from the pre-work conference. The double sampling method is detailed in the following sections.

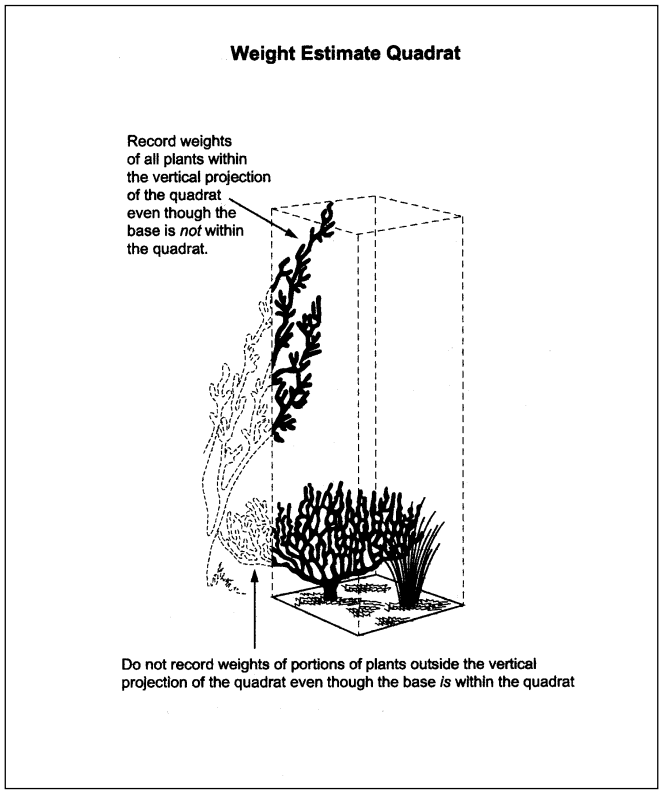
4.1.2.1 Establishing a Weight Unit

A weight unit is a part of a plant, an entire plant, or a group of plants of the same species used for assessing 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 (*Achnatherum hymenoides*) may be visually estimated to equal 10 grams (g). This clump of grass is then harvested and weighed with a hand scale to determine actual weight. This process is repeated until 10g of Indian ricegrass (*Achnatherum hymenoides*) can be visually estimated with accuracy. After weight units are established, field teams can be very accurate in production estimation. The field team maintained proficiency by periodically harvesting and weighing to check estimates of production.

4.1.2.2 Double Sampling Methodology (Estimating and Harvesting)

Production (in grams) was estimated by counting the weight units of each species in each plot. All plants and parts of plants inside a quadrant outlined by the 9.6 ft^2 frame up to a height of four 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 (1/4 inch stubble height). 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 10g 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.

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 10 days or more 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.



Source: USDI BLM 1996

Figure 4-1. Weight Estimate Box

4.1.2.3 Large Shrub Plots

Extended plots were established when the vegetation consisted of "large" shrubs. Neither the SOW or 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 larger shrubs that are too wide to be adequately measured within the 9.6 ft^2 frame. Large shrub plots were usually established in areas of tall, thick big sagebrush (*Artemisia tridentata*), greasewood (*Sarcobatus vermiculatus*) flats, or in foothill regions with bitterbrush (*Purshia tridentata*) and mountain mahogany (*Cercocarpus montanus*). For transects with large shrubs, two extended plots, each measuring 0.1 acre in size, were established at fixed points along the transect. In these extended plots only the large shrub species were estimated. These shrubs were not measured inside the ten 9.6 ft^2 plots in the transect to avoid double counting them.

4.1.2.4 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. 1999b), utilization is determined by visual inspection of 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 utilization of plants. An attempt was made to locate un-grazed plants near the transect. These un-grazed plants were assumed to represent the species

approximately 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 on the plants where grazing was detectable was recorded for each species on each transect.

4.1.2.5 Sensitive Plants Protocol

Threatened, endangered, culturally important, or otherwise sensitive plants were estimated rather than harvested for the purposes of this inventory. Weights for cacti and yucca species were estimated using standard protocols as described in the Bureau of Land Management (BLM) Technical Reference 1734-7 (Habich 2001). The recommended values are as follows: 10 percent of total weight for prickly pear (*Opuntia* spp.), five percent for barrel-type cacti (*Ferocactus* spp., *Sclerocactus* spp., and *Echinocereus* spp.), 15 percent for cholla cacti (*Cylindropuntia* spp. and *Grusonia* spp.), and 15 percent for yuccas (*Yucca* spp.). A list of all plant species recorded during the inventory is included as Appendix B.

4.1.3 Frequency Data Collection

Frequency describes the abundance and distribution of species. Frequency measurements are an easy and efficient method for monitoring changes in a plant community over time. Frequency is the number of times a species is present in a given number of sampling units, usually expressed as a percentage.

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

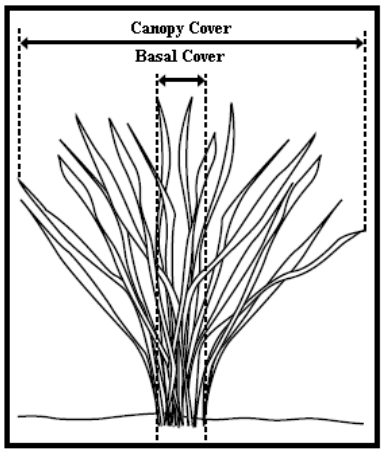
4.1.4 Cover Data Collection

Ground cover measurements are used to quantify the amount of vegetation, organic litter, biological crusts, and exposed soil surface throughout an area. Cover is also important from a hydrologic perspective when examining basal 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 of a site, as well as the 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 hard to compare results from different portions of a large area where sampling takes several weeks or a few 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 Point-Intercept method employed on this study consisted of a modified pin/point frame. At each plot along a transect, a pin flag was placed in each of the four corners of the 9.6-square-foot quadrant frame. The cover category is determined by the first interception at each of the pin points. Forty measurements,

or hits, were recorded from ten frame placements. Only the point of the pin flag was used to record a hit. Emphasis was placed on lowering the pin directly (perpendicular to the ground) in the corners of the quadrant frame as specified in technical reference 1734-4 Sampling Vegetation Attributes (Coulloudon et al. 1999a). Ground cover hits fell into the following categories: Basal Vegetation, Canopy (foliar) Vegetation, Litter, Bare Ground, Rock/Gravel, and Biological Crust. A Basal Vegetation cover hit was recorded when the pin flag struck the ground surface occupied by the basal portion of the plant. Canopy Vegetation hits were recorded as foliar cover when the pin flag struck the foliage of plants (Figure 4-2). Litter hits were recorded when the pin flag intercepted herbaceous or woody plant debris. Bare Ground was recorded when the pin flag struck bare ground free of litter, vegetation, gravel, stone, or biological crusts. Rock/Gravel was recorded when the pin flag intercepted gravel (particles > 2 millimeters in diameter) or stone that was free of vegetation. 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, Salzer, and Willoughby 1998

Figure 4-2. Vegetative Cover

4.1.5 Soil Texture Test

At each transect a small soil pit was dug to expose the soil profile. At each soil horizon, a sample was analyzed using the USDA Soil Texturing Field Flow Chart (Appendix C). The Flow Chart uses a step-by-step procedure for estimating sand, silt, and clay content. The soil texture test also uses the ribbon method to determine the fraction of fine-grained particles within the sample. Once the soil texture of each horizon had been determined, the results were compared to the appropriate map unit description for the area in which the transect was located. The surveyor then selected the soil unit that best fit the profile and recorded the soil texture that was most diagnostic of the selected soil map unit.

4.2 Post-Field Data Processing Methodology

After completion of field data collection, the data was downloaded into a database. Harvested biomass was air dried for 10 days and dry weights were entered individually 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, the results were grouped by soil component within each compartment. In 2014, ecological site correlations and ESDs were published by the NRCS and were assigned to each transect according to the soil component identified in the field. ESDs were not verified in the field because they had not been published prior to field data collection. Further analysis for each compartment 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 Bureau of Land Management (BLM) 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 air-dry-weight (% 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:

Corrected Green Weight = (% 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 (*Sporobolus airoides*) was estimated to weigh 10 grams but the harvested weight was measured as 9 grams, then all estimates of alkali sacaton (*Sporobolus airoides*) 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 (*Sporobolus airoides*) 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 that were not harvested in a transect, 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.)

Cacti and yucca species were never clipped during fieldwork, but published %ADW values were used in the calculations (Habich 2001). Additionally, prickly Russian thistle (*Salsola tragus*) can be difficult to clip once it matures and begins to dry. A value of 80 percent was applied to individuals not clipped during the survey.

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 ungrazed. Grazed or utilized species were measured according to the average amount of plants that remained ungrazed near the transect. For example, if alkali sacaton (*Sporobolus airoides*) was recorded at a utilization factor of 90 percent ungrazed, then the amount of alkali sacaton (*Sporobolus airoides*) 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 normally would be less than a measurement taken of the same plant 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 (*Sporobolus airoides*) was

measured in a transect during August, that measurement may represent only 88 percent of the full growth of that species.

The growth curves used in this analysis are associated with the Common Resource Areas (CRAs) found within the project. A CRA is a subdivision of a Major Land Resource Area (MLRA) and is defined by soils, climate, and landscape conditions. Three CRAs, 35.2, 35.3, and 35.6, were found to be present in the project region. Table 4-1 shows the percent production by month for each CRA growth curve.

Table 4.1. Percent production by month for each CRA growth curve

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Percent production by month in AZ3521, 35.2, 6-10" p.z. (all sites) growth curve											
0	1	9	20	27	14	10	11	5	3	0	0
Percent production by month in AZ3531, 35.3, 10-14" p.z. (all sites) growth curve											
0	1	3	17	18	10	19	20	10	1	1	0
Percent production by month in AZ3561, 35.6, 13-17" p.z. (all sites) growth curve											
0	1	5	16	17	15	15	15	11	5	0	0

To illustrate, assume that a transect located in CRA 35.2 was sampled August 21. The first step in the growth curve analysis is to estimate, using growth curve AZ3521, the percentage of growth completed up to that date by adding up the preceding 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 pro-rated and added to the total. The value is determined by dividing the percent of growth occurring in August (11 percent in this case) 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. 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. Precipitation data gathered from 15 rain gauges located throughout the Western Navajo Agency were used to determine the percent of normal production for the 2013 and 2014 water years up to the time of data collection. The years prior to sampling and after 2000 were averaged and used as a historic comparison. The water year was about 120 percent of the average for 2013 and 155 percent for the spring of 2014.

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:

$$Reconstruction\ Equation = \frac{0.89}{(0.90 \times 1.02 \times 0.8835)} = 1.10$$

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

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

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

$$72\ grams \times \frac{0.89}{0.90 \times 1.02 \times 0.8835} = 72\ grams \times 1.10 = 79.20\ grams$$

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. 1999a). 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. Forty ground cover point intercepts were measured in each transect, so ground cover categories were divided by 40 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 of bare ground on that transect would be 75 percent:

$$\frac{30\ \text{“bare ground” hits}}{40\ total\ hits} \times 100 = 75\%\ bare\ ground$$

Ground cover calculation categories included canopy vegetation, basal vegetation, litter, rocks or gravel, biological soil crust, and 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

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.

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 master 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), plus a sixth category representing species injurious to livestock, 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.

Undesirable (or emergency) 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 plants (denoted in tables and in the database with a superscript t)—These plants are poisonous to grazing animals. They have various palatability ratings and may or may not be consumed. Toxic plants may become abundant if unpalatable and if the more highly preferred species are removed.

Injurious plants (denoted in tables and in the database with a superscript i)—These plants are physically harmful to grazing animals. Specifically, these plants usually have spines or thorns that irritate the mouths or lower legs of domestic livestock. They may be utilized during seasons when they don't present serious harm so these plants also have a palatability rating.

Many species have more than one forage value according to the season of use. For example, muttongrass (*Poa fendleriana*) is considered preferred by sheep in the spring, but only desirable during the remainder of the year. Grazing in District 8 is permitted throughout the year so a single forage value is needed. The lowest seasonal forage value was chosen for each plant 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, 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 systems (GIS) files from the BIA. Home sites, farmland, and roads were buffered and removed from the total acreage available for livestock grazing. Roads were buffered 1.5 to 15 meters from their center line. Washes and streams were also given a ten foot buffer.

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 4.2) Slopes up to ten percent had no reduction in carrying capacity; moderate slopes had a 30 percent reduced carrying capacity, while steep slopes had a 60 reduction in carrying capacity. Slopes that are greater than 60 percent are generally inaccessible to livestock and were excluded from the available grazing acres.

Table 4.2. Distance to Water Reduction and Slope/Reductions

Distance to Water	Stocking Rate Reduction	Slope	Stocking Rate 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 further 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.

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

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 soil components within each analysis unit (compartment). 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 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 soil component 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 determined by dividing this number by the average amount of available forage in each soil component within an analysis unit. Table 4.3 is an example calculation for sheep using an available forage amount of 100 pounds per acre.

Table 4.3. 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 District 8 is four sheep. In other words, 790 pounds of forage can support one animal unit per month, or four sheep for a month, as shown in Figure 4.3.

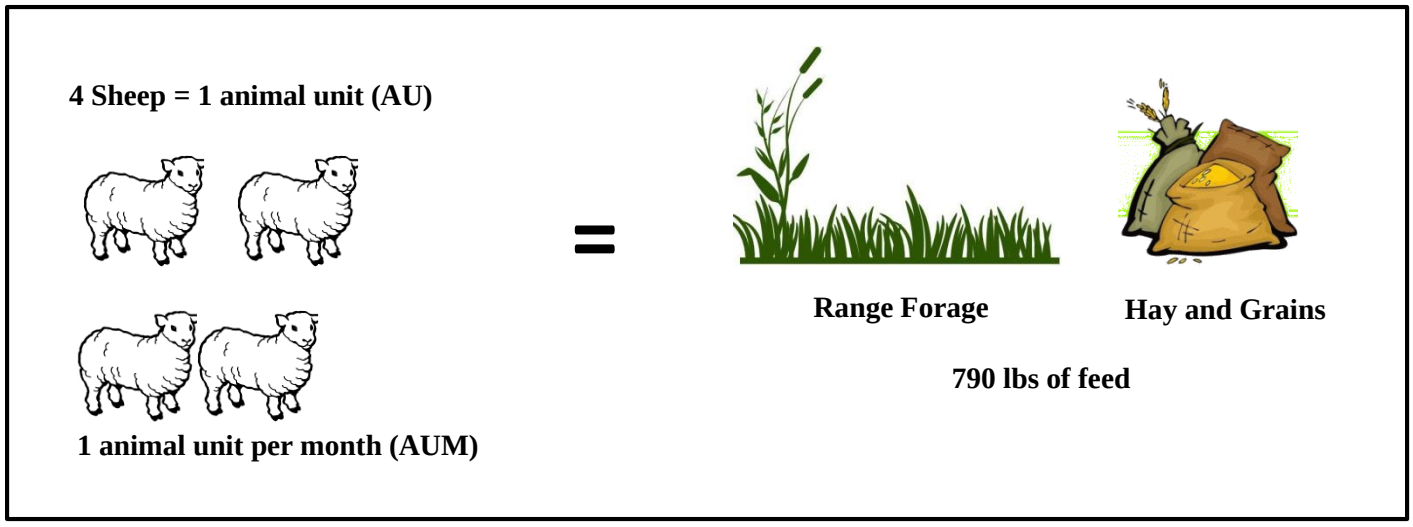


Figure 4-3. Amount of forage to support 1 animal unit (AU).

RESULTS

5. RESULTS

Five hundred and fifty five transects were read on the Land Management District 2 study area, which included 46 grazing compartments. The attributes collected at each transect were biomass production, ground cover, and species composition. Species frequency, annual forage production, and initial stocking rates were calculated from production data grouped by soil components in soil map units within each compartment. Carrying capacity was calculated by GIS analysis of the acres of each soil component within each analysis unit. Carrying capacity and acreage numbers have been rounded to the nearest whole number in all tables. The electronic database that accompanies this report contains numbers in decimal form

Table 5-1 displays the carrying capacity of the range resource in Land Management District 2. The total size of the study area is 659,816 acres. Areas that were considered non-range were removed from the analysis; these included 15,076 acres of roads, home sites, and water. There were 100,031 acres which could not be analyzed due to a lack of transects within the ecological sites in each analysis unit.

The study results show an unadjusted carrying capacity of 3,192 sheep units in the entire Land Management District 2 project area. The carrying capacity is not consistent across an analysis unit; therefore, it is important to examine the stocking rates of each ecological site to determine which areas within the analysis unit may be able to tolerate more livestock and which areas may be exceeding the carrying capacity.

Table 5.1. Carrying Capacity Results Summary

Compartment	Grazeable Acres[1]	Number of Transects	Initial Carrying Capacity (SUYL[2])	Adjusted Carrying Capacity (SUYL)
1	1,098	2	6	4
2	52	1	< 1	< 1
3	11,953	13	50	39
4	15,826	15	84	77
5	17,252	18	91	86
6	17,636	24	107	100
7	2,997	4	17	16
8	508	2	3	3
9	1,268	2	12	11
10	2,486	3	53	48
11	3,593	4	15	14
12	2,310	5	21	19
13	3,015	7	51	46
14	6,703	12	31	25

Compartment	Grazeable Acres[1]	Number of Transects	Initial Carrying Capacity (SUYL[2])	Adjusted Carrying Capacity (SUYL)
15	736	3	1	1
16	17,630	17	96	88
17	4,370	6	43	41
18	7,537	8	34	31
19	16,420	21	203	189
20	41,616	41	47	30
21	17,895	17	65	54
22	14,619	17	25	11
23	10,205	11	58	47
24	13,579	15	91	81
25	6,022	8	16	12
26	11,555	15	62	50
27	9,888	9	45	33
28	128	1	1	0
29	80	1	0	0
30	17,349	24	56	34
31	184	2	0	0
32	93	1	4	2
33	85	1	0	0
34	339	1	12	6
35	2,196	3	3	2
36	189	2	0	0
37	53	1	0	0
38	3,704	6	16	7
39	12,228	14	462	243
40	903	1	9	8
41	597	1	4	4
42	702	1	5	5
43	5,033	7	10	8
44	15,121	18	111	102
45	22,560	25	88	81
46	145,220	145	989	576
Total	**485,533**	**555**	**3,098**	**2,234**

[1]Grazeable acres represent the remaining acreage after removing non-rangeland and areas with slopes > 60 percent. [2] SUYL = sheep unit year long

5.1 Description of Results by Compartment

The results of this study have been broken down into the following categories: carrying capacity, initial stocking rates, 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 reflect an accurate depiction of available forage. However, in some cases only one transect was located in a soil component. 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 soil component 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 soil component 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 are also 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 soil component to determine which areas may be able to tolerate more livestock and which areas may be exceeding the carrying capacity.

5.1.2 Available Forage Production

Available forage is the portion of the total reconstructed production classified as preferred, desirable, and emergency forage. This quantity is used to calculate stocking rates. Forage production is low to moderate throughout the project area. The highest average production of available forage is in Compartment 32 (96 lbs/acre), followed by Compartment 34 (86 lbs/acre). The remaining units average about 18 lbs/acre. The highest producing ecological sites are R035XC315AZ in Compartments 10, 32, and 34, R035XC302AZ in Compartment 39, and R035XC314AZ in Compartment 38.

The Results by Ecological Site 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.

5.1.3 Ground Cover

Ground cover values provide a baseline for determining the trend in future studies. An average of all ground cover data for the Land Management District 2 project area is included for comparison (Figures 5-1, 5-2, 5-3). The most represented ground cover category across the project area is bare ground. The highest percentage of bare ground was found in the southern regions of the Shonto and Inscription House communities. Bare ground is of particular concern in Land Management District 2, as much of the area is composed of sandy soils that are highly susceptible to erosion.

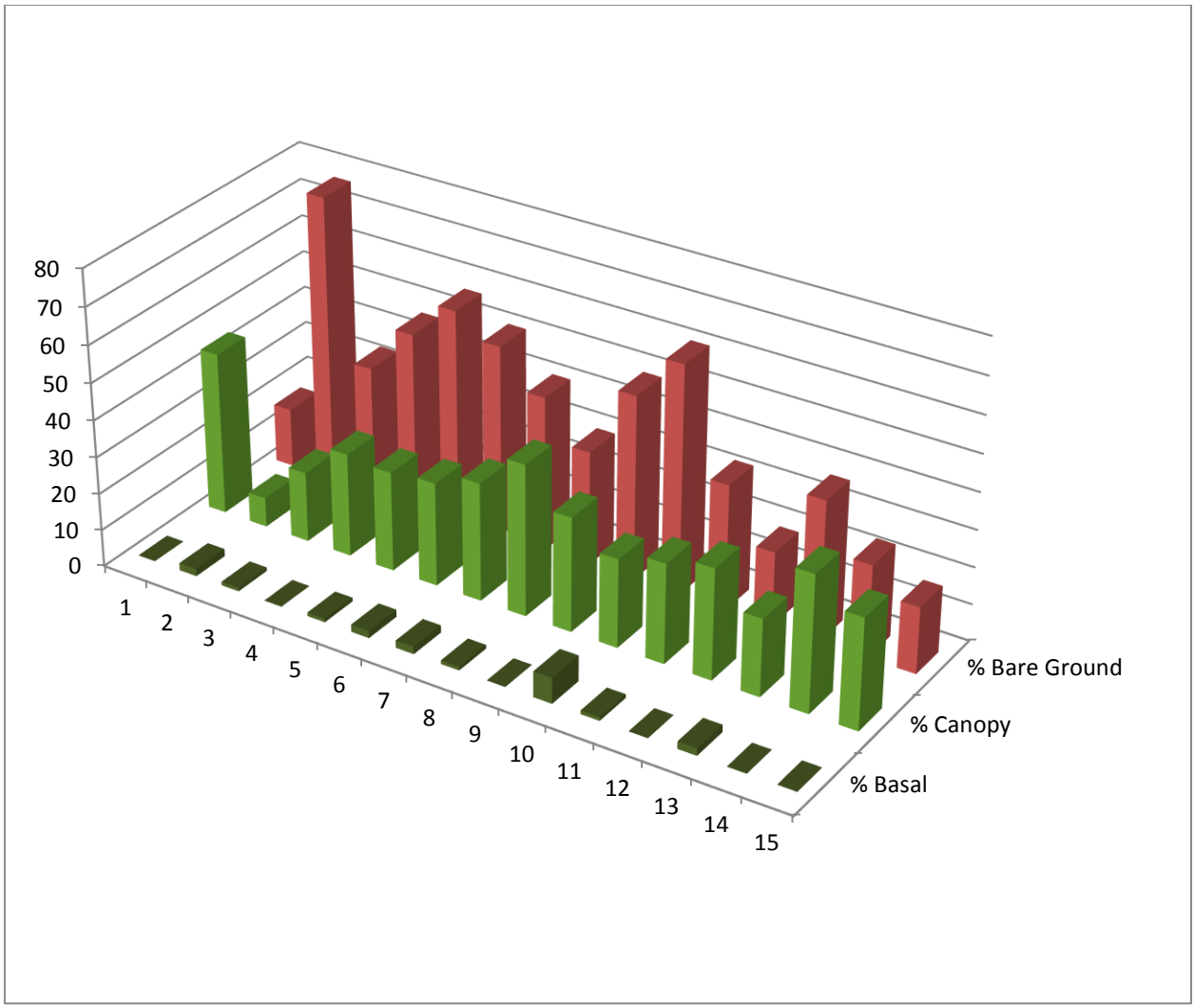


Figure 5-1. Point Intercept Results for Compartments 1-15

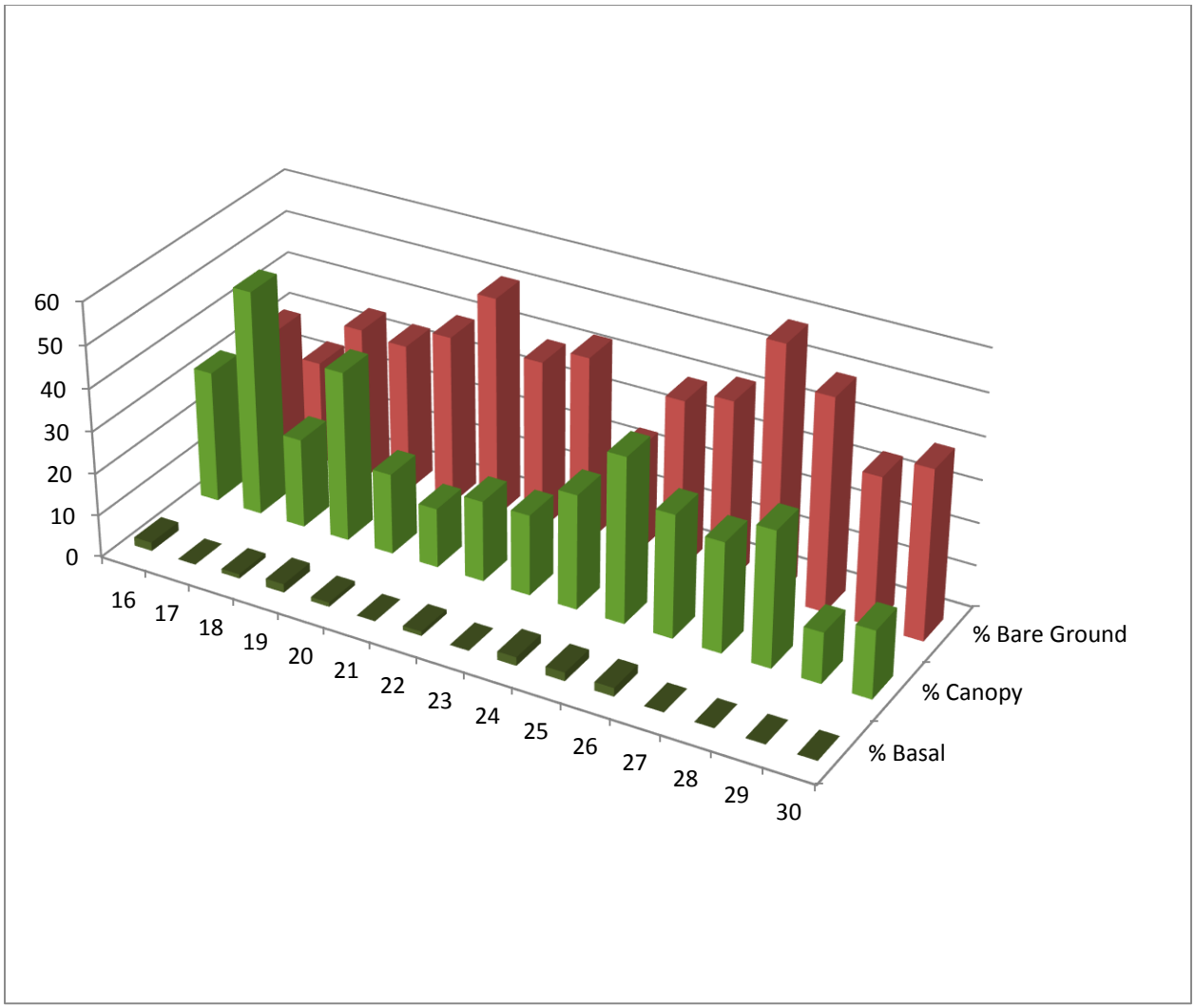


Figure 5-2. Point Intercept Results for Compartments 16-30

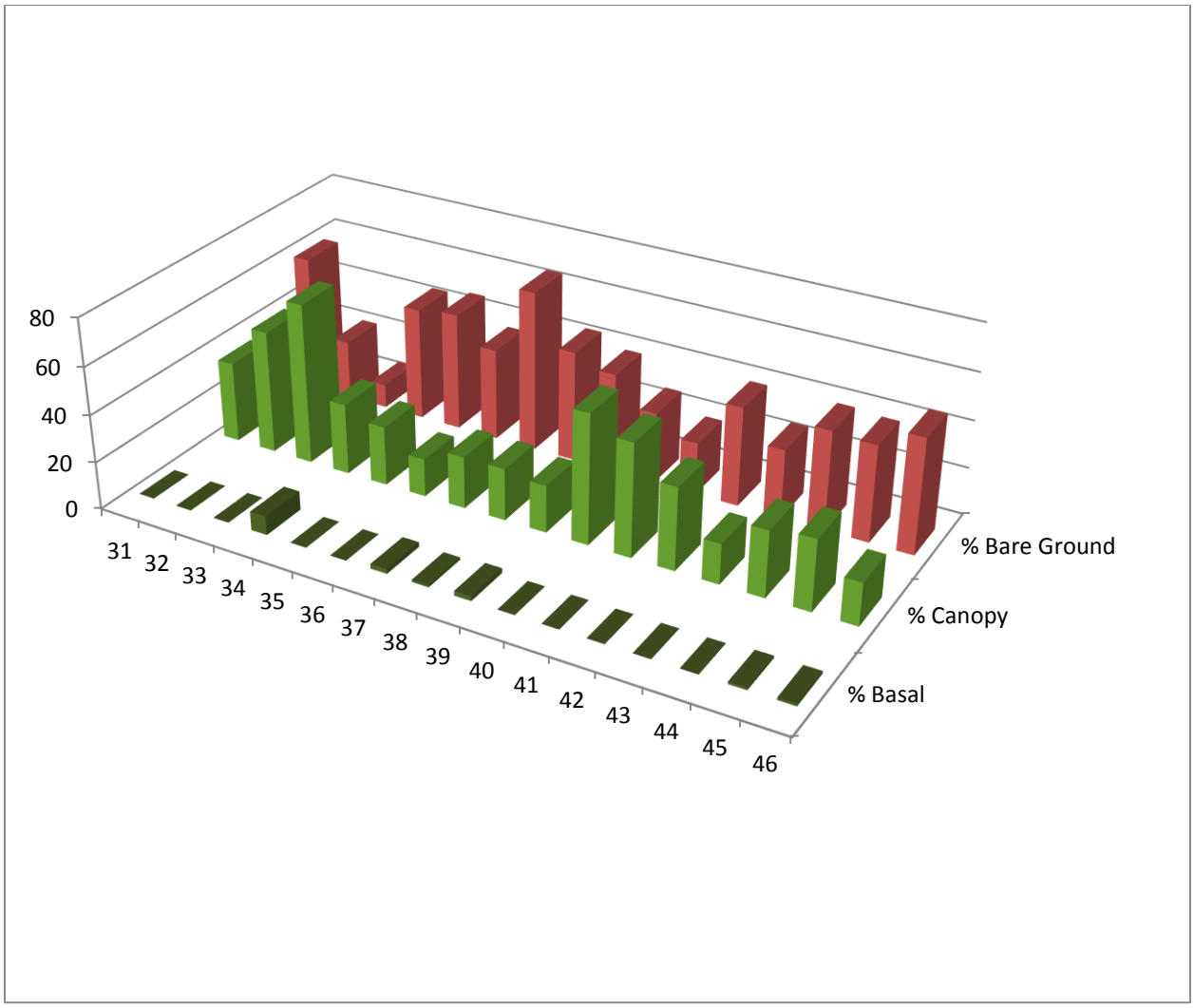


Figure 5-3. Point Intercept Results for Compartments 31-46

5.1.4 Frequency and Composition

The most commonly encountered species by transect are listed in the results section of each analysis unit along with forage value information (an explanation of forage values is found in Section 3.2.5). 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 broom snakeweed (*Gutierrezia sarothrae*), sand dropseed (*Sporobolus cryptandrus*), blue grama (*Bouteloua gracilis*), big sagebrush (*Artemisia tridentata*), and Indian ricegrass (*Achnatherum hymenoides*).

5.2 Results by Compartment

This section provides a brief discussion of the results and current plant communities found in each compartment, followed by a table displaying the percent of ground cover, initial carrying capacity, slope adjusted carrying capacity, and a breakdown of the results for each ecological site found within each individual compartment. One or two representative photographs from transects within the compartment are included.

5.2.1 Compartment 1

Compartment 1 resides in the flatlands below Black Mesa, just south of Highway 160. This compartment has a total area of 1,748 acres of which 1,098 acres are considered to be grazeable. There are four ecological sites, but only two contain transects. Stocking rates are a little above the project average, but due to the small size of each sampled ecological site, carrying capacities are well below average. The most commonly encountered species include big sagebrush (*Artemisia tridentata*), bottlebrush squirreltail (*Elymus elymoides*), and broom snakeweed (*Gutierrezia sarothrae*). The primary producers of available forage are big sagebrush (21 lbs/acre) and blue grama (*Bouteloua gracilis*) (10 lbs/acre). The historic climax plant community for the sampled ecological sites (R035XC312AZ and R035XC328AZ) consists primarily of cool and warm season grasses with a small component of shrub and forb species. The R035XC328AZ site will often have a small percentage of juniper/pinyon trees as well. Both sites will see an increase in shrubs and decrease in perennial grasses with continuous disturbance.

Compartment 1 (Transects 1-001 and 1-002)

Compartment	01		
% Canopy	44	**Initial Carrying Capacity**	6
% Bare Ground	16	**Slope Adjusted Carrying Capacity**	4
% Basal	0		

Ecological Site Summary

Ecological Site	# of Transects	Grazeable Acres	Available Forage	Stocking Rate	Initial Carrying Capacity
R035XC312AZ	1	241	29	82	3
R035XC328AZ	1	857	7	324	3

5.2.2 Compartment 2

Compartment 2 has only 52 grazeable acres and abuts Highway 160 to the north and Compartment 1 to the west. This area has only one transect which is located in the R035XC328AZ ecological site. Big sagebrush (*Artemisia tridentata*) is the most abundant plant species, but several native grasses are present, as well. These include Indian ricegrass (*Achnatherum hymenoides*), blue grama (*Bouteloua gracilis*), and sand dropseed (*Sporobolus cryptandrus*). The carrying capacity is very low, less than one sheep unit per acre, and the stocking rate (151 acres/sheep unit) is above average for the project area. The historic climax plant community for R035XC328AZ is characterized by grassland with a small percentage of shrubs and trees in the overstory. Common species include Indian ricegrass, needle and thread (*Hesperostipa comata*), New Mexico feathergrass (*Hesperostipa neomexicana*), blue grama, sand dropseed, James' galleta (*Pleuraphis jamesii*), big sagebrush, broom snakeweed (*Gutierrezia sarothrae*), and shadscale saltbush (*Atriplex confertifolia*).

Compartment 2 (Transect 2-003)

Compartment	02		
% Canopy	8	**Initial Carrying Capacity**	0
% Bare Ground	78	**Slope Adjusted Carrying Capacity**	0
% Basal	2		

Ecological Site Summary

Ecological Site	# of Transects	Grazeable Acres	Available Forage	Stocking Rate	Initial Carrying Capacity
R035XC328AZ	1	52	16	152	0

5.2.3 Compartment 3

Compartment 3 is located south of Highway 160 and encompasses a portion of Black Mesa, including foothills, upper slopes, and mesa top. This compartment contains 13 transects which fall within six different ecological sites (F035XF627AZ, F035XF629AZ, R035XC315AZ, R035XC328AZ, R035XC337AZ, and R035XF606AZ). Carrying capacity is highest in the F035XF627AZ ecological site, while the best stocking rate can be found in the R035XC337AZ site. The current plant community in the F035XF627AZ site is characterized by shrub species such as broom snakeweed (*Gutierrezia sarothrae*), big sagebrush (*Artemisia tridentata*), longflower rabbitbrush (*Chrysothamnus depressus*), and mormon tea (*Ephedra viridis*). Frequently encountered grass and forb species include bottlebrush squirreltail (*Elymus elymoides*), blue grama (*Bouteloua gracilis*), perennial rockcress (*Arabis perennans*), and buckwheat (*Eriogonum* spp.). This is similar to the historic climax plant community, but certain species are either diminished or absent. These are Indian ricegrass (*Achnatherum hymenoides*), needle and thread (*Hesperostipa comata*), muttongrass (*Poa fendleriana*), and Bigelow sage (*Artemisia bigelovii*).

The F035XF627AZ and F035XF629AZ ecological sites are the largest in this compartment. However, F035XF629AZ has a much lower carrying capacity than F035XF627AZ. This is due to a low production in the understory. Herbaceous forage species that do occur, such as Indian ricegrass and bottlebrush squirreltail, are scarce and the majority of available forage is being produced by Stansbury cliffrose (*Purshia stansburiana*). This is a low-producing ecological site in general, but historically, there would be a greater profusion of grass species and a greater variety of forage shrubs such as mountain mahogany (*Cercocarpus montanus*) and antelope bitterbrush (*Purshia tridentata*).

The historic climax plant community for the R035XC315AZ site is primarily composed of grasses, such as Indian ricegrass, black grama (*Bouteloua eriopoda*), and blue grama with about a 25 percent cover of shrub species. As the site deteriorates, certain species are likely to increase or invade including, big sagebrush, sand sagebrush (*Artemisia filifolia*), rabbitbrush (*Chrysothamnus* spp.), broom snakeweed, sandhill muhly (*Muhlenbergia pungens*), and various annuals. Only one transect was placed within this site. The main species found were big sagebrush, broom snakeweed, and blue grama.

Grassland with only small amounts of shrubs, forbs, and trees makes up the historic climax plant community of the R035XC328AZ site. Common cool season grasses are Indian ricegrass, bottlebrush squirreltail, needle and thread, and New Mexico feathergrass (*Hesperostipa neomexicana*). The primary warm season grasses include black grama, blue grama, sand dropseed, and James' galleta (*Pleuraphis jamesii*). When present, shrubs include big sagebrush, fourwing saltbush (*Atriplex canescens*), broom snakeweed, and plains pricklypear (*Opuntia polyacantha*). Unmanaged grazing and drought will lead to an increase in shrubs like broom snakeweed and big sagebrush, a decrease in cool season, perennial grasses, and an increase in annual species and warm season grasses. Currently, two of the transects are dominated by shrubs, big sagebrush, fourwing saltbush, and roundleaf buffaloberry (*Shepherdia rotundifolia*), and have little herbaceous cover. The third transect has a more diverse species component, but production is low. The most common species are rock goldenrod (*Petradoria pumila*) and narrowleaf yucca (*Yucca angustissima*).

The R035XC337AZ site is normally made up of grasslands, with shrubs making up about 60 percent of the overstory. Soils are mildly to moderately alkaline, which gives rise to a plant community adapted to a high soil pH. Common species are alkali sacaton (*Sporobolus airoides*), James' galleta, rose heath

(*Chaetopappa ericoides*), shadscale saltbush (*Atriplex confertifolia*), Torrey's jointfir (*Ephedra torreyana*), and winterfat (*Krascheninnikovia lanata*). As the site deteriorates, less palatable grass species and subshrubs will increase and introduced annuals like prickly Russian thistle (*Salsola tragus*) will begin to invade. The one transect placed within this site encountered mostly big sagebrush, fourwing saltbush, black greasewood (*Sarcobatus vermiculatus*), and burningbush (*Bassia scoparia*). Burningbush is an introduced annual that can be both highly invasive and toxic to livestock when consumed in large amounts, especially during times of drought and when mature plants are consumed. However, the early stages of growth have a high forage value for all classes of livestock and if perennial grasses are present, they easily out-compete this species (Casey 2009). Prickly Russian thistle is present, but not abundant at this time.

The historic climax plant community for the R035XF606AZ site is represented by grassland with a 30-40 percent shrub component. Dominant species include needle and thread, blue grama, bottlebrush squirreltail, winterfat, fourwing saltbush, and big sagebrush. Trees and forbs make up a small portion of the community. Perennial grass species, especially cool season grasses, will decline and shrubs will increase following under various conditions including drought, extended periods of winter-dominated moisture, unmanaged grazing, and reductions in the normal fire frequency. This site contains only one transect which encountered a plant community dominated by big sagebrush, prairie sagewort (*Artemisia frigida*), and Greene's rabbitbrush (*Chrysothamnus greenei*). Although not abundant, numerous forb species were also found and several perennial grass species.

Compartment 3 (Transect 3-007 and 3-014)

Compartment	03
% Canopy	19
% Bare Ground	35
% Basal	1
Initial Carrying Capacity	50
Slope Adjusted Carrying Capacity	39

Ecological Site Summary

Ecological Site	# of Transects	Grazeable Acres	Available Forage	Stocking Rate	Initial Carrying Capacity
F035XF627AZ	4	4204	18	135	31
F035XF629AZ	3	4204	3	777	5
R035XC315AZ	1	744	18	129	6
R035XC328AZ	3	1557	1	3000	1
R035XC337AZ	1	193	24	97	2
R035XF606AZ	1	1051	13	189	6

5.2.4 Compartment 4

Compartment 4 occupies the southwest corner of the Inscription House Chapter. This compartment has a total of 15,826 grazeable acres and 15 transects that are contained within five ecological sites (R035XA118AZ, R035XC315AZ, R035XC377AZ, R035XF606AZ, and R035XF607AZ). The most represented site is the R035XF607AZ site, which also has the highest carrying capacity. This region is characterized by sagebrush shrubland with an overstory of pinyon and juniper. The historic climax community is composed primarily of Indian ricegrass (*Achnatherum hymenoides*), muttongrass (*Poa fendleriana*), big sagebrush (*Artemisia tridentata*), and antelope bitterbrush (*Purshia tridentata*). The main species found on the transects included Indian ricegrass, blue grama (*Bouteloua gracilis*), James' galleta (*Pleuraphis jamesii*), sand dropseed (*Sporobolus cryptandrus*), big sagebrush, and broom snakeweed (*Gutierrezia sarothrae*). This suite of species is common throughout the compartment, although species of globemallow (*Sphaeralcea* spp.) and Stansbury cliffrose (*Purshia stansburiana*) are abundant in several other ecological sites.

Cool and warm season grasses dominate the historic climax plant community of the R035XA118AZ site. The main grasses include Indian ricegrass, bottlebrush squirreltail (*Elymus elymoides*), needle and thread (*Hesperostipa comata*), black grama (*Bouteloua eriopoda*), and blue grama. Shrubs are scattered and include sand sagebrush (*Artemisia filifolia*), fourwing saltbush (*Atriplex canescens*), jointfir (*Ephedra* spp.), and winterfat (*Krascheninnikovia lanata*). Prolonged disturbance will eventually cause this site to revert on an early seral state characterized by non-native and native annual forbs mixed with subshrubs, annual grasses, and a few remnant native, perennial grasses. This site has only one transect, but the primary species recorded were the annual, non-native forb, prickly Russian thistle (*Salsola tragus*) and the subshrub, broom snakeweed, which indicates that this portion of the site has been severely disturbed.

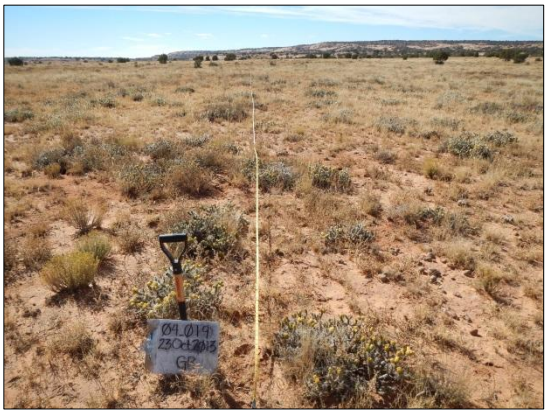
The historic climax plant community for the R035XC315AZ site is primarily composed of grasses, such as Indian ricegrass, black grama, and blue grama with about a 25 percent cover of shrub species. As the site deteriorates, certain species are likely to increase or invade including, big sagebrush, sand sagebrush, rabbitbrush (*Chrysothamnus* spp.), broom snakeweed, sandhill muhly (*Muhlenbergia pungens*), and various annuals. This site has moved away from the climax community and is now dominated by the prickly Russian thistle. Less abundant, but still a main component of the community, are James' galleta, blue grama, whipple cholla (*Cylindropuntia whipplei*), and big sagebrush.

The R035XC377AZ site tends to be grassland with scattered shrubs and trees when in an undisturbed state. Major grasses include Indian ricegrass, sand dropseed, needle and thread, blue grama, and black grama. Shrubs include big sagebrush, Greene's rabbitbrush (*Chrysothamnus greenei*), fourwing saltbush, broom snakeweed, and jointfir. As the site begins to deteriorate, increases will be seen in certain grasses like sandhill muhly, Fendler's threeawn (*Aristida purpurea* var. *fendleriana*), false buffalograss (*Monroa squarrosa*), and James' galleta. Rabbitbrush and annual forbs will also increase. Currently, production of all species is low and the plant community is a mix of forbs, shrubs, and grasses, the most common being narrowleaf yucca (*Yucca angustissima*), Stansbury cliffrose, and broom snakeweed.

The historic climax plant community for the R035XF606AZ site is represented by grassland with a 30-40 percent shrub component. Dominant species include needle and thread, blue grama, bottlebrush squirreltail, winterfat, fourwing saltbush, and big sagebrush. Trees and forbs make up a small portion of the community. Perennial grass species, especially cool season grasses, will decline and shrubs will

increase following under various conditions including drought, extended periods of winter-dominated moisture, unmanaged grazing, and reductions in the normal fire frequency. Big sagebrush, blue grama, and broom snakeweed are the main components of the plant community recorded during this survey.

Compartment 4 (Transects 4-019 and 4-025)



Compartment	04
% Canopy	28
% Bare Ground	48
% Basal	0
Initial Carrying Capacity	84
Slope Adjusted Carrying Capacity	77

Ecological Site Summary

Ecological Site	# of Transects	Grazeable Acres	Available Forage	Stocking Rate	Initial Carrying Capacity
R035XA118AZ	1	1135	7	355	3
R035XC315AZ	2	1907	12	205	9
R035XC377AZ	1	534	3	777	1
R035XF606AZ	3	3603	21	113	32
R035XF607AZ	8	8647	11	224	39

5.2.5 Compartment 5

Compartment 5 is found in the southeast corner of the Inscription House Chapter, just east of Compartment 4 and contains 17,252 grazeable acres. This area is comprised of low, rolling hills covered in sagebrush shrubland and an open canopy of pinyon/juniper woodland. Eighteen transects are located in the compartment and occur within four ecological sites. The largest ecological site is R035XC315AZ. The historic climax plant community is dominated by grasses with a smaller component of subshrubs. With continued disturbance, certain species will likely invade or increase. These include big sagebrush (*Artemisia tridentata*), sand sagebrush (*Artemisia filifolia*), broom snakeweed (*Gutierrezia sarothrae*), sandhill muhly (*Muhlenbergia pungens*), and various annuals. Currently, this site contains some desirable grasses, such as Indian ricegrass (*Achnatherum hymenoides*) and blue grama (*Bouteloua gracilis*), but many less desirable species are abundant, as well, including annual grasses and forbs, big sagebrush, and broom snakeweed.

A smaller, but still substantial component of the compartment is the R035XA118AZ ecological site. Without undue disturbance, this site typically contains grassland dominated by Indian ricegrass, bottlebrush squirreltail (*Elymus elymoides*), needle and thread (*Hesperostipa comata*), blue grama, black grama (*Bouteloua eriopoda*), and alkali sacaton (*Sporobolus airoides*). At the time of the survey, the community was typified by Indian ricegrass, blue grama, sandhill muhly, prickly Russian thistle, and broom snakeweed.

The R035XA115AZ site has a historic climax community made up of warm season grasses such as black grama, blue grama, and James' galleta. Common woody species include Bigelow sage (*Artemisia bigelovii*), jointfir (*Ephedra* spp.), and Stansbury cliffrose (*Purshia stansburiana*). A small percentage of non-native annuals may be present, but they do not affect the site's ecological processes. Prolonged disturbance will cause an increase in shrub species and subsequent decline in favorable grass species. A shift does appear to have occurred as the plant community is now dominated prickly Russian thistle (*Salsola tragus*), broom snakeweed, and blue grama.

The final ecological site, R035XC312AZ, is characterized by warm and cool season grasses when in an undisturbed state. Dominant species include Indian ricegrass, blue grama, bottlebrush squirreltail, common wolfstail (*Lycurus phleoides*), spike muhly (*Muhlenbergia wrightii*), western wheatgrass (*Pascopyrum smithii*), muttongrass (*Poa fendleriana*), sand dropseed (*Sporobolus cryptandrus*), big sagebrush, fourwing saltbush (*Atriplex canescens*), and winterfat (*Krascheninnikovia lanata*). Continuous yearlong grazing can lead to an increase in shrub species and annual, non-native species. Prickly Russian thistle now dominates the plant community, and native grasses are not well represented.

Compartment 5 (Transects 5-032 and 5-045)

Compartment	05
% Canopy	27
% Bare Ground	58
% Basal	1
Initial Carrying Capacity	91
Slope Adjusted Carrying Capacity	86

Ecological Site Summary

Ecological Site	# of Transects	Grazeable Acres	Available Forage	Stocking Rate	Initial Carrying Capacity
R035XA115AZ	4	3425	13	186	18
R035XA118AZ	4	5932	7	324	18
R035XC312AZ	1	140	2	1402	0
R035XC315AZ	9	7755	16	144	54

5.2.6 Compartment 6

Compartment 6 occupies either side of Geshi Canyon just south of the community of Shonto. This compartment contains 24 transects in six ecological sites and 17,636 grazeable acres. The R035XC315AZ site makes up about half of the compartment and has the highest carrying capacity. Commonly encountered species in this site include Indian ricegrass (*Achnatherum hymenoides*), big sagebrush (*Artemisia tridentata*), broom snakeweed (*Gutierrezia sarothrae*), blue grama (*Bouteloua gracilis*), and sand dropseed (*Sporobolus cryptandrus*). Compared to the historic climax plant community, this site is lacking certain perennial grasses, such as black grama (*Bouteloua eriopoda*) and needle and thread (*Hesperostipa comata*), and shrubs and subshrubs are more prevalent. This situation is typical for this site when exposed to continuous disturbance from factors like grazing and drought.

This compartment has one forested ecological site (F035XF627AZ), which is located in the sandstone upland regions. In a relatively undisturbed state, this site is dominated by pinyon and juniper trees, but shrubs and perennial grasses are common in the understory. Understory species often include muttongrass (*Poa fendleriana*), bottlebrush squirreltail (*Elymus elymoides*), blue grama, Indian ricegrass, big sagebrush, mormon tea (*Ephedra viridis*), broom snakeweed, and Stanley's cliffrose (*Purshia stansburiana*). This ecological site is not well represented in the compartment and only has one transect. Data from this transect contain many of the species listed above, but production is low and several annual forbs and grasses were present as well. The remaining ecological sites are similar to the R035XC315AZ site in that the plant communities are dominated by big sagebrush and subshrubs with a mixed understory of perennial grasses and annual species.

Compartment 6 (Transects 6-051 and 6-056)

Compartment	06
% Canopy	28
% Bare Ground	52
% Basal	2
Initial Carrying Capacity	107
Slope Adjusted Carrying Capacity	100

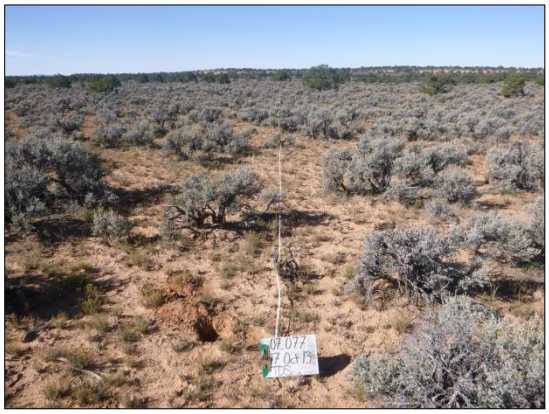
Ecological Site Summary

Ecological Site	# of Transects	Grazeable Acres	Available Forage	Stocking Rate	Initial Carrying Capacity
F035XF627AZ	1	1391	10	231	6
R035XA115AZ	3	1500	9	266	6
R035XA118AZ	1	2572	10	236	11
R035XC312AZ	4	1623	9	262	6
R035XC315AZ	12	8602	19	124	69
R035XF607AZ	3	1948	12	204	10

5.2.7 Compartment 7

Compartment 7 is a small compartment located northeast of the Shonto Community. This area contains a mix of pinyon/juniper woodland and sagebrush shrubland. It contains about 3,000 grazeable acres, has only one ecological site (R035XC315AZ), and four transects. The historic climax plant community is grassland with a moderate amount of forbs and shrubs. With continual disturbance, production from perennial grasses decreases, while shrubs and annuals increase. Currently, the majority of production is associated with big sagebrush (*Artemisia tridentata*) and broom snakeweed (*Gutierrezia sarothrae*). Primary grass species include blue grama (*Bouteloua gracilis*) and sand dropseed (*Sporobolus cryptandrus*) and introduced annuals are common, as well.

Compartment 7 (Transects 7-075 and 7-077)



Compartment	07		
% Canopy	32	**Initial Carrying Capacity**	17
% Bare Ground	42	**Slope Adjusted Carrying Capacity**	16
% Basal	2		

Ecological Site Summary

Ecological Site	# of Transects	Grazeable Acres	Available Forage	Stocking Rate	Initial Carrying Capacity
R035XC315AZ	4	2997	14	172	17

5.2.8 Compartment 8

Compartment 8 is located east of the Shonto Community, has 508 grazeable acres, one ecological site (R035XF607AZ), and two transects. The main component of the current plant community is big sagebrush (*Artemisia tridentata*), and the most common understory species is blue grama (*Bouteloua gracilis*). The historic climax plant community for the R035XF607AZ site tends to be comprised of about 60 percent shrub canopy including big sagebrush. However, some of more desirable perennial grasses are not present or are diminished at this time. These include Indian ricegrass (*Achnatherum hymenoides*), bottlebrush squirreltail (*Elymus elymoides*), and muttongrass (*Poa fendleriana*).

Compartment 8 (Transects 8-078 and 8-079)

Compartment	08		
% Canopy	41	**Initial Carrying Capacity**	3
% Bare Ground	31	**Slope Adjusted Carrying Capacity**	3
% Basal	1		

Ecological Site Summary

Ecological Site	# of Transects	Grazeable Acres	Available Forage	Stocking Rate	Initial Carrying Capacity
R035XF607AZ	2	508	15	162	3

5.2.9 Compartment 9

Compartment 9 is located east of the Shonto Community just west of Compartment 8. The area is comprised of rolling sagebrush hills with a light to moderate cover of pinyon and juniper. There are 1,268 grazeable acres with two transects, one in the R035XC315AZ site, and one in the R035XF607AZ site. Blue grama (*Bouteloua gracilis*) was the most abundant species found at the transect associated with R035XC315AZ. Additional species included big sagebrush (*Artemisia tridentata*), broom snakeweed (*Gutierrezia sarothrae*), and sand dropseed (*Sporobolus cryptandrus*). These same species are also part of the historic climax plant community, but in the historic climax plant community, overall species diversity would be higher and grasses like Indian ricegrass (*Achnatherum hymenoides*) and needle and thread (*Hesperostipa comata*) would be dominant.

The R035XF607AZ site occupies the higher regions of Compartment 9 and tends to produce a wide variety of plant species when disturbance is slight to moderate. Common species include Indian ricegrass (*Achnatherum hymenoides*), bottlebrush squirreltail (*Elymus elymoides*), needle and thread (*Hesperostipa comata*), and muttongrass (*Poa fendleriana*), globemallow (*Sphaeralcea* spp.), milkvetch (*Astragalus* spp.), Utah serviceberry (*Amelanchier utahensis*), big sagebrush (*Artemisia tridentata*), mormon tea (*Ephedra viridis*), and antelope bitterbrush (*Purshia tridentata*). The plant community sampled at the transect indicates that this area has undergone a regime of continuous disturbance, as species like big sagebrush and blue grama have increased while more desirable forage species are absent and overall production is low.

Compartment 9 (Transects 9-080 and 9-081)

Compartment	09
% Canopy	31
% Bare Ground	50
% Basal	0
Initial Carrying Capacity	12
Slope Adjusted Carrying Capacity	11

Ecological Site Summary

Ecological Site	# of Transects	Grazeable Acres	Available Forage	Stocking Rate	Initial Carrying Capacity
R035XC315AZ	1	563	24	97	6
R035XF607AZ	1	705	21	113	6

5.2.10 Compartment 10

Compartment 10 is located northeast of the Shonto Community and contains 2,486 grazeable acres. There are three transects, all located within the R035XC315AZ ecological site. The historic climax plant community is primarily composed of grasses, such as Indian ricegrass (*Achnatherum hymenoides*), black grama (*Bouteloua eriopoda*), and blue grama (*Bouteloua gracilis*), with about a 25 percent cover of shrub species. As the site deteriorates, certain species are likely to increase or invade including, big sagebrush (*Artemisia tridentata*), sand sagebrush (*Artemisia filifolia*), rabbitbrush (*Chrysothamnus* spp.), broom snakeweed (*Gutierrezia sarothrae*), sandhill muhly (*Muhlenbergia pungens*), and various annuals. At the present time, the site has a fairly large component of big sagebrush. The understory is dominated by the introduced perennial grass, crested wheatgrass (*Agropyron cristatum*). It would be preferable to see native perennial grasses in the community, but crested wheatgrass does provide excellent forage during the spring and summer and works to protect the soil. This species was commonly used in seed mixes during the 50's up through the 80's and was likely introduced during a previous range improvement project.

Compartment 10 (Transects 10-083 and 10-084)

Compartment	10		
% Canopy	24	**Initial Carrying Capacity**	53
% Bare Ground	62	**Slope Adjusted Carrying Capacity**	48
% Basal	7		

Ecological Site Summary

Ecological Site	# of Transects	Grazeable Acres	Available Forage	Stocking Rate	Initial Carrying Capacity
R035XC315AZ	3	2486	50	47	53

5.2.11 Compartment 11

Compartment 11 occupies a small area in the southeastern portion of the Inscription House Chapter, north of Highway 98. There are 3,593 grazeable acres in which were placed four transects, all within the R035XC315AZ ecological site. The historic climax plant community is primarily composed of grasses, such as Indian ricegrass (*Achnatherum hymenoides*), black grama (*Bouteloua eriopoda*), and blue grama (*Bouteloua gracilis*), with about a 25 percent cover of shrub species. As the site deteriorates, certain species are likely to increase or invade including, big sagebrush (*Artemisia tridentata*), sand sagebrush (*Artemisia filifolia*), rabbitbrush (*Chrysothamnus* spp.), broom snakeweed (*Gutierrezia sarothrae*), sandhill muhly (*Muhlenbergia pungens*), and various annuals. The plant community sampled at the transects found blue grama to be the most common species. Shrubs were not especially dense and included big sagebrush, rubber rabbitbrush (*Ericameria nauseosa*), and broom snakeweed. Various annual forbs were present, as well, and many desirable climax grasses were not present. The components of the plant community indicate that the site has undergone moderate to substantial disturbance. However, field observations noted an abundance of biocrusts which, coupled with the relative lack of shrub species, indicate the disturbance occurred in the past and is not ongoing.

Compartment 11 (Transects 11-085 and 11-087)

Compartment	11
% Canopy	27
% Bare Ground	34
% Basal	1
Initial Carrying Capacity	15
Slope Adjusted Carrying Capacity	14

Ecological Site Summary

Ecological Site	# of Transects	Grazeable Acres	Available Forage	Stocking Rate	Initial Carrying Capacity
R035XC315AZ	4	3593	10	242	15

5.2.12 Compartment 12

Compartment 12 is located north of the Shonto Community, just adjacent to the eastern boundary of the Inscription House Chapter. This chapter is comprised of rolling hills with occasional small valleys. Pinyon/juniper woodlands are often present on the sides of the valleys and hilltops and biological crusts are well developed. This compartment contains 2,310 grazeable acres and has five transects located within the R035XC315AZ and R035XF607AZ ecological sites. The historic climax plant community for the R035XC315AZ site is primarily composed of grasses, such as Indian ricegrass (*Achnatherum hymenoides*), black grama (*Bouteloua eriopoda*), and blue grama (*Bouteloua gracilis*), with about a 25 percent cover of shrub species. As the site deteriorates, certain species are likely to increase or invade, including big sagebrush (*Artemisia tridentata*), sand sagebrush (*Artemisia filifolia*), rabbitbrush (*Chrysothamnus* spp.), broom snakeweed (*Gutierrezia sarothrae*), sandhill muhly (*Muhlenbergia pungens*), and various annuals. At the present time, the most abundant species are blue grama, crested wheatgrass (*Agropyron cristatum*), and broom snakeweed. Crested wheatgrass is an introduced grass, but it does provide excellent forage during the spring and summer and provides good ground cover.

Historically, the R035XF607AZ site was composed mostly of shrubs and grasses with a smaller component of forbs and trees. Typical species in the historic climax plant community include Indian ricegrass, muttongrass (*Poa fendleriana*), blue grama, needle and thread (*Hesperostipa comata*), sandhill muhly (*Muhlenbergia pungens*), big sagebrush, mormon tea (*Ephedra viridis*), and antelope bitterbrush (*Purshia tridentata*). Improper grazing practices and/or drought leads to an increase in shrub cover, especially big sagebrush, reduction of perennial grasses, and eventually, the introduction of non-native annual species. Data from the transects found big sagebrush to be a dominant shrub species with blue grama and broom snakeweed as the most common understory species. Additional perennial grasses were observed, as well, such as Indian ricegrass, needle and thread, muttongrass, and sand dropseed, but production was low. No introduced annuals were encountered.

Compartment 12 (Transects 12-090 and 12-092)

Compartment	12		
% Canopy	30	**Initial Carrying Capacity**	21
% Bare Ground	20	**Slope Adjusted Carrying Capacity**	19
% Basal	0		

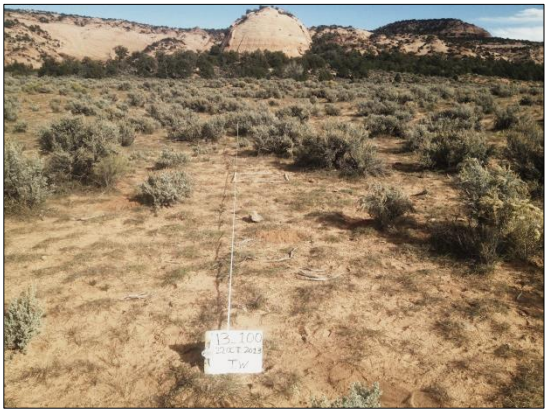
Ecological Site Summary

Ecological Site	# of Transects	Grazeable Acres	Available Forage	Stocking Rate	Initial Carrying Capacity
R035XC315AZ	2	1313	26	91	14
R035XF607AZ	3	997	15	160	6

5.2.13 Compartment 13

Compartment 13 encompasses a region of small mesas and canyons at the upper end of Cattle Canyon. Pinyon/juniper woodlands occupy much of the mesa tops and numerous rock outcrops exist along the canyon rims. Vegetation is often scarce except for along the canyon bottoms and central regions of the mesas. This compartment contains 3,015 grazeable acres, seven transects, and one ecological site (R035XF607AZA). The historic climax plant community is composed mostly of shrubs and grasses with a smaller component of forbs and trees. Typical species include Indian ricegrass (*Achnatherum hymenoides*), muttongrass (*Poa fendleriana*), blue grama (*Bouteloua gracilis*), needle and thread (*Hesperostipa comata*), sandhill muhly (*Muhlenbergia pungens*), big sagebrush, mormon tea (*Ephedra viridis*), and antelope bitterbrush (*Purshia tridentata*). Improper grazing practices and/or drought leads to an increase in shrub cover, especially big sagebrush, reduction of perennial grasses, and eventually, the introduction of non-native annual species. Data from the transects show that big sagebrush and plains pricklypear (*Opuntia polyacantha*) are prevalent throughout much of the compartment, especially on the mesa tops and in canyon bottoms. Crested wheatgrass (*Agropyron cristatum*) is common in the understory. Crested wheatgrass is an introduced grass, but it does provide excellent forage during the spring and summer and provides good ground cover. Stansbury cliffrose is frequently encountered in the rockier sites, especially around the canyon edges.

Compartment 13 (Transects 13-097 and 13-0100)



Compartment	13		
% Canopy	21	**Initial Carrying Capacity**	51
% Bare Ground	38	**Slope Adjusted Carrying Capacity**	46
% Basal	2		

Ecological Site Summary

Ecological Site	# of Transects	Grazeable Acres	Available Forage	Stocking Rate	Initial Carrying Capacity
R035XF607AZ	7	3015	40	59	51

5.2.14 Compartment 14

Compartment 14 resides in the uplands above a network of canyons along eastern border of the Shonto Chapter. The highest areas contain pinyon/juniper woodlands with scattered ponderosa pine (*Pinus ponderosa*) and Gambel oak (*Quercus gambelii*).There are 6,703 grazeable acres, 12 transects, and three ecological sites (F035XF627AZ, R035XC314AZ, and R035XF607AZ). The F035XF627AZ site is a forested ecological site. In a relatively undisturbed state, this site is dominated by pinyon and juniper trees, but shrubs and perennial grasses are common in the understory. Understory species often include muttongrass (*Poa fendleriana*), bottlebrush squirreltail (*Elymus elymoides*), blue grama (*Bouteloua gracilis*), Indian ricegrass (*Achnatherum hymenoides*), big sagebrush (*Artemisia tridentata*), mormon tea (*Ephedra viridis*), broom snakeweed (*Gutierrezia sarothrae*), and Stansbury cliffrose (*Purshia stansburiana*). This is the second largest site in the compartment and contains half of the transects. Tree overstory is currently sparse, and the dominant woody species is big sagebrush and broom snakeweed. Prevalent herbaceous species include crested wheatgrass (*Agropyron cristatum*), lobeleaf groundsel (*Packera multilobata*), blue grama, and bottlebrush squirreltail.

The sandstone upland areas are represented by the R035XC314AZ site. Without undue disturbance, this site contains many perennial grasses, a 30-40 percent shrub cover, and scattered pinyon and juniper trees. Major grasses are Indian ricegrass, needle and thread (*Hesperostipa comata*), James' galleta (*Pleuraphis jamesii*), and blue grama. Common shrubs include Bigelow sage (*Artemisia bigelovii*), Greene's rabbitbrush (*Chrysothamnus greenei*), jointfir (*Ephedra* spp.), broom snakeweed, antelope bitterbrush (*Purshia tridentata*), and Stansbury cliffrose. Species most likely to increase or invade are cheatgrass (*Bromus tectorum*), thrift mock goldenweed (*Stenotus armerioides*), broom snakeweed, and annual forbs. Dominant plant species found along the transects include blue grama, muttongrass, broom snakeweed, Bigelow sagebrush, and littleleaf mountain mahogany (*Cercocarpus intricatus*).

The R035XF607AZ site is the largest ecological site in the compartment, but it also has the least amount of available forage and thus, the lowest carrying capacity. The historic climax plant community is composed mostly of shrubs and grasses with a smaller component of forbs and trees. Typical species include Indian ricegrass, muttongrass, blue grama, needle and thread, sandhill muhly (*Muhlenbergia pungens*), big sagebrush, mormon tea, and antelope bitterbrush (*Purshia tridentata*). Improper grazing practices and/or drought leads to an increase in shrub cover, especially big sagebrush, reduction of perennial grasses, and eventually, the introduction of non-native annual species. At this point in time, all present species are not very abundant, although species diversity is fairly high. The most commonly encountered species are big sagebrush, plains pricklypear (*Opuntia polyacantha*), and ragwort (*Senecio* sp.).

Compartment 14 (Transects 14-101 and Transects 14-104)

Compartment	14		
% Canopy	37	**Initial Carrying Capacity**	31
% Bare Ground	25	**Slope Adjusted Carrying Capacity**	25
% Basal	0		

Ecological Site Summary

Ecological Site	# of Transects	Grazeable Acres	Available Forage	Stocking Rate	Initial Carrying Capacity
F035XF627AZ	6	2669	23	103	26
R035XC314AZ	2	298	14	174	2
R035XF607AZ	4	3736	2	1167	3

5.2.15 Compartment 15

Compartment 15 is located amidst the alluvial fans spreading out below the southeastern flank of Navajo Mountain. This area contains sagebrush/blackbrush shrublands with scattered pinyon and juniper trees. The compartment contains 736 grazeable acres and three transects within two ecological sites. The historic climax plant community for the R035XC315AZ site is primarily composed of grasses, such as Indian ricegrass (*Achnatherum hymenoides*), black grama (*Bouteloua eriopoda*), and blue grama (*Bouteloua gracilis*), with about a 25 percent cover of shrub species. As the site deteriorates, certain species are likely to increase or invade including, big sagebrush (*Artemisia tridentata*), sand sagebrush (*Artemisia filifolia*), rabbitbrush (*Chrysothamnus* spp.), broom snakeweed (*Gutierrezia sarothrae*), sandhill muhly (*Muhlenbergia pungens*), and various annuals. At present, big sagebrush is the dominant plant species followed by broom snakeweed and blackbrush (*Coleogyne ramosissima*).

The historic climax plant community for the R035XY243UT is dominated by blackbrush with a 35 percent perennial grass and 10 percent forb component. With deteriorating conditions, desirable grasses will decrease, while blackbrush and broom snakeweed increase. Species most likely to invade are cheatgrass (*Bromus tectorum*), Prickly Russian thistle (*Salsola tragus*), and Utah juniper (*Juniperus osteosperma*). The single transect within this site had very low production. The most common species are black sagebrush (*Artemisia nova*), Stansbury cliffrose (*Purshia stansburiana*), and blackbrush.

Compartment 15 (Transects 15-113 and 15-115)

Compartment	15		
% Canopy	30	**Initial Carrying Capacity**	1
% Bare Ground	18	**Slope Adjusted Carrying Capacity**	1
% Basal	0		

Ecological Site Summary

Ecological Site	# of Transects	Grazeable Acres	Available Forage	Stocking Rate	Initial Carrying Capacity
R035XC315AZ	2	356	2	1087	0
R035XY243UT	1	380	3	919	0

5.2.16 Compartment 16

Compartment 16 is located in the southeastern portion of the Shonto Chapter, just north of Highway 160. This area is characterized by rolling sagebrush hills and pinyon/juniper woodlands. This compartment has 17,630 grazeable acres and 17 transects within five ecological sites. The largest site is the R035XF607AZ site. The historic climax plant community is composed mostly of shrubs and grasses with a smaller component of forbs and trees. Typical species include Indian ricegrass (*Achnatherum hymenoides*), muttongrass (*Poa fendleriana*), blue grama (*Bouteloua gracilis*), needle and thread (*Hesperostipa comata*), sandhill muhly (*Muhlenbergia pungens*), big sagebrush (*Artemisia tridentata*), mormon tea (*Ephedra viridis*), and antelope bitterbrush (*Purshia tridentata*). Improper grazing practices and/or drought leads to an increase in shrub cover, especially big sagebrush, a reduction of perennial grasses, and eventually, the introduction of non-native annual species. The present plant community contains primarily blue grama with an overstory of big sagebrush and broom snakeweed.

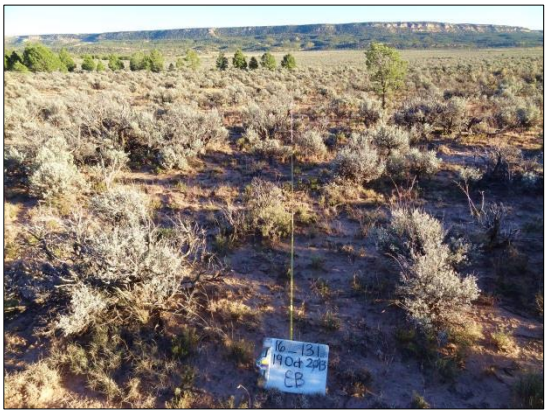
Rock Outcrop makes up the second largest ecological site. This site does not have a written description, but it tends to have sparse vegetation and numerous areas of exposed bedrock/rock outcrops. This site only had one transect, which was located on an expanse of bedrock. No vegetation was present.

The F035XF627AZ site is a forested ecological site. In a relatively undisturbed state, this site is dominated by pinyon and juniper trees, but shrubs and perennial grasses are common in the understory. Understory species often include muttongrass (*Poa fendleriana*), bottlebrush squirreltail (*Elymus elymoides*), blue grama (*Bouteloua gracilis*), Indian ricegrass (*Achnatherum hymenoides*), big sagebrush (*Artemisia tridentata*), mormon tea (*Ephedra viridis*), broom snakeweed (*Gutierrezia sarothrae*), and Stansbury cliffrose (*Purshia stansburiana*). The tree canopy is currently light to moderate, and the understory is dominated by blue grama with an overstory of big sagebrush and broom snakeweed. Several annual species, such as false buffalograss (*Monroa squarrosa*) and purslane (*Portulaca* spp.) are common, as well.

The historic climax plant community for the R035XC315AZ site is primarily composed of grasses, such as Indian ricegrass (*Achnatherum hymenoides*), black grama (*Bouteloua eriopoda*), and blue grama (*Bouteloua gracilis*), with about a 25 percent cover of shrub species. As the site deteriorates, certain species are likely to increase or invade including, big sagebrush (*Artemisia tridentata*), sand sagebrush (*Artemisia filifolia*), rabbitbrush (*Chrysothamnus* spp.), broom snakeweed (*Gutierrezia sarothrae*), sandhill muhly (*Muhlenbergia pungens*), and various annuals. As with most sites in this compartment, the current plant community is composed mainly of big sagebrush, broom snakeweed, and blue grama.

The final ecological site, R035XC312AZ, is characterized by warm and cool season grasses when in an undisturbed state. Dominant species include Indian ricegrass, blue grama, bottlebrush squirreltail, common wolfstail (*Lycurus phleoides*), spike muhly (*Muhlenbergia wrightii*), western wheatgrass (*Pascopyrum smithii*), muttongrass (*Poa fendleriana*), sand dropseed (*Sporobolus cryptandrus*), big sagebrush, fourwing saltbush (*Atriplex canescens*), and winterfat (*Krascheninnikovia lanata*). Continuous yearlong grazing can lead to an increase in shrub species and annual, non-native species. This is a small site within the compartment and contains only one transect. Vegetation encountered on the transect includes big sagebrush, James' galleta (*Pleuraphis jamesii*), broom snakeweed, and blue grama.

Compartment 16 (Transects 16-124 and 16-131)



Compartment	16
% Canopy	31
% Bare Ground	30
% Basal	2
Initial Carrying Capacity	96
Slope Adjusted Carrying Capacity	88

Ecological Site Summary

Ecological Site	# of Transects	Grazeable Acres	Available Forage	Stocking Rate	Initial Carrying Capacity
F035XF627AZ	4	3966	16	145	27
R035XC312AZ	1	261	20	117	2
R035XC315AZ	4	2806	26	92	31
R035XF607AZ	7	5552	15	157	35
Rock outcrop	1	5045	0	0	0

5.2.17 Compartment 17

Compartment 17 is located in the southeastern portion of the Inscription House Chapter, just north of Highway 98 and east of Navajo Route 16. This area contains low, undulating hills with scattered pinyon and juniper trees and sagebrush shrublands. There are 4,370 grazeable acres and six transects within two ecological sites. The majority of the compartment contains the R035XC315AX ecological site. The historic climax plant community for the R035XC315AZ site is primarily composed of grasses, such as Indian ricegrass (*Achnatherum hymenoides*), black grama (*Bouteloua eriopoda*), and blue grama (*Bouteloua gracilis*), with about a 25 percent cover of shrub species. As the site deteriorates, certain species are likely to increase or invade, including big sagebrush (*Artemisia tridentata*), sand sagebrush (*Artemisia filifolia*), rabbitbrush (*Chrysothamnus* spp.), broom snakeweed (*Gutierrezia sarothrae*), sandhill muhly (*Muhlenbergia pungens*), and various annuals. At the time of the survey, primary grass species found was blue grama. Big sagebrush and broom snakeweed make up a substantial part of the overstory. Although mostly dried up, two annual species were also commonly encountered. These were false buffalograss (*Monroa squarrosa*) and silkcotton purslane (*Portulaca halimoides*).

The R035XF606AZ site only occupies 200 acres within the compartment and has one transect. The historic climax plant community for the R035XF606AZ site is represented by grassland with a 30-40 percent shrub component. Dominant species include needle and thread (*Hesperostipa comata*), blue grama, bottlebrush squirreltail (*Elymus elymoides*), winterfat (*Krascheninnikovia lanata*), fourwing saltbush (*Atriplex canescens*), and big sagebrush. Trees and forbs make up a small portion of the community. Perennial grass species, especially cool season grasses, will decline and shrubs will increase under various conditions, including drought, extended periods of winter-dominated moisture, unmanaged grazing, and reductions in the normal fire frequency. Primary species on the transect include broom snakeweed, sand dropseed (*Sporobolus cryptandrus*), blue grama, and false buffalograss.

Compartment 17 (Transects 17-136 and 17-137)

Compartment	17		
% Canopy	53	**Initial Carrying Capacity**	43
% Bare Ground	25	**Slope Adjusted Carrying Capacity**	41
% Basal	0		

Ecological Site Summary

Ecological Site	# of Transects	Grazeable Acres	Available Forage	Stocking Rate	Initial Carrying Capacity
R035XC315AZ	5	4166	24	98	43
R035XF606AZ	1	204	3	701	0

5.2.18 Compartment 18

Compartment 18 is located in the east central region of the Inscription House Chapter, east of Navajo Route 16. This area is marked with stabilized sand dunes, rolling sagebrush shrubland and pockets of pinyon/juniper woodland. There are 7,537 grazeable acres and eight transects within three ecological sites. The historic climax plant community for the R035XC315AZ site is primarily composed of grasses, such as Indian ricegrass (*Achnatherum hymenoides*), black grama (*Bouteloua eriopoda*), and blue grama (*Bouteloua gracilis*), with about a 25 percent cover of shrub species. As the site deteriorates, certain species are likely to increase or invade, including big sagebrush (*Artemisia tridentata*), sand sagebrush (*Artemisia filifolia*), rabbitbrush (*Chrysothamnus* spp.), broom snakeweed (*Gutierrezia sarothrae*), sandhill muhly (*Muhlenbergia pungens*), and various annuals. At present, big sagebrush is the dominant plant species followed by broom snakeweed and blackbrush (*Coleogyne ramosissima*).

The F035XF627AZ site is a forested ecological site. In a relatively undisturbed state, this site is dominated by pinyon and juniper trees, but shrubs and perennial grasses are common in the understory. Understory species often include muttongrass (*Poa fendleriana*), bottlebrush squirreltail (*Elymus elymoides*), blue grama, Indian ricegrass, big sagebrush, mormon tea (*Ephedra viridis*), broom snakeweed, and Stansbury cliffrose (*Purshia stansburiana*). The major species found during the survey are blue grama, muttongrass, field sagewort (*Artemisia campestris*), broom snakeweed, and big sagebrush.

The R035XF607AZ site is the largest ecological site in the compartment. The historic climax plant community is composed mostly of shrubs and grasses with a smaller component of forbs and trees. Typical species include Indian ricegrass, muttongrass, blue grama, needle and thread (*Hesperostipa comata*), sandhill muhly, big sagebrush, mormon tea, and antelope bitterbrush (*Purshia tridentata*). Improper grazing practices and/or drought leads to an increase in shrub cover, especially big sagebrush, reduction of perennial grasses, and eventually, the introduction of non-native annual species. Big sagebrush, rubber rabbitbrush (*Ericameria nauseosa*), blue grama, and sand dropseed (*Sporobolus cryptandrus*) are the key components of the sampled community.

Compartment 18 (Transects 18-142 and 18-145)

Compartment	18
% Canopy	21
% Bare Ground	36
% Basal	1
Initial Carrying Capacity	34
Slope Adjusted Carrying Capacity	31

Ecological Site Summary

Ecological Site	# of Transects	Grazeable Acres	Available Forage	Stocking Rate	Initial Carrying Capacity
F035XF627AZ	1	1859	4	598	3
R035XC315AZ	3	2770	14	163	17
R035XF607AZ	4	2908	11	214	14

5.2.19 Compartment 19

Compartment 19 is located halfway between the communities of Inscription House and Shonto, near the upper reaches of Begashibito Wash. The compartment contains a mix of small canyons and hills with scattered pinyon and juniper trees and sagebrush shrubland. There are 16,420 grazeable acres and 21 transects within two ecological sites. All but one transect are located within the R035XC315AZ site. The historic climax plant community is primarily composed of grasses, such as Indian ricegrass (*Achnatherum hymenoides*), black grama (*Bouteloua eriopoda*), and blue grama (*Bouteloua gracilis*), with about a 25 percent cover of shrub species. As the site deteriorates, certain species are likely to increase or invade, including big sagebrush (*Artemisia tridentata*), sand sagebrush (*Artemisia filifolia*), rabbitbrush (*Chrysothamnus* spp.), broom snakeweed (*Gutierrezia sarothrae*), sandhill muhly (*Muhlenbergia pungens*), and various annuals. It appears that big sagebrush has increased on this site, as it is a major component of plant communities sampled in the survey. Annual species, such as goosefoot (*Chenopodium* sp.) purslane (*Portulaca* spp.), and prickly Russian thistle (*Salsola tragus*) are also abundant. Other species include blue grama, sand dropseed (*Sporobolus cryptandrus*), and tall dropseed (*Sporobolus contractus*).

The second ecological site, R035XC312AZ, is characterized by warm and cool season grasses when in an undisturbed state. Dominant species include Indian ricegrass, blue grama, bottlebrush squirreltail (*Elymus elymoides*), common wolfstail (*Lycurus phleoides*), spike muhly (*Muhlenbergia wrightii*), western wheatgrass (*Pascopyrum smithii*), muttongrass (*Poa fendleriana*), sand dropseed, big sagebrush, fourwing saltbush (*Atriplex canescens*), and winterfat (*Krascheninnikovia lanata*). Continuous yearlong grazing can lead to an increase in shrub species and annual, non-native species. Currently, the non-native, annual forb, prickly Russian thistle is dominant in the plant community, followed by false buffalograss (*Monroa squarrosa*), yellow rabbitbrush (*Chrysothamnus viscidiflorus*), and little hogweed (*Portulaca oleracea*).

Compartment 19 (Transects 19-156 and 19-164)

Compartment	19
% Canopy	40
% Bare Ground	35
% Basal	2
Initial Carrying Capacity	203
Slope Adjusted Carrying Capacity	189

Ecological Site Summary

Ecological Site	# of Transects	Grazeable Acres	Available Forage	Stocking Rate	Initial Carrying Capacity
R035XC312AZ	1	145	8	304	0
R035XC315AZ	20	16275	29	80	202

5.2.20 Compartment 20

Compartment 20 encompasses a region of badlands, canyons, and sand dunes in the northeast corner of the Shonto Community, close to the Utah state line. This is one of the larger compartments and contains 41,616 grazeable acres. The 41 transects were placed within five ecological sites. The largest site, and the one with the highest carrying capacity, is the R035XC328AZ site. Grassland with only small amounts of shrubs, forbs, and trees makes up the historic climax plant community of the R035XC328AZ site. Common cool season grasses are Indian ricegrass (*Achnatherum hymenoides*), bottlebrush squirreltail (*Elymus elymoides*), needle and thread (*Hesperostipa comata*), and New Mexico feathergrass (*Hesperostipa neomexicana*). The primary warm season grasses include black grama (*Bouteloua eriopoda*), blue grama (*Bouteloua gracilis*), sand dropseed (*Sporobolus cryptandrus*), and James' galleta (*Pleuraphis jamesii*). When present, shrubs include big sagebrush (*Artemisia tridentata*), fourwing saltbush (*Atriplex canescens*), broom snakeweed (*Gutierrezia sarothrae*), and plains pricklypear (*Opuntia polyacantha*). Unmanaged grazing and drought will lead to an increase in shrubs like broom snakeweed and big sagebrush, a decrease in cool season, perennial grasses, and an increase in annual species and warm season grasses. Production on the transects was variable and dominant species include big sagebrush, roundleaf buffaloberry (*Shepherdia rotundifolia*), broom snakeweed, and Greene's rabbitbrush (*Chrysothamnus greenei*). Perennial grasses were scarce, although one transect did contain a fair amount of Indian ricegrass.

The historic climax plant community for the R035XC314AZ site contains many perennial grasses, a 30-40 percent shrub cover, and scattered pinyon and juniper trees. Major grasses are Indian ricegrass, needle and thread, James' galleta, and blue grama. Common shrubs include Bigelow sage (*Artemisia bigelovii*), Greene's rabbitbrush, jointfir (*Ephedra* spp.), broom snakeweed, antelope bitterbrush (*Purshia tridentata*), and Stansbury cliffrose (*Purshia stansburiana*). Species most likely to increase or invade are cheatgrass (*Bromus tectorum*), thrift mock goldenweed (*Stenotus armerioides*), broom snakeweed, and annual forbs. The major species found in the current plant community include broom snakeweed, roundleaf buffaloberry, blackbrush (*Coleogyne ramosissima*), and phacelia (*Phacelia* sp.).

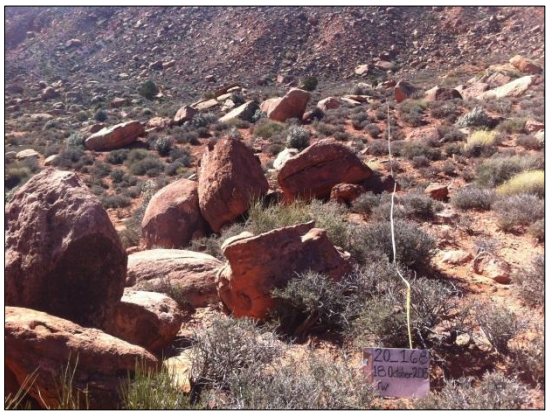
The R035XC302AZ site is composed of sedimentary cliffs. The historic climax plant community contains a mix of trees, shrubs, forbs, and grasses, the proportion depending upon soil depth, aspect, and extent of run-on/run-off areas. Prolonged disturbance will lead first to an increase in shrub species, especially composites like broom snakeweed and rabbitbrush (*Chrysothamnus* spp.). Continued disturbance will cause further depletions in native, perennial grasses and eventually lead to a shrub community with an understory of non-native annual species, such as cheatgrass and redstem stork's bill (*Erodium cicutarium*). No non-native species were encountered at this site, but native plant production is quite low and shrubs, particularly roundleaf buffaloberry, are above the ratio associated with the historic climax plant community.

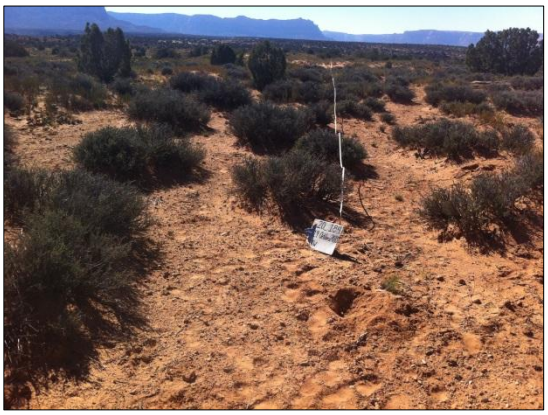
The R035XC317AZ site is composed of sandy loam upland, and the historic climax plant community tends to be dominated by a mix of warm and cool season grasses like purple threeawn (*Aristida purpurea*), black grama, blue grama, and Indian ricegrass. Shrubs and subshrubs are scattered and include big sagebrush, fourwing saltbush, jointfir, and broom snakeweed. Native annual forbs and grasses may be present in small amounts. As the site deteriorates, broom snakeweed and Greene's rabbitbrush will increase along with big sagebrush at higher elevations and jointfir at lower, dryer sites. At this point, managed grazing, brush thinning, and favorable moisture can return to the site to the historic climax plant

community. However, unmanaged grazing and drought can lead to the introduction of non-native annuals and an irreversible change in the plant community. Eventually, non-native species will largely replace native herbaceous species and woody shrubs and trees will come to dominate the overstory. At the time of the survey, no non-native species were found, but production of perennial grasses is very low. The most commonly encountered species include Greene's rabbitbrush, broom snakeweed, phacelia (*Phacelia* sp.), and plains pricklypear. The overall low production coupled with the prevalence of non-forage species suggests that this site is at risk for further deterioration and the introduction of non-native species.

The R035XC333AZ site is a sandstone upland site characterized by shallow soils and shrubland dominated by blackbrush with lesser amounts of fourwing saltbush, Bigelow sagebrush, and jointfir. Common grass species include Indian ricegrass, James' galleta, blue grama, and sand dropseed. Unmanaged grazing can quickly reduce understory species and lead to a near monoculture of blackbrush. Continued disturbance will see the meager understory replaced by non-native species such as cheatgrass, red brome (*Bromus rubens*), and prickly Russian thistle (*Salsola tragus*). Transects in this site show that the site is somewhat degraded, as blackbrush and broom snakeweed are prevalent while forage grasses are scarce. Annual forbs and grasses are also common, but no introduced, non-native species were found. The most abundant perennial grass encountered was blue grama.

Compartment 20 (Transects 20-168 and 20-184)





Compartment	20
% Canopy	19
% Bare Ground	40
% Basal	1
Initial Carrying Capacity	47
Slope Adjusted Carrying Capacity	30

Ecological Site Summary

Ecological Site	# of Transects	Grazeable Acres	Available Forage	Stocking Rate	Initial Carrying Capacity
R035XC302AZ	1	3153	1	2443	1
R035XC314AZ	10	9175	4	664	14
R035XC317AZ	10	6738	1	2788	2
R035XC328AZ	14	16817	3	729	23
R035XC333AZ	6	5733	3	926	6

5.2.21 Compartment 21

Compartment 21 is located in the northwest region of the Shonto Community and encompasses the mesa country found just east of Paiute Canyon. This area is composed of pinyon/juniper woodland, sagebrush shrubland, and grassy openings. There are 17,895 grazeable acres, 17 transects, and four ecological sites. The largest site, and the one with the highest carrying capacity, is the R035XF607AZ site. The historic climax plant community is composed mostly of shrubs and grasses with a smaller component of forbs and trees. Typical species include Indian ricegrass (*Achnatherum hymenoides*), muttongrass (*Poa fendleriana*), blue grama (*Bouteloua gracilis*), needle and thread (*Hesperostipa comata*), sandhill muhly (*Muhlenbergia pungens*), big sagebrush (*Artemisia tridentata*), Torrey's jointfir (*Ephedra torreyana*), and antelope bitterbrush (*Purshia tridentata*). Improper grazing practices and/or drought leads to an increase in shrub cover, especially big sagebrush, reduction of perennial grasses, and eventually, the introduction of non-native annual species. Currently, it is evident that shrubs have increased, particularly big sagebrush and Greene's rabbitbrush (*Chrysothamnus greenei*). Forage production is low and small amounts of the non-native forb redstem stork's bill (*Erodium cicutarium*) occurred on one transect.

The second largest site is Rock Outcrop, but no description is yet available. In general, this site is characterized by large expanses of exposed bedrock and rock outcrops, low production, and a mix of shrubs, grasses, and forbs. The one transect located in this site found a community marked by various annual forbs, broom snakeweed, Stansbury cliffrose (*Purshia stansburiana*), and Torrey's jointfir.

The R035XF627AZ site has the best stocking rate, but due to its smaller size, the carrying capacity is less than that found in the R035XF607AZ site. In a relatively undisturbed state, this site is dominated by pinyon and juniper trees, but shrubs and perennial grasses are common in the understory. Understory species often include muttongrass, bottlebrush squirreltail (*Elymus elymoides*), blue grama, Indian ricegrass, big sagebrush, Torrey's jointfir, broom snakeweed, and Stansbury cliffrose. Unmanaged grazing and a lack of fire can cause an increase in tree/shrub canopy, while the introduction of fire and managed grazing can push the community towards a more open shrub/grassland state. Transects within this site found that tree canopy ranges from low to moderate. The current understory community is dominated by big sagebrush mixed with Cutler's jointfir (*Ephedra cutleri*), plains pricklypear (*Opuntia polyacantha*), roundleaf buffaloberry (*Shepherdia rotundifolia*), and broom snakeweed. Herbaceous species are not prevalent, but those present are primarily annual forbs and grasses including small amounts of non-natives like redstem stork's bill and cheatgrass (*Bromus tectorum*).

The R035XC328AZ site is the smallest in the compartment. The historic climax plant community contains mostly grass species with a small amount of big sagebrush, broom snakeweed, and Utah juniper (*Juniperus osteosperma*). Deterioration of the site is marked by increases in woody species, decreases in perennial grasses, and eventually, the introduction of non-native annual species. Currently, the site is dominated by blackbrush (*Coleogyne ramosissima*) and rubber rabbitbrush (*Ericameria nauseosa*), with few species found in the shrub interspaces.

Compartment 21 (Transects 21-209 and 21_218)

Compartment	21
% Canopy	14
% Bare Ground	52
% Basal	0
Initial Carrying Capacity	65
Slope Adjusted Carrying Capacity	54

Ecological Site Summary

Ecological Site	# of Transects	Grazeable Acres	Available Forage	Stocking Rate	Initial Carrying Capacity
F035XF627AZ	11	5150	13	186	28
R035XC328AZ	1	358	2	1234	0
R035XF607AZ	4	7210	10	233	31
Rock outcrop	1	5177	3	926	6

5.2.22 Compartment 22

Compartment 22 is a mid-sized compartment located within the confines of Paiute Canyon, just south of the Utah state line. It contains 14,619 grazeable acres, 17 transects and two ecological sites. All transects except for one fall within the R035XC328AZ site, which makes about 85 percent of the compartment. Grassland with only small amounts of shrubs, forbs, and trees makes up the historic climax plant community of the R035XC328AZ site. Common cool season grasses are Indian ricegrass (*Achnatherum hymenoides*), bottlebrush squirreltail (*Elymus elymoides*), needle and thread (*Hesperostipa comata*), and New Mexico feathergrass (*Hesperostipa neomexicana*). The primary warm season grasses include black grama (*Bouteloua eriopoda*), blue grama (*Bouteloua gracilis*), sand dropseed (*Sporobolus cryptandrus*), and James' galleta (*Pleuraphis jamesii*). When present, shrubs include big sagebrush (*Artemisia tridentata*), fourwing saltbush (*Atriplex canescens*), broom snakeweed (*Gutierrezia sarothrae*), and plains pricklypear (*Opuntia polyacantha*). Unmanaged grazing and drought will lead to an increase in shrubs like broom snakeweed and big sagebrush, a decrease in cool season, perennial grasses, and an increase in annual species and warm season grasses. At the time of the survey, shrubs were much in evidence, especially roundleaf buffaloberry (*Shepherdia rotundifolia*) and broom snakeweed. Additionally, invasive, non-native species were also prevalent, including prickly Russian thistle (*Salsola tragus*), redstem stork's bill (*Erodium cicutarium*), and cheatgrass (*Bromus tectorum*).

The R035XC302AZ site is composed of sedimentary cliffs. The historic climax plant community contains a mix of trees, shrubs, forbs, and grasses, the proportion depending upon soil depth, aspect, and extent of run-on/run-off areas. Prolonged disturbance will lead first to an increase in shrub species, especially composites like broom snakeweed and rabbitbrush (*Chrysothamnus* spp.). Continued disturbance will cause further depletions in native, perennial grasses and eventually lead to a shrub community with an understory of non-native annual species such as cheatgrass and redstem stork's bill. Production is currently low and the main species include broom snakeweed, plains pricklypear, and yucca (*Yucca* spp.). Herbaceous species are sparse and include mostly annual forbs, including redstem stork's bill.

Grazing can be difficult to manage in this compartment as the grazeable acres are all located along the bottoms and lower benches of the main canyon and side canyons. The confining nature of these canyons tends to concentrate animals and overgrazing can happen at a rapid pace, especially during times of low moisture, when forage is not readily available.

Compartment 22 (Transects 22-226 and 22-242)

Compartment	22
% Canopy	19
% Bare Ground	40
% Basal	1
Initial Carrying Capacity	25
Slope Adjusted Carrying Capacity	11

Ecological Site Summary

Ecological Site	# of Transects	Grazeable Acres	Available Forage	Stocking Rate	Initial Carrying Capacity
R035XC302AZ	1	2308	1	2194	1
R035XC328AZ	16	12311	5	524	23

5.2.23 Compartment 23

Compartment 23 is located in the central region of the Shonto Community in the broken hill country found east of the upper reaches of Paiute Canyon. It contains 10,205 grazeable acres, 11 transects, and two ecological sites. The R035XF607AZ site is twice the size of the second site, R035XF627AZ, and the carrying capacity is roughly twice as large, as well. The historic climax plant community for the R035XF607AZ site is composed mostly of shrubs and grasses with a smaller component of forbs and trees. Typical species include Indian ricegrass (*Achnatherum hymenoides*), muttongrass (*Poa fendleriana*), blue grama (*Bouteloua gracilis*), needle and thread (*Hesperostipa comata*), sandhill muhly (*Muhlenbergia pungens*), big sagebrush (*Artemisia tridentata*), Torrey's jointfir (*Ephedra torreyana*), and antelope bitterbrush (*Purshia tridentata*). Improper grazing practices and/or drought leads to an increase in shrub cover, especially big sagebrush, reduction of perennial grasses, and eventually, the introduction of non-native annual species. Currently, big sagebrush, rabbitbrush (*Chrysothamnus* spp.), and plains pricklypear (*Opuntia polyacantha*) make the majority of the overstory, while the understory contains a mix of blue grama, bottlebrush squirreltail (*Elymus elymoides*), lobeleaf groundsel (*Packera multilobata*), and fineleaf hymenopappus (*Hymenopappus filifoliius*). A small amount of cheatgrass (*Bromus tectorum*) was found at one transect.

The R035XF627AZ site has a historic climax plant community dominated by pinyon and juniper trees, but shrubs and perennial grasses are common in the understory. Understory species often include muttongrass, bottlebrush squirreltail, blue grama, Indian ricegrass, big sagebrush, Torrey's jointfir, broom snakeweed, and Stansbury cliffrose (*Purshia stansburiana*). Unmanaged grazing and a lack of fire can cause an increase in tree/shrub canopy, while the introduction of fire and managed grazing can push the community towards a more open shrub/grassland state. Observations made at the transects indicate that tree canopy is fairly dense at this time. Common species encountered include big sagebrush, broom snakeweed (*Gutierrezia sarothrae*), antelope bitterbrush, blue grama, bottlebrush squirreltail, and ragwort (*Packera* spp.).

Compartment 23 (Transects 23-243 and 23-252)

Compartment	23
% Canopy	19
% Bare Ground	44
% Basal	0
Initial Carrying Capacity	58
Slope Adjusted Carrying Capacity	46

Ecological Site Summary

Ecological Site	# of Transects	Grazeable Acres	Available Forage	Stocking Rate	Initial Carrying Capacity
F035XF627AZ	5	3802	10	229	17
R035XF607AZ	6	6403	15	156	41

5.2.24 Compartment 24

Compartment 24 is located in the east central portion of the Shonto Community and occupies a region of low hills and small drainages. This compartment contains 13,579 grazeable acres, 15 transects, and three ecological sites. The highest carrying capacity and highest acreage belongs to the R035XF607AZ site. The historic climax plant community for the R035XF607AZ site is composed mostly of shrubs and grasses with a smaller component of forbs and trees. Typical species include Indian ricegrass (*Achnatherum hymenoides*), muttongrass (*Poa fendleriana*), blue grama (*Bouteloua gracilis*), needle and thread (*Hesperostipa comata*), sandhill muhly (*Muhlenbergia pungens*), big sagebrush (*Artemisia tridentata*), Torrey's jointfir (*Ephedra torreyana*), and antelope bitterbrush (*Purshia tridentata*). Improper grazing practices and/or drought leads to an increase in shrub cover, especially big sagebrush, reduction of perennial grasses, and eventually, the introduction of non-native annual species. Production at this site is currently being driven primarily by big sagebrush, blue grama, and broom snakeweed (*Gutierrezia sarothrae*). Less abundant, but still common, are rubber rabbitbrush (*Ericameria nauseosa*), tall dropseed (*Sporobolus contractus*), nodding buckwheat (*Eriogonum cernuum*), bottlebrush squirreltail (*Elymus elymoides*), and little hogweed (*Portulaca oleracea*).

The R035XF627AZ site has a historic climax plant community dominated by pinyon and juniper trees, but shrubs and perennial grasses are common in the understory. Understory species often include muttongrass, bottlebrush squirreltail, blue grama, Indian ricegrass, big sagebrush, Torrey's jointfir, broom snakeweed, and Stansbury cliffrose (*Purshia stansburiana*). Unmanaged grazing and a lack of fire can cause an increase in tree/shrub canopy, while the introduction of fire and managed grazing can push the community towards a more open shrub/grassland state. Tree canopy at the transects tended to be around 10 percent. Shrubs are abundant and include big sagebrush, yellow rabbitbrush (*Chrysothamnus viscidiflorus*), and broom snakeweed. Common herbaceous species are blue grama, dropseed (*Sporobolus* spp.), and little hogweed. A variety of species were found, but only in trace amounts.

The third ecological site is the R035XC315AZ site, which is primarily composed of grasses, such as Indian ricegrass, black grama (*Bouteloua eriopoda*), and blue grama, with about a 25 percent cover of shrub species. As the site deteriorates, certain species are likely to increase or invade, including big sagebrush, sand sagebrush (*Artemisia filifolia*), rabbitbrush (*Chrysothamnus* spp.), broom snakeweed, sandhill muhly (*Muhlenbergia pungens*), and various annuals. The majority of the biomass is currently being produced by big sagebrush, blue grama, little hogweed, and flatspine bur ragweed (*Ambrosia acanthicarpa*).

Compartment 24 (Transects 24-262 and 24-265)

Compartment	24		
% Canopy	27	**Initial Carrying Capacity**	91
% Bare Ground	25	**Slope Adjusted Carrying Capacity**	81
% Basal	2		

Ecological Site Summary

Ecological Site	# of Transects	Grazeable Acres	Available Forage	Stocking Rate	Initial Carrying Capacity
F035XF627AZ	5	4847	9	271	18
R035XC315AZ	2	1947	19	128	15
R035XF607AZ	8	6785	20	117	58

5.2.25 Compartment 25

Compartment 25 is restricted primarily to Cummings Mesa which rises above a network of sandstone canyons, just below the Utah state line. Two transects were also placed within Wetherill Canyon which bisects the mesa and drains north towards Lake Powell. This compartment has 6,022 grazeable acres, eight transects, and four ecological sites. There are two transects in the canyon, one in the R035XC302AZ site and one in the R035XC314AZ site. The R035XC302AZ site is composed of sedimentary cliffs. The historic climax plant community contains a mix of trees, shrubs, forbs, and grasses, the proportion depending upon soil depth, aspect, and extent of run-on/run-off areas. Prolonged disturbance will lead first to an increase in shrub species, especially composites like broom snakeweed (*Gutierrezia sarothrae*) and rabbitbrush (*Chrysothamnus* spp.). Continued disturbance will cause further depletions in native perennial grasses and eventually lead to a shrub community with an understory of non-native annual species, such as cheatgrass (*Bromus tectorum*) and redstem stork's bill (*Erodium cicutarium*). At the time of the survey, cheatgrass was much in evidence and producing the most biomass of any other species. Other common species include winding mariposa lily (*Calochortus flexuosus*), six weeks fescue (*Vulpia octoflora*), narrowleaf yucca (*Yucca angustissima*), blackbrush (*Coleogyne ramosissima*), foothill deathcamas (*Zigadenus paniculatus*), onion (*Allium* sp.), and muttongrass (*Poa fendleriana*).

The historic climax plant community for the R035XC314AZ site contains many perennial grasses, a 30-40 percent shrub cover, and scattered pinyon and juniper trees. Major grasses are Indian ricegrass (*Achnatherum hymenoides*), needle and thread (*Hesperostipa comata*), James' galleta (*Pleuraphis jamesii*), and blue grama (*Bouteloua gracilis*). Common shrubs include Bigelow sage (*Artemisia bigelovii*), Greene's rabbitbrush (*Chrysothamnus greenei*), jointfir (*Ephedra* spp.), broom snakeweed, antelope bitterbrush (*Purshia tridentata*), and Stansbury cliffrose (*Purshia stansburiana*). Species most likely to increase or invade are cheatgrass, thrift mock goldenweed (*Stenotus armerioides*), broom snakeweed, and annual forbs. Production is currently limited at this site, but the more abundant species include winding mariposa lily, six weeks fescue, mormon tea (*Ephedra viridis*), milkvetch (*Astragalus* sp.), and blackbrush.

Ecological sites on the mesa top include R035XC331AZ and R035XC373AZ. The R035XC331AZ site is a shallow upland defined by shallow soils over limestone and sandstone bedrock with a plant community composed primarily of blackbrush, jointfir (*Ephedra* spp.), James' galleta, desert needlegrass (*Achnatherum speciosum*), and blue grama. Site degradation leads to an increase in blackbrush and the introduction of non-native species such as cheatgrass, redstem stork's bill, and prickly Russian thistle (*Salsola tragus*). Field surveys of this area found that the site has been degraded with blackbrush and plains pricklypear (Opuntia polyacantha) dominating the overstory and the understory mostly made up of annuals, including cheatgrass.

The R035XC373AZ site is a sandy upland site with a plant community consisting of blackbrush, jointfir, fourwing saltbush (*Atriplex canescens*), James' galleta, Indian ricegrass, and blue grama. Disturbance at this site will initially lead to an increase in blackbrush, broom snakeweed, jointfir, yucca (*Yucca* spp.), and rabbitbrush. Overtime, bare ground will increase leading to small blowouts and areas of active soil deposition. The structure of the plant community will also change with species like sand sagebrush (*Artemisia filifolia*), rubber rabbitbrush (*Ericameria nauseosa*), sand buckwheat (*Eriogonum leptocladon*), Greene's rabbitbrush, pillar false gumweed (*Vanclevea stylosa*), and sandhill muhly (*Muhlenbergia pungens*) coming to occupy the blowout areas. Eventually, continuous disturbance will

lead to a shrub overstory will mostly native and non-native species occupying the shrub interspaces. This site appears to have been heavily utilized by livestock in the past. Blackbrush is very dense in most places and cheatgrass is prevalent. Native herbaceous species are almost entirely annual forbs and grasses.

Compartment 25 (Transects 25-271 and 25-274)

Compartment	25		
% Canopy	39	**Initial Carrying Capacity**	16
% Bare Ground	40	**Slope Adjusted Carrying Capacity**	12
% Basal	2		

Ecological Site Summary

Ecological Site	# of Transects	Grazeable Acres	Available Forage	Stocking Rate	Initial Carrying Capacity
R035XC302AZ	1	797	15	154	5
R035XC314AZ	1	149	7	322	0
R035XC331AZ	1	1450	3	725	2
R035XC373AZ	5	3626	6	418	9

5.2.26 Compartment 26

Compartment 26 is located east of Potato Canyon along the western edge of the Inscription House Community. This area is comprised of sagebrush shrubland with occasional areas of exposed sandstone outcrops. There are 11,555 grazeable acres, 15 transects, and five ecological sites. The most represented site is the R035XF607AZ site which also, despite its size, has one of the lowest carrying capacities in the compartment. The historic climax plant community for the R035XF607AZ site is composed mostly of shrubs and grasses with a smaller component of forbs and trees. Typical species include Indian ricegrass (*Achnatherum hymenoides*), muttongrass (*Poa fendleriana*), blue grama (*Bouteloua gracilis*), needle and thread (*Hesperostipa comata*), sandhill muhly (*Muhlenbergia pungens*), big sagebrush (*Artemisia tridentata*), Torrey's jointfir (*Ephedra torreyana*), and antelope bitterbrush (*Purshia tridentata*). Improper grazing practices and/or drought leads to an increase in shrub cover, especially big sagebrush, reduction of perennial grasses, and eventually, the introduction of non-native annual species. Production in the current plant community is being driven by blue grama, broom snakeweed (*Gutierrezia sarothrae*), and big sagebrush. Production is low for all forage species, but as only one transect fell within this site, it is difficult to tell whether or not this is a pattern or an exception.

The highest carrying capacity is associated with the R035XA118AZ site. Cool and warm season grasses dominate the historic climax plant community of this site. The main grasses include Indian ricegrass, bottlebrush squirreltail (*Elymus elymoides*), needle and thread (*Hesperostipa comata*), black grama (*Bouteloua eriopoda*), and blue grama. Shrubs are scattered and include sand sagebrush (*Artemisia filifolia*), fourwing saltbush (*Atriplex canescens*), jointfir (*Ephedra* spp.), and winterfat (*Krascheninnikovia lanata*). Prolonged disturbance will eventually cause this site to revert to an early seral state characterized by non-native and native annual forbs mixed with subshrubs, annual grasses, and a few remnant native, perennial grasses. The current plant community still contains many native perennials, especially blue grama and sand dropseed (*Sporobolus cryptandrus*).

The R035XA115AZ site has a historic climax community made up of warm season grasses such as black grama, blue grama, and James' galleta (*Pleuraphis jamesii*). Common woody species include Bigelow sage (*Artemisia bigelovii*), jointfir (*Ephedra* spp.), and Stansbury cliffrose (*Purshia stansburiana*). A small percentage on non-native annuals may be present, but they do not affect the site's ecological processes. Prolonged disturbance will cause an increase in shrub species and subsequent decline in favorable grass species. Transect data show that blue grama is the dominant species at this time with a moderate canopy of big sagebrush. Other species include sand dropseed, Indian ricegrass, broom snakeweed, and plains pricklypear (*Opuntia polyacantha*).

The majority of transects are located in the R035XF606AZ site. The historic climax plant community for this site is represented by grassland with a 30-40 percent shrub component. Dominant species include needle and thread, blue grama, bottlebrush squirreltail, winterfat, fourwing saltbush, and big sagebrush. Trees and forbs make up a small portion of the community. Perennial grass species, especially cool season grasses, will decline and shrubs will increase following under various conditions including drought, extended periods of winter-dominated moisture, unmanaged grazing, and reductions in the normal fire frequency. At this time, big sagebrush has evidently increased and is the dominant species on

most transects. Pinyon and juniper canopy is also fairly high. The shrub interspaces contain a mix of pricklypear (*Opuntia* spp.), little hogweed (*Portulaca oleracea*), broom snakeweed, and blue grama.

The historic climax plant community for the R035XC314AZ site contains many perennial grasses, a 30-40 percent shrub cover, and scattered pinyon and juniper trees. Major grasses are Indian ricegrass, needle and thread, James' galleta, and blue grama. Common shrubs include Bigelow sagebrush, Greene's rabbitbrush (*Chrysothamnus greenei*), jointfir, broom snakeweed, antelope bitterbrush, and Stansbury cliffrose. Species most likely to increase or invade are cheatgrass (*Bromus tectorum*), thrift mock goldenweed (*Stenotus armerioides*), broom snakeweed, and annual forbs. The transects in this site fell in areas of stabilized sand dunes. The most common shrub is Cutler's jointfir (Ephedra cutleri) and the highest producing grasses are blue grama and sandhill muhly. Indian ricegrass is not as abundant, but does occur fairly frequently. A small amount of prickly Russian thistle (*Salsola tragus*) was found on one transect.

Compartment 26 (Transects 26-278 and 26-280)

Compartment	26
% Canopy	29
% Bare Ground	43
% Basal	2
Initial Carrying Capacity	62
Slope Adjusted Carrying Capacity	50

Ecological Site Summary

Ecological Site	# of Transects	Grazeable Acres	Available Forage	Stocking Rate	Initial Carrying Capacity
R035XA115AZ	3	1294	23	104	12
R035XA118AZ	1	1811	26	92	20
R035XC314AZ	4	684	13	177	4
R035XF606AZ	6	2284	16	151	15
R035XF607AZ	1	5482	5	494	11

5.2.27 Compartment 27

Compartment 27 is located in the south central region of the Inscription House Community, north of Highway 98 and west of Navajo Route 16. This area is made up mostly of rolling shrubland, but some areas of exposed, sandstone bedrock and pinyon/juniper woodland exists above the network of canyons to the west. There are 9,888 grazeable acres, nine transects, and four ecological sites. The highest carrying capacity is found in the R035XF607AZ site. The historic climax plant community for the R035XF607AZ site is composed mostly of shrubs and grasses with a smaller component of forbs and trees. Typical species include Indian ricegrass (*Achnatherum hymenoides*), muttongrass (*Poa fendleriana*), blue grama (*Bouteloua gracilis*), needle and thread (*Hesperostipa comata*), sandhill muhly (*Muhlenbergia pungens*), big sagebrush (*Artemisia tridentata*), Torrey's jointfir (*Ephedra torreyana*), and antelope bitterbrush (*Purshia tridentata*). Improper grazing practices and/or drought leads to an increase in shrub cover, especially big sagebrush, reduction of perennial grasses, and eventually, the introduction of non-native annual species. The current plant community is missing many of the perennial grasses associated with the historic climax plant community, but one species, blue grama, is prevalent and James' galleta (*Pleuraphis jamesii*) is common as well. The overstory is composed primarily of big sagebrush.

The R035XF606AZ site is represented historically by grassland with a 30-40 percent shrub component. Dominant species include needle and thread, blue grama, bottlebrush squirreltail (*Elymus elymoides*), winterfat (*Krascheninnikovia lanata*), fourwing saltbush (*Atriplex canescens*), and big sagebrush. Trees and forbs make up a small portion of the community. Perennial grass species, especially cool season grasses, will decline and shrubs will increase following under various conditions including drought, extended periods of winter-dominated moisture, unmanaged grazing, and reductions in the normal fire frequency. Only one transect was located in this ecological site. The area surrounding the transect consists of a low, sandy ridge populated with pinyon and juniper trees with scarce vegetation in the understory. The more common species include fineleaf hymenopappus (*Hymenopappus filifolius*), rockcress (*Arabis* sp.), James' galleta, Indian ricegrass, plains pricklypear (*Opuntia polyacantha*), and Stansbury cliffrose (*Purshia stansburiana*).

The historic climax plant community for the R035XC314AZ site contains many perennial grasses, a 30-40 percent shrub cover, and scattered pinyon and juniper trees. Major grasses are Indian ricegrass, needle and thread, James' galleta, and blue grama. Common shrubs include Bigelow sage (*Artemisia bigelovii*), Greene's rabbitbrush (*Chrysothamnus greenei*), jointfir (*Ephedra spp.*), broom snakeweed (*Gutierrezia sarothrae*), antelope bitterbrush, and Stansbury cliffrose. Species most likely to increase or invade are cheatgrass (*Bromus tectorum*), thrift mock goldenweed (*Stenotus armerioides*), broom snakeweed, and annual forbs. Currently, this site is in a degraded condition with production of forage grasses being low and production of the non-native, annual forb, prickly Russian thistle (*Salsola tragus*) being high. The most commonly encountered shrub species is Cutler's jointfir (*Ephedra cutleri*), followed by rubber rabbitbrush (*Ericameria nauseosa*).

The R035XC302AZ site is composed of sedimentary cliffs. The historic climax plant community contains a mix of trees, shrubs, forbs, and grasses, the proportion depending upon soil depth, aspect, and extent of run-on/run-off areas. Prolonged disturbance will lead first to an increase in shrub species, especially composites like broom snakeweed and rabbitbrush (*Chrysothamnus* spp.). Continued disturbance will cause further depletions in native, perennial grasses and eventually lead to a shrub community with an understory of non-native annual species such as cheatgrass and redstem stork's bill (*Erodium cicutarium*).

In compartment 27, this site is found in the sandy regions near the canyon rims in the western region. Sand loving species such as blue grama, Cutler's jointfir, sand dropseed (*Sporobolus cryptandrus*), false buffalograss (*Monroa squarrosa*), rubber rabbitbrush, and frosted mint (*Poliomintha incana*) are common components of the plant community.

Compartment 27 (Transects 27-293 and 27-297)

Compartment	27
% Canopy	26
% Bare Ground	59
% Basal	0
Initial Carrying Capacity	45
Slope Adjusted Carrying Capacity	33

Ecological Site Summary

Ecological Site	# of Transects	Grazeable Acres	Available Forage	Stocking Rate	Initial Carrying Capacity
R035XC302AZ	2	3977	11	224	18
R035XC314AZ	3	746	14	172	4
R035XF606AZ	1	1501	5	432	3
R035XF607AZ	3	3664	12	191	19

5.2.28 Compartment 28

Compartment 28 is a very small compartment located on a small peninsula of land just above the canyon country near Inscription House. There are 128 grazeable acres, one transect, and one ecological site. The historic climax plant community for the R035XF607AZ site is composed mostly of shrubs and grasses with a smaller component of forbs and trees. Typical species include Indian ricegrass (*Achnatherum hymenoides*), muttongrass (*Poa fendleriana*), blue grama (*Bouteloua gracilis*), needle and thread (*Hesperostipa comata*), sandhill muhly (*Muhlenbergia pungens*), big sagebrush (*Artemisia tridentata*), Torrey's jointfir (*Ephedra torreyana*), and antelope bitterbrush (*Purshia tridentata*). Improper grazing practices and/or drought leads to an increase in shrub cover, especially big sagebrush, reduction of perennial grasses, and eventually, the introduction of non-native annual species. The plant community encountered at the transect contains a dense canopy of big sagebrush and moderate overstory of pinyon/juniper woodland. Herbaceous species are fairly scarce, but include blue grama, bottlebrush squirreltail (*Elymus elymoides*), broom snakeweed (*Gutierrezia sarothrae*), and sand dropseed (*Sporobolus cryptandrus*).

Compartment 28 (Transect 28-301)

Compartment	28		
% Canopy	32	**Initial Carrying Capacity**	1
% Bare Ground	50	**Slope Adjusted Carrying Capacity**	0
% Basal	0		

Ecological Site Summary

Ecological Site	# of Transects	Grazeable Acres	Available Forage	Stocking Rate	Initial Carrying Capacity
R035XF607AZ	1	128	13	185	1

5.2.29 Compartment 29

Compartment 29 is one of the smallest compartments in the project area. It is located just above the network of canyons near Inscription House and immediately west of Navajo Route 16. It contains 80 grazeable acres, one transect, and one ecological site. The R035XF627AZ site has a historic climax plant community dominated by pinyon and juniper trees, but shrubs and perennial grasses are common in the understory. Understory species often include muttongrass (*Poa fendleriana*), bottlebrush squirreltail (*Elymus elymoides*), blue grama (*Bouteloua gracilis*), Indian ricegrass (*Achnatherum hymenoides*), big sagebrush (*Artemisia tridentata*), Torrey's jointfir (*Ephedra torreyana*), broom snakeweed (*Gutierrezia sarothrae*), and Stansbury cliffrose (*Purshia stansburiana*). Unmanaged grazing and a lack of fire can cause an increase in tree/shrub canopy, while the introduction of fire and managed grazing can push the community towards a more open shrub/grassland state. The single transect is in an area of fairly dense pinyon/juniper woodland with big sagebrush in the understory. Herbaceous species are not prevalent, but biological crusts cover much of the bare ground.

Compartment 29 (Transect 29-302)

Compartment	29		
% Canopy	12	**Initial Carrying Capacity**	0
% Bare Ground	35	**Slope Adjusted Carrying Capacity**	0
% Basal	0		

Ecological Site Summary

Ecological Site	# of Transects	Grazeable Acres	Available Forage	Stocking Rate	Initial Carrying Capacity
F035XF627AZ	1	80	5	492	0

5.2.30 Compartment 30

Compartment 30 is located on upland areas amidst the canyons found in the central region of the Inscription House Community. There are 17,349 grazeable acres, 24 transects, and three ecological sites. The largest ecological site is the R035XC302AZ site. The historic climax plant community contains a mix of trees, shrubs, forbs, and grasses, the proportion depending upon soil depth, aspect, and extent of run-on/run-off areas. Prolonged disturbance will lead first to an increase in shrub species, especially composites like broom snakeweed (*Gutierrezia sarothrae*) and rabbitbrush (*Chrysothamnus* spp.). Continued disturbance will cause further depletions in native, perennial grasses and eventually lead to a shrub community with an understory of non-native annual species such as cheatgrass (*Bromus tectorum*) and redstem stork's bill (*Erodium cicutarium*). The current plant community is dominated by blackbrush (*Coleogyne ramosissima*) with large areas of bare ground and exposed bedrock in the shrub interspaces. Other species found include plains pricklypear (*Opuntia polyacantha*), Torrey's jointfir (*Ephedra torreyana*), flatspine stickseed (*Lappula occidentalis*), winding mariposa lily (*Calochortus flexuosus*), and sixweeks fescue (*Vulpia occidentalis*).

The historic climax plant community for the R035XC314AZ site contains many perennial grasses, a 30-40 percent shrub cover, and scattered pinyon and juniper trees. Major grasses are Indian ricegrass (*Achnatherum hymenoides*), needle and thread (*Hesperostipa comata*), James' galleta (*Pleuraphis jamesii*), and blue grama (*Bouteloua gracilis*). Common shrubs include Bigelow sage (*Artemisia bigelovii*), Greene's rabbitbrush (*Chrysothamnus greenei*), jointfir (*Ephedra* spp.), broom snakeweed, antelope bitterbrush (*Purshia tridentata*), and Stansbury cliffrose (*Purshia stansburiana*). Species most likely to increase or invade are cheatgrass, thrift mock goldenweed (*Stenotus armerioides*), broom snakeweed, and annual forbs. Currently, the majority of production is from shrubs and cacti, including big sagebrush, banana yucca (*Yucca baccata*), plains pricklypear, blackbrush, and Sonoran scrub oak (*Quercus turbinella*). Forage grasses include blue grama, tall dropseed (*Sporobolus contractus*), and muttongrass (*Poa fendleriana*). Two transects encountered the non-native forb, prickly Russian thistle (*Salsola tragus*), but at this time, this species is not common within this site.

The R035XF627AZ site has a historic climax plant community dominated by pinyon and juniper trees, but shrubs and perennial grasses are common in the understory. Understory species often include muttongrass, bottlebrush squirreltail (*Elymus elymoides*), blue grama, Indian ricegrass, big sagebrush, Torrey's jointfir (*Ephedra torreyana*), broom snakeweed, and Stansbury cliffrose. Unmanaged grazing and a lack of fire can cause an increase in tree/shrub canopy, while the introduction of fire and managed grazing can push the community towards a more open shrub/grassland state. Transects in this site found that pinyon/juniper woodland and big sagebrush have increased. The majority of herbaceous species are present only in small amounts, but the more prevalent species include the forage grasses bottlebrush squirreltail and blue grama.

Compartment 30 (Transects 30-304 and 30-311)

Compartment	30		
% Canopy	16	**Initial Carrying Capacity**	56
% Bare Ground	40	**Slope Adjusted Carrying Capacity**	34
% Basal	0		

Ecological Site Summary

Ecological Site	# of Transects	Grazeable Acres	Available Forage	Stocking Rate	Initial Carrying Capacity
F035XF627AZ	4	937	10	241	4
R035XC302AZ	5	13826	7	360	38
R035XC314AZ	15	2586	13	185	14

5.2.31 Compartment 31

Compartment 31 is consists of a tributary canyon that drains into Potato Canyon in the central part of the Inscription House Community. It contains 184 acres, two transects, and two ecological sites. The R035XC314AZ site is much smaller than the R035XC315AZ site, but has more available forage and a slightly higher carrying capacity. The historic climax plant community for the R035XC314AZ site contains many perennial grasses, a 30-40 percent shrub cover, and scattered pinyon and juniper trees. Major grasses are Indian ricegrass (*Achnatherum hymenoides*), needle and thread (*Hesperostipa comata*), James' galleta (*Pleuraphis jamesii*), and blue grama (*Bouteloua gracilis*). Common shrubs include Bigelow sage (*Artemisia bigelovii*), Greene's rabbitbrush (*Chrysothamnus greenei*), jointfir (*Ephedra spp*.), broom snakeweed (*Gutierrezia sarothrae*), antelope bitterbrush (*Purshia tridentata*), and Stansbury cliffrose (*Purshia stansburiana*). Species most likely to increase or invade are cheatgrass (*Bromus tectorum*), thrift mock goldenweed (*Stenotus armerioides*), broom snakeweed, and annual forbs. At this time, the majority of forage is being provided by fourwing saltbush (*Atriplex canescens*) and tall dropseed (*Sporobolus contractus*). The non-native annual forb Prickly Russian thistle (*Salsola tragus*) is fairly abundant, as well.

The historic climax plant community for the R035XC315AZ site is primarily composed of grasses, such as Indian ricegrass, black grama (*Bouteloua eriopoda*), and blue grama with about a 25 percent cover of shrub species. As the site deteriorates, certain species are likely to increase or invade including, big sagebrush, sand sagebrush (*Artemisia filifolia*), rabbitbrush (*Chrysothamnus* spp.), broom snakeweed, sandhill muhly (*Muhlenbergia pungens*), and various annuals. This site currently dominated by prickly Russian thistle, redstem stork's bill (*Erodium cicutarium*), and various native annuals. No perennial grasses were encountered during the survey.

Compartment 31 (Transects 31-328 and 31-329)

Compartment	31		
% Canopy	34	**Initial Carrying Capacity**	0
% Bare Ground	58	**Slope Adjusted Carrying Capacity**	0
% Basal	0		

Ecological Site Summary

Ecological Site	# of Transects	Grazeable Acres	Available Forage	Stocking Rate	Initial Carrying Capacity
R035XC314AZ	1	21	26	91	0
R035XC315AZ	1	163	2	1173	0

5.2.32 Compartment 32

Compartment 32 is a small compartment located in a canyon bottom just above Compartment 31. There are 93 acres, one transect, and one ecological site. The historic climax plant community for the R035XC315AZ site is primarily composed of grasses, such as Indian ricegrass (*Achnatherum hymenoides*), black grama (*Bouteloua eriopoda*), and blue grama (*Bouteloua gracilis*) with about a 25 percent cover of shrub species. As the site deteriorates, certain species are likely to increase or invade including, big sagebrush (*Artemisia tridentata*), sand sagebrush (*Artemisia filifolia*), rabbitbrush (*Chrysothamnus* spp.), broom snakeweed (*Gutierrezia sarothrae*), sandhill muhly (*Muhlenbergia pungens*), and various annuals. This site is in a state of deterioration, which is evident by the lack of perennial grass species and the abundance of annual forbs including prickly Russian thistle (*Salsola tragus*), redstem stork's bill (*Erodium cicutarium*), and cheatgrass (*Bromus tectorum*). However, forage is being provided by the native shrub fourwing saltbush (*Atriplex canescens*).

Compartment 32 (Transect 32-330)

Compartment	32		
% Canopy	52	**Initial Carrying Capacity**	4
% Bare Ground	25	**Slope Adjusted Carrying Capacity**	2
% Basal	0		

Ecological Site Summary

Ecological Site	# of Transects	Grazeable Acres	Available Forage	Stocking Rate	Initial Carrying Capacity
R035XC315AZ	1	93	96	25	4

5.2.33 Compartment 33

Compartment 33 is located in a narrow canyon just above Compartments 31 and 32 and adjacent to the Inscription House Monument. There are 85 grazeable acres, one transect, and one ecological site. The R035XC312AZ site is characterized by warm and cool season grasses when in an undisturbed state. Dominant species include Indian ricegrass (*Achnatherum hymenoides*), blue grama (*Bouteloua gracilis*), bottlebrush squirreltail (*Elymus elymoides*), common wolfstail (*Lycurus phleoides*), spike muhly (*Muhlenbergia wrightii*), western wheatgrass (*Pascopyrum smithii*), muttongrass (*Poa fendleriana*), sand dropseed (*Sporobolus cryptandrus*), big sagebrush (*Artemisia tridentata*), fourwing saltbush (*Atriplex canescens*), and winterfat (*Krascheninnikovia lanata*). Continuous yearlong grazing can lead to an increase in shrub species and annual, non-native species. Currently, the non-native, annual forb prickly Russian thistle is dominant in the plant community, followed by pigweed (*Amaranthus* sp.), sixweeks grama (*Bouteloua barbata*), cheatgrass (*Bromus tectorum*), and sand dropseed (*Sporobolus cryptandrus*).

Compartment 33 (Transect 33-331)

Compartment	33		
% Canopy	68	**Initial Carrying Capacity**	0
% Bare Ground	10	**Slope Adjusted Carrying Capacity**	0
% Basal	0		

Ecological Site Summary

Ecological Site	# of Transects	Grazeable Acres	Available Forage	Stocking Rate	Initial Carrying Capacity
R035XC312AZ	1	85	1	1612	0

5.2.34 Compartment 34

Compartment 34 is located in a small canyon south of the Inscription House Monument. This compartment contains 339 grazeable acres, one transect, and one ecological site. The historic climax plant community for the R035XC315AZ site is primarily composed of grasses, such as Indian ricegrass (*Achnatherum hymenoides*), black grama (*Bouteloua eriopoda*), and blue grama (*Bouteloua gracilis*) with about a 25 percent cover of shrub species. As the site deteriorates, certain species are likely to increase or invade including, big sagebrush (*Artemisia tridentata*), sand sagebrush (*Artemisia filifolia*), rabbitbrush (*Chrysothamnus* spp.), broom snakeweed (*Gutierrezia sarothrae*), sandhill muhly (*Muhlenbergia pungens*), and various annuals. Available forage is currently being supplied by fourwing saltbush (*Atriplex canescens*), and herbaceous species are mostly annuals, including prickly Russian thistle (*Salsola tragus*) and cheatgrass (*Bromus tectorum*).

Compartment 34 (Transect 34-332)

Compartment	34		
% Canopy	30	**Initial Carrying Capacity**	12
% Bare Ground	48	**Slope Adjusted Carrying Capacity**	6
% Basal	8		

Ecological Site Summary

Ecological Site	# of Transects	Grazeable Acres	Available Forage	Stocking Rate	Initial Carrying Capacity
R035XC315AZ	1	339	87	27	12

5.2.35 Compartment 35

Compartment 35 is located above the western rim of Binne Etteni Canyon in the south central region of the Inscription House Community. There are 2,196 grazeable acres, three transects, and three ecological sites. The R035XC302AZ site is the largest in the compartment. The R035XC302AZ site is composed of sedimentary cliffs. The historic climax plant community contains a mix of trees, shrubs, forbs, and grasses, the proportion depending upon soil depth, aspect, and extent of run-on/run-off areas. Prolonged disturbance will lead first to an increase in shrub species, especially composites like broom snakeweed (*Gutierrezia sarothrae*) and rabbitbrush (*Chrysothamnus* spp.). Continued disturbance will cause further depletions in native perennial grasses and eventually lead to a shrub community with an understory of non-native annual species, such as cheatgrass (*Bromus tectorum*) and redstem stork's bill (*Erodium cicutarium*). The vast amount of production currently being produced in this site comes from annual forbs and grasses, including prickly Russian thistle (*Salsola tragus*) and cheatgrass indicating that the site is in a degraded condition.

The historic climax plant community for the R035XC315AZ site is primarily composed of grasses, such as Indian ricegrass (*Achnatherum hymenoides*), black grama (*Bouteloua eriopoda*), and blue grama (*Bouteloua gracilis*) with about a 25 percent cover of shrub species. As the site deteriorates, certain species are likely to increase or invade including, big sagebrush (*Artemisia tridentata*), sand sagebrush (*Artemisia filifolia*), rabbitbrush, broom snakeweed, sandhill muhly (*Muhlenbergia pungens*), and various annuals. The primary producers recorded at this site include prickly Russian thistle, redstem stork's bill, plains pricklypear (*Opuntia polyacantha*), and fourwing saltbush (*Atriplex canescens*).

The historic climax plant community for the R035XC314AZ site contains many perennial grasses, a 30-40 percent shrub cover, and scattered pinyon and juniper trees. Major grasses are Indian ricegrass, needle and thread (*Hesperostipa comata*), James' galleta (*Pleuraphis jamesii*), and blue grama. Common shrubs include Bigelow sage (*Artemisia bigelovii*), Greene's rabbitbrush (*Chrysothamnus greenei*), jointfir (*Ephedra* spp.), broom snakeweed, antelope bitterbrush (*Purshia tridentata*), and Stansbury cliffrose (*Purshia stansburiana*). Species most likely to increase or invade are cheatgrass, thrift mock goldenweed (*Stenotus armerioides*), broom snakeweed, and annual forbs. No non-native species were found along the transect within this site, but it still appears to be in a degraded state as the main components of the plant community include plains pricklypear, narrowleaf yucca (Yucca angustissima), and various annuals.

Compartment 35 (Transects 35-333 and 35-335)

Compartment	35		
% Canopy	25	**Initial Carrying Capacity**	3
% Bare Ground	50	**Slope Adjusted Carrying Capacity**	2
% Basal	0		

Ecological Site Summary

Ecological Site	# of Transects	Grazeable Acres	Available Forage	Stocking Rate	Initial Carrying Capacity
R035XC302AZ	1	1273	1	3591	0
R035XC314AZ	1	239	0	6077	0
R035XC315AZ	1	684	9	266	3

5.2.36 Compartment 36

Compartment 36 is located along the upper reaches of Potato Canyon, just underneath Gray Mesa. There are 189 grazeable acres, two transects, and one ecological site. The historic climax plant community for the R035XC314AZ site contains many perennial grasses, a 30-40 percent shrub cover, and scattered pinyon and juniper trees. Major grasses are Indian ricegrass (*Achnatherum hymenoides*), needle and thread (*Hesperostipa comata*), James' galleta (*Pleuraphis jamesii*), and blue grama (*Bouteloua gracilis*). Common shrubs include Bigelow sage (*Artemisia bigelovii*), Greene's rabbitbrush (*Chrysothamnus greenei*), jointfir (*Ephedra spp*.), broom snakeweed (*Gutierrezia sarothrae*), antelope bitterbrush (*Purshia tridentata*), and Stansbury cliffrose (*Purshia stansburiana*). Species most likely to increase or invade are cheatgrass (*Bromus tectorum*), thrift mock goldenweed (*Stenotus armerioides*), broom snakeweed, and annual forbs. Conditions in this compartment indicate that this site has deteriorated with the majority of production being contributed from prickly Russian thistle (*Salsola tragus*) and broom snakeweed. Cheatgrass is also present in lesser amounts and many of the other herbaceous species, although native, are annuals. However, certain forage species are still in the plant community. These include fourwing saltbush (*Atriplex canescens*), Indian ricegrass, and tall dropseed (*Sporobolus contractus*).

Compartment 36 (Transect 36-336 and 36-337)

Compartment	36		
% Canopy	16	**Initial Carrying Capacity**	0
% Bare Ground	39	**Slope Adjusted Carrying Capacity**	0
% Basal	0		

Ecological Site Summary

Ecological Site	# of Transects	Grazeable Acres	Available Forage	Stocking Rate	Initial Carrying Capacity
R035XC314AZ	2	189	3	775	0

5.2.37 Compartment 37

Compartment 37 encompasses one of the small side canyons that drain into Potato Canyon in the Inscription House Community. This compartment has only 53 grazeable acres, one transect, and one ecological site. The historic climax plant community for the R035XC314AZ site contains many perennial grasses, a 30-40 percent shrub cover, and scattered pinyon and juniper trees. Major grasses are Indian ricegrass (*Achnatherum hymenoides*), needle and thread (*Hesperostipa comata*), James' galleta (*Pleuraphis jamesii*), and blue grama (*Bouteloua gracilis*). Common shrubs include Bigelow sage (*Artemisia bigelovii*), Greene's rabbitbrush (*Chrysothamnus greenei*), jointfir (*Ephedra spp*.), broom snakeweed (*Gutierrezia sarothrae*), antelope bitterbrush (*Purshia tridentata*), and Stansbury cliffrose (*Purshia stansburiana*). Species most likely to increase or invade are cheatgrass (*Bromus tectorum*), thrift mock goldenweed (*Stenotus armerioides*), broom snakeweed, and annual forbs. A small amount of prickly Russian thistle was found at the transect, but the majority of production is currently from native perennials including sand dropseed (*Sporobolus cryptandrus*), Indian ricegrass, snowball sand verbena (*Abronia fragrans*), and scarlet globemallow (*Sphaeralcea coccinea*). Sand dropseed, snowball sand verbena, and scarlet globemallow lose palatability quickly as they dry out, but they do provide adequate forage during the spring and summer months.

Compartment 37 (Transect 37-338)

Compartment	37		
% Canopy	22	**Initial Carrying Capacity**	0
% Bare Ground	68	**Slope Adjusted Carrying Capacity**	0
% Basal	2		

Ecological Site Summary

Ecological Site	# of Transects	Grazeable Acres	Available Forage	Stocking Rate	Initial Carrying Capacity
R035XC314AZ	1	53	20	119	0

5.2.38 Compartment 38

Compartment 38 lies within the Geshi Canyon system in the central region of the Inscription House Community. This compartment contains a mix of sandstone outcrops, channel bottoms, and grassy benches. It contains 3,704 grazeable acres, six transects, and three ecological sites. The R035XC302AZ site is the most prevalent in this compartment. This site is composed of sedimentary cliffs and the historic climax plant community contains a mix of trees, shrubs, forbs, and grasses, the proportion depending upon soil depth, aspect, and extent of run-on/run-off areas. Prolonged disturbance will lead first to an increase in shrub species, especially composites like broom snakeweed (*Gutierrezia sarothrae*) and rabbitbrush (*Chrysothamnus* spp.). Continued disturbance will cause further depletions in native, perennial grasses and eventually lead to a shrub community with an understory of non-native annual species such as cheatgrass (*Bromus tectorum*) and redstem stork's bill (*Erodium cicutarium*). Only one transect was located within this site. Production was low in the encountered plant community, but it contains a mix of native species including Bigelow sage (*Artemisia bigelovii*), Indian ricegrass (*Achnatherum hymenoides*), and sand dropseed (*Sporobolus cryptandrus*).

The second ecological site, R035XC312AZ, is characterized by warm and cool season grasses when in an undisturbed state. Dominant species include Indian ricegrass, blue grama (*Bouteloua gracilis*), bottlebrush squirreltail (*Elymus elymoides*), common wolfstail (*Lycurus phleoides*), spike muhly (*Muhlenbergia wrightii*), western wheatgrass (*Pascopyrum smithii*), muttongrass (*Poa fendleriana*), sand dropseed, big sagebrush (*Artemisia tridentata*), fourwing saltbush (*Atriplex canescens*), and winterfat (*Krascheninnikovia lanata*). Continuous yearlong grazing can lead to an increase in shrub species and annual, non-native species. Currently, shrub species are not particularly abundant, but the invasive annuals cheatgrass and redstem stork's bill are widespread. However, desirable species such as dropseed (*Sporobolus* sp.), Indian ricegrass, muttongrass, needle and thread (*Hesperostipa comata*), and fourwing saltbush also occur throughout the site. This suggests that this site may improve with favorable moisture, pasture rest, and rotational grazing.

The historic climax plant community for the R035XC314AZ site contains many perennial grasses, a 30-40 percent shrub cover, and scattered pinyon and juniper trees. Major grasses are Indian ricegrass, needle and thread, James' galleta (*Pleuraphis jamesii*), and blue grama. Common shrubs include Bigelow sage, Greene's rabbitbrush (*Chrysothamnus greenei*), jointfir (*Ephedra* spp.), broom snakeweed, antelope bitterbrush (*Purshia tridentata*), and Stansbury cliffrose (*Purshia stansburiana*). Species most likely to increase or invade are cheatgrass, thrift mock goldenweed (*Stenotus armerioides*), broom snakeweed, and annual forbs. The profusion of cacti species and small amounts of prickly Russian thistle (*Salsola tragus*) found at the transects, suggest that heavy grazing has occurred in this site sometime in the past. However, much of the production is being contributed from native grasses including Indian ricegrass, tall dropseed (*Sporobolus contractus*), alkali sacaton (*Sporobolus airoides*), and needle and thread.

Compartment 38 (Transects 38-341 and 38-343)

Compartment	38
% Canopy	22
% Bare Ground	47
% Basal	1
Initial Carrying Capacity	16
Slope Adjusted Carrying Capacity	7

Ecological Site Summary

Ecological Site	# of Transects	Grazeable Acres	Available Forage	Stocking Rate	Initial Carrying Capacity
R035XC302AZ	1	3051	2	971	3
R035XC312AZ	1	81	34	70	1
R035XC314AZ	4	572	49	48	12

5.2.39 Compartment 39

Compartment 39 is located below the northeast corner of Gray Mesa along portions of Navajo Creek, Sand Canyon, and Far End Canyon. The narrower canyon bottoms tend to have a mix of mesic shrubs and perennial, bunchgrasses. The wider bottoms contain loose sand colonized by various species of rabbitbrush (*Chrysothamnus* spp.), grasses, and some blackbrush (*Coleogyne ramosissima*). The upper benches in the compartment have large populations of blackbrush mixed with areas of exposed sandstone bedrock. There are 12,228 grazeable acres, 14 transects, and three ecological sites in this compartment. The R035XC302AZ site is the largest in the compartment and has a much higher carrying capacity than do the other two sites. This site is composed of sedimentary cliffs and the historic climax plant community contains a mix of trees, shrubs, forbs, and grasses, the proportion depending upon soil depth, aspect, and extent of run-on/run-off areas. Prolonged disturbance will lead first to an increase in shrub species, especially composites like broom snakeweed (*Gutierrezia sarothrae*) and rabbitbrush (*Chrysothamnus* spp.). Continued disturbance will cause further depletions in native, perennial grasses and eventually lead to a shrub community with an understory of non-native annual species such as cheatgrass (*Bromus tectorum*) and redstem stork's bill (*Erodium cicutarium*). Grazing disturbance has caused some site deterioration, particularly in some of the more accessible areas. Cheatgrass was found on one transect and blackbrush and annual species have increased at other locations. That said many of the upper reaches of the canyons have an abundance of desirable forage grasses. One transect reported almost 10,000 lbs/acre of needle and thread (*Hesperostipa comata*) and 600 lbs/acre of black grama (*Bouteloua eriopoda*). As needle and thread dries out, the long awns can become injurious to grazing animals, and palatability is much reduced. As this report uses the forage ratings associated with the season of least palatability in order to give a conservative representation of production appropriate for year-long grazing, needle and thread is not allowed to count towards available forage. It should be noted, though, that this species is quite palatable during the spring and summer months and is a valuable source of forage during these seasons.

The historic climax plant community for the R035XC314AZ site contains many perennial grasses, a 30-40 percent shrub cover, and scattered pinyon and juniper trees. Major grasses are Indian ricegrass (*Achnatherum hymenoides*), needle and thread, James' galleta (*Pleuraphis jamesii*), and blue grama (*Bouteloua gracilis*). Common shrubs include Bigelow sage (*Artemisia bigelovii*), Greene's rabbitbrush (*Chrysothamnus greenei*), jointfir (*Ephedra* spp.), broom snakeweed, antelope bitterbrush (*Purshia tridentata*), and Stansbury cliffrose (*Purshia stansburiana*). Species most likely to increase or invade are cheatgrass, thrift mock goldenweed (*Stenotus armerioides*), broom snakeweed, and annual forbs. Most transects in this site are located on blackbrush benches. Herbaceous vegetation is often scarce due to the prevalence of blackbrush and exposed bedrock. The most common species include blackbrush and tulip pricklypear (*Opuntia phaeacantha*). A few transects are located closer to the main canyon bottoms and are dominated by Greene's rabbitbrush, broom snakeweed, western wheatgrass (*Pascopyrum smithii*), muttongrass (*Poa fendleriana*), bottlebrush squirreltail (*Elymus elymoides*), and sand dropseed (*Sporobolus cryptandrus*).

The historic climax plant community for the R035XC315AZ site is primarily composed of grasses, such as Indian ricegrass, black grama, and blue grama with about a 25 percent cover of shrub species. As the site deteriorates, certain species are likely to increase or invade including, big sagebrush (*Artemisia tridentata*), sand sagebrush (*Artemisia filifolia*), rabbitbrush, broom snakeweed, sandhill muhly

(*Muhlenbergia pungens*), and various annuals. One transect fell within this site and it is located on a level terrace above the main channel of Far End Canyon. The usual species associated with site deterioration are not much in evidence at this location, but prickly pear (*Opuntia* spp.) has greatly increased and invasive annuals are present as well. These include prickly Russian thistle (*Salsola tragus*) and cheatgrass.

Compartment 39 (Transects 39-348 and 39-351)

Compartment	39
% Canopy	20
% Bare Ground	42
% Basal	2
Initial Carrying Capacity	462
Slope Adjusted Carrying Capacity	243

Ecological Site Summary

Ecological Site	# of Transects	Grazeable Acres	Available Forage	Stocking Rate	Initial Carrying Capacity
R035XC302AZ	4	9912	105	23	439
R035XC314AZ	9	1859	19	126	15
R035XC315AZ	1	457	42	57	8

5.2.40 Compartment 40

Compartment 40 is located in the sagebrush flats above the Chaiyahi Rim, just south of Navajo Mountain. There are 903 grazeable acres, one transect, and one ecological site contained in this compartment. The historic climax plant community for the R035XC315AZ site is primarily composed of grasses, such as Indian ricegrass (*Achnatherum hymenoides*), black grama (*Bouteloua eriopoda*), and blue grama (*Bouteloua gracilis*) with about a 25 percent cover of shrub species. As the site deteriorates, certain species are likely to increase or invade including, big sagebrush (*Artemisia tridentata*), sand sagebrush (*Artemisia filifolia*), rabbitbrush (*Chrysothamnus* spp.), broom snakeweed (*Gutierrezia sarothrae*), sandhill muhly (*Muhlenbergia pungens*), and various annuals. Big sagebrush has increased at this site and is producing the highest amount of biomass of all species in the plant community. The shrub interspaces are dominated by blue grama and other species include Indian ricegrass, broom snakeweed, and several annual species.

Compartment 40 (Transect 40-358)

Compartment	40		
% Canopy	55	**Initial Carrying Capacity**	9
% Bare Ground	30	**Slope Adjusted Carrying Capacity**	8
% Basal	0		

Ecological Site Summary

Ecological Site	# of Transects	Grazeable Acres	Available Forage	Stocking Rate	Initial Carrying Capacity
R035XC315AZ	1	903	25	96	9

5.2.41 Compartment 41

Compartment 41 is located in an area of sagebrush shrubland just west of Compartment 40. A few low ridges cut through this region and tend to have pinyon/juniper woodland along the crests. The compartment contains 597 grazeable acres, one transect, and one ecological site. The historic climax plant community for the R035XC315AZ site is primarily composed of grasses, such as Indian ricegrass (*Achnatherum hymenoides*), black grama (*Bouteloua eriopoda*), and blue grama (*Bouteloua gracilis*) with about a 25 percent cover of shrub species. As the site deteriorates, certain species are likely to increase or invade including, big sagebrush (*Artemisia tridentata*), sand sagebrush (*Artemisia filifolia*), rabbitbrush (*Chrysothamnus* spp.), broom snakeweed (*Gutierrezia sarothrae*), sandhill muhly (*Muhlenbergia pungens*), and various annuals. Big sagebrush is currently dense in this area and bare ground is common in the shrub interspaces. The sparse understory consists of plants like sandmat (*Chamaesyce* spp.), blue grama, sixweeks fescue (*Vulpia octoflora*), woolly plantain (*Plantago patagonica*), and bottlebrush squirreltail (*Elymus elymoides*).

Compartment 41 (Transect 41-359)

Compartment	41		
% Canopy	48	**Initial Carrying Capacity**	4
% Bare Ground	22	**Slope Adjusted Carrying Capacity**	4
% Basal	0		

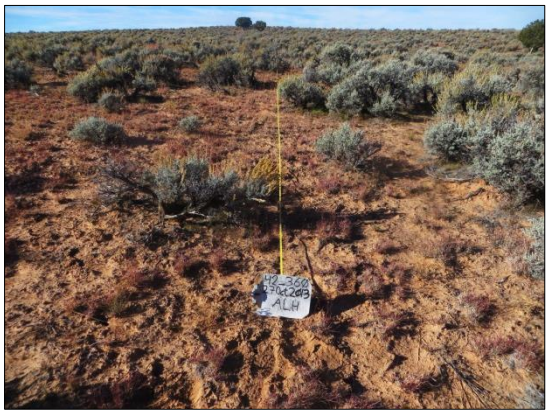
Ecological Site Summary

Ecological Site	# of Transects	Grazeable Acres	Available Forage	Stocking Rate	Initial Carrying Capacity
R035XC315AZ	1	597	16	149	4

5.2.42 Compartment 42

Compartment 42 is located in an area of rolling sagebrush hills just west of Compartment 41. Pinyon and juniper trees are scattered throughout. The compartment contains 702 grazeable acres, one transect, and one ecological site. The historic climax plant community for the R035XC315AZ site is primarily composed of grasses, such as Indian ricegrass (*Achnatherum hymenoides*), black grama (*Bouteloua eriopoda*), and blue grama (*Bouteloua gracilis*) with about a 25 percent cover of shrub species. As the site deteriorates, certain species are likely to increase or invade, including big sagebrush (*Artemisia tridentata*), sand sagebrush (*Artemisia filifolia*), rabbitbrush (*Chrysothamnus* spp.), broom snakeweed (*Gutierrezia sarothrae*), sandhill muhly (*Muhlenbergia pungens*), and various annuals. Big sagebrush is more abundant than in the historic climax plant community, but is still at a moderate density. Common understory species include blue grama, sixweeks fescue (*Vulpia octoflora*), bottlebrush squirreltail (*Elymus elymoides*), and woolly plantain (*Plantago patagonica*).

Compartment 42 (Transect 42-360)



Compartment	42		
% Canopy	35	**Initial Carrying Capacity**	5
% Bare Ground	42	**Slope Adjusted Carrying Capacity**	5
% Basal	0		

Ecological Site Summary

Ecological Site	# of Transects	Grazeable Acres	Available Forage	Stocking Rate	Initial Carrying Capacity
R035XC315AZ	1	702	19	128	5

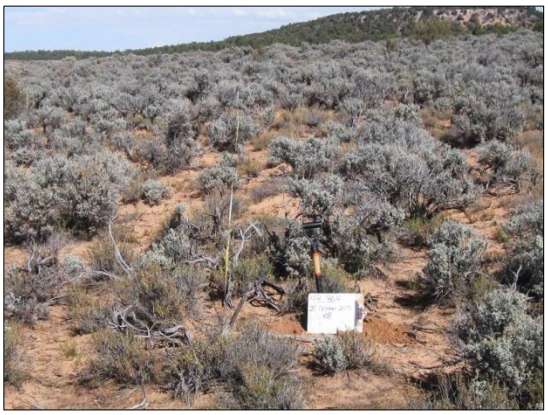
5.2.43 Compartment 43

Compartment 43 lies among the upper reaches of the various small canyons that drain north into the main body of Paiute Canyon. This area is characterized by pinyon/juniper woodland with occasional sagebrush openings and rocky cliffs. This compartment contains 5,033 acres, seven transects, and three ecological sites. The ecological sites are all roughly the same size, but R035XC328AZ is a bit larger than the other two sites. Grassland with only small amounts of shrubs, forbs, and trees makes up the historic climax plant community of the R035XC328AZ site. Common cool season grasses are Indian ricegrass (*Achnatherum hymenoides*), bottlebrush squirreltail (*Elymus elymoides*), needle and thread (*Hesperostipa comata*), and New Mexico feathergrass (*Hesperostipa neomexicana*). The primary warm season grasses include black grama (*Bouteloua eriopoda*), blue grama (*Bouteloua gracilis*), sand dropseed (*Sporobolus cryptandrus*), and James' galleta (*Pleuraphis jamesii*). When present, shrubs include big sagebrush (*Artemisia tridentata*), fourwing saltbush (*Atriplex canescens*), broom snakeweed (*Gutierrezia sarothrae*), and plains pricklypear (*Opuntia polyacantha*). Unmanaged grazing and drought will lead to an increase in shrubs like broom snakeweed and big sagebrush, a decrease in cool season, perennial grasses, and an increase in annual species and warm season grasses. Two transects were located in this compartment and both areas are marked by a moderate canopy cover of pinyon and juniper with a sparse understory. The most common species encountered were big sagebrush, broom snakeweed, roundleaf buffaloberry (*Shepherdia rotundifolia*), and blue grama. A few species of cool season, perennial grasses were also found, but only infrequently.

The R035XF627AZ site has a historic climax plant community dominated by pinyon and juniper trees, but shrubs and perennial grasses are common in the understory. Understory species often include muttongrass (*Poa fendleriana*), bottlebrush squirreltail, blue grama, Indian ricegrass, big sagebrush, Torrey's jointfir (*Ephedra torreyana*), broom snakeweed, and Stansbury cliffrose (*Purshia stansburiana*). Unmanaged grazing and a lack of fire can cause an increase in tree/shrub canopy, while the introduction of fire and managed grazing can push the community towards a more open shrub/grassland state. The single transect in this site was placed in an area with a moderate canopy of pinyon and juniper. The understory is composed primarily of bare ground and litter with only marginal amounts of woody or herbaceous species. Biological crusts are well developed suggesting that while overgrazing/drought has likely reduced the understory community, this site is currently no experiencing any grazing pressure. The main plant species found included blue grama, big sagebrush, muttongrass, broom snakeweed, and spiderwort (*Tradescantia* sp.).

Historically, the R035XF607AZ site was composed mostly of shrubs and grasses with a smaller component of forbs and trees. Typical species in the historic climax plant community include Indian ricegrass, muttongrass, blue grama, needle and thread, sandhill muhly (*Muhlenbergia pungens*), big sagebrush, mormon tea (*Ephedra viridis*), and antelope bitterbrush (*Purshia tridentata*). Improper grazing practices and/or drought leads to an increase in shrub cover, especially big sagebrush, reduction of perennial grasses, and eventually, the introduction of non-native annual species. Currently, pinyon, juniper, and big sagebrush have increased at the site and perennial grasses have been reduced. Common species include big sagebrush, roundleaf buffaloberry, broom snakeweed, yellow rabbitbrush (*Chrysothamnus viscidiflorus*), and pricklypear (*Opuntia* sp.).

Compartment 43 (Transects 43-362 and 43-364)



Compartment	43		
% Canopy	17	**Initial Carrying Capacity**	10
% Bare Ground	29	**Slope Adjusted Carrying Capacity**	8
% Basal	0		

Ecological Site Summary

Ecological Site	# of Transects	Grazeable Acres	Available Forage	Stocking Rate	Initial Carrying Capacity
F035XF627AZ	1	1281	6	385	3
R035XC328AZ	2	1958	3	785	2
R035XF607AZ	4	1794	5	436	4

5.2.44 Compartment 44

Compartment 44 occupies a region of rolling hills to the west of Paiute Canyon. Common plant communities include sagebrush shrubland, blackbrush shrubland, and pinyon/juniper woodland. There are 15,121 grazeable acres, 18 transects, and four ecological sites. The R035XC315AZ site is slightly smaller than the largest ecological site, R035XF607, but has a much larger carrying capacity. The historic climax plant community for the R035XC315AZ site is primarily composed of grasses, such as Indian ricegrass (*Achnatherum hymenoides*), black grama (*Bouteloua eriopoda*), and blue grama (*Bouteloua gracilis*) with about a 25 percent cover of shrub species. As the site deteriorates, certain species are likely to increase or invade including, big sagebrush (*Artemisia tridentata*), sand sagebrush (*Artemisia filifolia*), rabbitbrush (*Chrysothamnus* spp.), broom snakeweed (*Gutierrezia sarothrae*), sandhill muhly (*Muhlenbergia pungens*), and various annuals. Stands of big sagebrush are presently dense although in some areas, the canopy is more moderate. The main contributors of available forage are big sagebrush, blue grama, tall dropseed (*Sporobolus contractus*), and sand dropseed (*Sporobolus cryptandrus*).

The historic climax plant community for the R035XF607AZ site is composed mostly of shrubs and grasses with a smaller component of forbs and trees. Typical species include Indian ricegrass, muttongrass (*Poa fendleriana*), blue grama (*Bouteloua gracilis*), needle and thread (*Hesperostipa comata*), sandhill muhly, big sagebrush, Torrey's jointfir (*Ephedra torreyana*), and antelope bitterbrush (*Purshia tridentata*). Improper grazing practices and/or drought leads to an increase in shrub cover, especially big sagebrush, reduction of perennial grasses, and eventually, the introduction of non-native annual species. Non-native species are not yet a main component of this site, but a small amount of cheatgrass (*Bromus tectorum*) was found on one transect. Pinyon, juniper, and big sagebrush have increased throughout the site and herbaceous, understory species are often sparse. Commonly encountered species include big sagebrush, broom snakeweed, blue grama, and sand dropseed.

The F035XF627AZ site is a forested ecological site. In a relatively undisturbed state, this site is dominated by pinyon and juniper trees, but shrubs and perennial grasses are common in the understory. Understory species often include muttongrass, bottlebrush squirreltail (*Elymus elymoides*), blue grama, Indian ricegrass, big sagebrush, mormon tea (*Ephedra viridis*), broom snakeweed, and Stansbury cliffrose (*Purshia stansburiana*). At the time of the survey, it was found that pinyon and juniper trees do dominate the site and common shrubs include big sagebrush and mormon tea. Other species include broom snakeweed, blue grama, and various annuals.

The last site, R035XC328, has a historic climax community defined by grassland with only small amounts of shrubs, forbs, and trees. Common cool season grasses are Indian ricegrass, bottlebrush squirreltail, needle and thread, and New Mexico feathergrass (*Hesperostipa neomexicana*). The primary warm season grasses include black grama, blue grama, sand dropseed, and James' galleta (*Pleuraphis jamesii*). When present, shrubs include big sagebrush, fourwing saltbush (*Atriplex canescens*), broom snakeweed, and plains pricklypear (*Opuntia polyacantha*). Unmanaged grazing and drought will lead to an increase in shrubs like broom snakeweed and big sagebrush, a decrease in cool season, perennial grasses, and an increase in annual species and warm season grasses. This site is in a degraded condition and prickly Russian thistle (*Salsola tragus*) is widespread. Production is low in other species which include littleleaf mountain mahogany (*Cercocarpus intricatus*), Greenleaf five eyes (*Chamaesaracha coronopus*), fourwing saltbush, bottlebrush squirreltail, and sand dropseed.

Compartment 44 (Transects 44-376 and 44-384)

Compartment	44
% Canopy	28
% Bare Ground	42
% Basal	0
Initial Carrying Capacity	111
Slope Adjusted Carrying Capacity	102

Ecological Site Summary

Ecological Site	# of Transects	Grazeable Acres	Available Forage	Stocking Rate	Initial Carrying Capacity
F035XF627AZ	2	3828	8	287	13
R035XC315AZ	6	5232	29	83	63
R035XC328AZ	1	702	4	644	1
R035XF607AZ	9	5359	15	161	33

5.2.45 Compartment 45

Compartment 45 occupies the mesa that extends outwards from the southern flanks of Navajo Mountain in the southeastern corner of the Navajo Mountain Community. This compartment contains 22,560 grazeable acres, 25 transects, and six ecological sites. The most represented site is R035XC315AZ which also has the highest carrying capacity. The historic climax plant community for the R035XC315AZ site is primarily composed of grasses, such as Indian ricegrass (*Achnatherum hymenoides*), black grama (*Bouteloua eriopoda*), and blue grama (*Bouteloua gracilis*) with about a 25 percent cover of shrub species. As the site deteriorates, certain species are likely to increase or invade including, big sagebrush (*Artemisia tridentata*), sand sagebrush (*Artemisia filifolia*), rabbitbrush (*Chrysothamnus* spp.), broom snakeweed (*Gutierrezia sarothrae*), sandhill muhly (*Muhlenbergia pungens*), and various annuals. At the current time, big sagebrush and broom snakeweed have clearly increased on the site and two invasive annuals, cheatgrass (*Bromus tectorum*) and redstem stork's bill (*Erodium cicutarium*), were present on some transects. The most common forage grass is blue grama.

The historic climax plant community for the R035XC302AZ site contains a mix of trees, shrubs, forbs, and grasses, the proportion depending upon soil depth, aspect, and extent of run-on/run-off areas. Prolonged disturbance will lead first to an increase in shrub species, especially composites like broom snakeweed and rabbitbrush (*Chrysothamnus* spp.). Continued disturbance will cause further depletions in native, perennial grasses and eventually lead to a shrub community with an understory of non-native annual species such as cheatgrass and redstem stork's bill. Only one transect occurred in this site, and the associated plant community contains a diverse mix of species. Production was highest in the desirable forage grass, desert needlegrass (*Achnatherum speciosum*), followed by Indian ricegrass. Spiny greasebush (*Glossopetalon spinescens*), black sagebrush (*Artemisia nova*), and rubber rabbitbrush (*Ericameria nauseosa*) are the dominant shrubs.

Historically, the R035XF607AZ site was composed mostly of shrubs and grasses with a smaller component of forbs and trees. Typical species in the historic climax plant community include Indian ricegrass, muttongrass (*Poa fendleriana*), blue grama, needle and thread (*Hesperostipa comata*), sandhill muhly, big sagebrush, mormon tea (*Ephedra viridis*), and antelope bitterbrush (*Purshia tridentata*). Improper grazing practices and/or drought leads to an increase in shrub cover, especially big sagebrush, reduction of perennial grasses, and eventually, the introduction of non-native annual species. Shrubs and trees have increased on this site and herbaceous, forage species are much reduced or absent. Dominant species now include big sagebrush, broom snakeweed, rubber rabbitbrush, and, to a lesser extent, blue grama.

The R035XF627AZ site has a historic climax plant community dominated by pinyon and juniper trees, but shrubs and perennial grasses are common in the understory. Understory species often include muttongrass, bottlebrush squirreltail (*Elymus elymoides*), blue grama, Indian ricegrass, big sagebrush, Torrey's jointfir (*Ephedra torreyana*), broom snakeweed, and Stansbury cliffrose (*Purshia stansburiana*). Unmanaged grazing and a lack of fire can cause an increase in tree/shrub canopy, while the introduction of fire and managed grazing can push the community towards a more open shrub/grassland state. Currently, this site is composed primarily of sagebrush shrubland with a pinyon/juniper overstory. The density of trees and shrubs has appeared to crowd much of the understory component and many of the tree and shrub interspaces contain mostly bare ground. The minimal amount of production is being supplied primarily by big sagebrush, blue grama, and annual forbs.

The R035XY236UT site contains shallow, rocky soils and its historic climax plant community is marked by a sparse canopy of pinyon and juniper with a shrub understory dominated by blackbrush (*Coleogyne ramosissima*), jointfir (*Ephedra* spp.), and Bigelow's sage (*Artemisia bigelovii*). The shrub community can be dense, but openings can be populated with a significant component of perennial forbs and grasses such as Indian ricegrass, needle and thread, James' galleta (*Pleuraphis jamesii*), various species of buckwheat (*Eriogonum* spp.). Disturbances in the form of grazing and drought can lead to increases in bare ground and the introduction of non-native annual species. The current plant community consists of a dense canopy of blackbrush with scattered pinyon and juniper. Very little herbaceous understory was encountered and virtually all of the non-woody production is from annual species, including cheatgrass.

The historic climax plant community for the R035XY243UT is dominated by blackbrush with a 35 percent perennial grass and 10 percent forb component. With deteriorating conditions, desirable grasses will decrease, while blackbrush and broom snakeweed increase. Species most likely to invade are cheatgrass, Prickly Russian thistle (*Salsola tragus*), and Utah juniper (*Juniperus osteosperma*). At this time, blackbrush stands are very dense and production from herbaceous understory species is extremely limited. Blue grama and Indian ricegrass occur in trace amounts.

Compartment 45 (Transects 45-388 and 45-399)

Compartment	45		
% Canopy	30	**Initial Carrying Capacity**	88
% Bare Ground	41	**Slope Adjusted Carrying Capacity**	81
% Basal	1		

Ecological Site Summary

Ecological Site	# of Transects	Grazeable Acres	Available Forage	Stocking Rate	Initial Carrying Capacity
F035XF627AZ	1	2008	4	579	3
R035XC302AZ	1	379	14	170	2
R035XC315AZ	15	13778	12	205	67
R035XF607AZ	5	2811	12	199	14
R035XY236UT	1	943	1	2026	0
R035XY243UT	2	2641	1	2693	1

5.2.46 Compartment 46

Compartment 46 is the largest compartment in the project area. It spans across the western half of the Navajo Mountain Community and the northern end of the Inscription House Community. Included within this compartment is the vast network of isolated canyons between Lake Powell and Navajo Canyon and a variety of mesas, sandstone uplands, and rolling grass/shrublands. This area has 145 transects, and 11 ecological sites. The R035XA115AZ site has a historic climax community made up of warm season grasses such as black grama (*Bouteloua eriopoda*), blue grama (*Bouteloua gracilis*), and James' galleta (*Pleuraphis jamesii*). Common woody species include Bigelow sage (*Artemisia bigelovii*), jointfir (*Ephedra* spp.), and Stansbury cliffrose (*Purshia stansburiana*). A small percentage of non-native annuals may be present, but they do not affect the site's ecological processes. Prolonged disturbance will cause an increase in shrub species and subsequent decline in favorable grass species. This is the smallest site in the compartment and at the present time, is dominated by blackbrush (*Coleogyne ramosissima*) with a scattering of annual species found in the shrub interspaces. No forage species were encountered on the one transect and as a result, this site is considered to be non-stockable.

The R035XB204AZ site is found on sandstone uplands and the historic climax plant community is made up primarily of perennial grasses like Indian ricegrass (*Achnatherum hymenoides*), blue grama, and James' galleta, and shrubs such as Bigelow sage, fourwing saltbush (*Atriplex canescens*), and Torrey's jointfir (*Ephedra torreyana*). Continual disturbance cause perennial grasses to decrease while Bigelow sagebrush and broom snakeweed (*Gutierrezia sarothrae*) will increase. Eventually, non-native species will colonize areas of bare ground and shrub species will continue to dominate. The current plant community is variable. Indian ricegrass is abundant in most transects while a minor proportion of transects are dominated by shrub species, including fourwing saltbush, plains pricklypear (*Opuntia polyacantha*), and blackbrush. Other common species include scarlet globemallow (*Sphaeralcea coccinea*), tufted evening primrose (*Oenothera caespitosa*), Cutler's jointfir (*Ephedra cutleri*), sand sagebrush (*Artemisia filifolia*), woolly plantain (*Plantago patagonica*), cryptantha (*Cryptantha* spp.), and gypsum phacelia (*Phacelia integrifolia*).

Blackbrush and Cutler's jointfir dominate the historic climax plant community of the R035XB206AZ site. Typical understory species are Indian ricegrass, purple threeawn (*Aristida purpurea*), bottlebrush squirreltail (*Elymus elymoides*), needle and thread (*Hesperostipa comata*), blue grama, black grama, James' galleta, and dropseed (*Sporobolus* spp.). As the site moves away from the climax state, perennial grasses will decrease, shrubs will increase, and bare ground will also increase leading to erosion and the introduction of non-native annuals. At this time, perennial grasses have declined and some non-native annuals were observed. Bare ground is somewhat high, as well, and as most of the transects are in sandy soils, this increases the risk of wind erosion. However, the overall diversity of native species is fairly high and some perennial forage species are abundant. These include Indian ricegrass and various species of dropseed. Common shrubs include sand sagebrush, blackbrush, pillar false gumweed (*Vanclevea stylosa*), and narrowleaf yucca (*Yucca angustissima*). One forb, cleftleaf wildheliotrope (*Phacelia crenulata*), was present in great numbers in most transects. This plant is not generally consumed by livestock, but does have the potential to cause skin irritation and blistering.

The R035XB226AZ site is found on dry, shale/sandstone uplands and the historic climax plant community is characterized by blackbrush and jointfir (Ephedra spp.) shrubland with various herbaceous species in the understory. These include Indian ricegrass, James' galleta, bush muhly (*Muhlenbergia*

porteri), and low woollygrass (*Dasyochloa pulchella*). Overgrazing and drought will lead to an increase in shrub species, decrease in perennial grasses, and eventual introduction of non-native annual species. The plant communities observed at the transects tended to have a moderate component of shrubs, especially blackbrush, with a scattering of forbs and grasses in the shrub interspaces. Small amounts of invasive annuals, such as red brome (*Bromus rubens*), cheatgrass (*Bromus tectorum*), and prickly Russian thistle (*Salsola tragus*) were observed at several locations. The most prevalent forage species are James' galleta and Indian ricegrass.

The R035XB230AZ site is associated with very shallow soils that are often represented by sheets of sand overlaying sandstone bedrock on structural benches. The historic climax plant community is composed primarily of cool season and warm season grasses and shrubs. Dominant species include blackbrush, Bigelow sage, fourwing saltbush, Indian ricegrass, sideoats grama (*Bouteloua curtipendula*), James' galleta, and muttongrass. As the site deteriorates, perennial grasses will decline and shrubs will begin to increase. Continual disturbance will create a site dominated by shrubs and annual, invasive forbs and grasses. At this time, the plant community is dominated by blackbrush and plains pricklypear. understory species include Indian ricegrass, scarlet globemallow, milkvetch (*Astragalus* spp.), James' galleta, and the introduced annual grass, common Mediterranean grass (*Schismus barbatus*).

Shallow, often gravelly, sandy soils are typical in the R035XB234AZ site. Blackbrush is the main component of the historical climax plant community along with understory species like Indian ricegrass, bottlebrush squirreltail, James' galleta, and sand dropseed. Other shrub species likely to be present include fourwing saltbush, jointfir, broom snakeweed, and plains pricklypear. Site deterioration is marked by an increase in shrubs, cacti species, annuals, and lower value grasses. From transect data, it is apparent that blackbrush and pricklypear have increased on the site. Shrub interspaces are occupied mostly by annual species, but James' galleta is also prevalent. A small number of non-native, annual grasses are present as well.

The R035XB251AZ site contains shallow soils that often contain large amounts of flags, channers, and gravel. The historic climax plant community consists of primarily of blackbrush mixed with perennial grasses such as black grama, James' galleta, and purple threeawn. Blackbrush typically decreases at lower elevations and is replaced by jointfir and rubber rabbitbrush. Pinyon, juniper, Stansbury cliffrose, and singleleaf ash (*Fraxinus anomala*) are often present at the higher elevations. Due to the shallow, rocky soils and dry conditions, production tends to be low throughout the year. This is a fragile site and even relatively small amounts of disturbance can lead to the introduction of non-native annual species as bare ground is common even during years of favorable moisture. Common shrub/cacti species in the current plant community include blackbrush, plains prickly pear, frosted mint (*Poliomintha incana*), broom snakeweed, and fourwing saltbush. Indian ricegrass and James' galleta are the primary forage species. Red brome and cheatgrass are abundant on a few transects, but overall, the incidence of non-native species was low.

Areas of flat, sandstone bedrock with scattered vegetation typify the R035XB255 ecological site. The climate tends to be dry and windy and most of the arriving precipitation tends to runoff to adjoining areas due to the large amount of exposed bedrock. However, pockets of soil located below bedrock areas will benefit from the runoff and will often support a wide variety of shrub and herbaceous species. Typical species include blackbrush, Bigelow sage, Stansbury cliffrose, Utah serviceberry (*Amelanchier*

utahensis), Indian ricegrass, black grama, blue grama, and James' galleta. Cheatgrass, red brome, and prickly Russian thistle are common non-native species that colonize this site following continuous disturbance. As is normal for this site, current production is low. Cheatgrass was encountered at one transect, but no other non-native species were present. The plant communities varied from transect to transect and included blackbrush, Torrey's jointfir, singleleaf ash, broom snakeweed, Stansbury cliffrose, roundleaf buffaloberry (*Shepherdia rotundifolia*), plains prickly pear, Indian ricegrass, purple threeawn, blue grama, sand dropseed, milkvetch, and woolly plantain.

The R035XC302AZ site is composed of sedimentary cliffs and the historic climax plant community contains a mix of trees, shrubs, forbs, and grasses, the proportion depending upon soil depth, aspect, and extent of run-on/run-off areas. Prolonged disturbance will lead first to an increase in shrub species, especially composites like broom snakeweed and rabbitbrush. Continued disturbance will cause further depletions in native, perennial grasses and eventually lead to a shrub community with an understory of non-native annual species such as cheatgrass and redstem stork's bill (*Erodium cicutarium*). This site currently has a high carrying capacity and compared to most other sites in this compartment, has a high amount of available forage. This forage is being supplied primarily from big sagebrush, Bigelow sage, Stansbury cliffrose, Indian ricegrass, dropseed, black grama, and James' galleta. Non-native species are not common, although red brome was found at several transect locations.

The historic climax plant community for the R035XC314AZ site contains many perennial grasses, a 30-40 percent shrub cover, and scattered pinyon and juniper trees. Major grasses are Indian ricegrass, needle and thread, James' galleta, and blue grama. Common shrubs include Bigelow sage, Greene's rabbitbrush (*Chrysothamnus greenei*), jointfir, broom snakeweed, antelope bitterbrush (*Purshia tridentata*), and Stansbury cliffrose. Species most likely to increase or invade are cheatgrass, thrift mock goldenweed (*Stenotus armerioides*), broom snakeweed, and annual forbs. At this time, the most commonly encountered species include pricklypear (*Opuntia* spp.) and blackbrush. Occasional understory species include Indian ricegrass, broom snakeweed, milkvetch, and sand dropseed. A small amount of cheatgrass and red brome was found on several transects.

The final ecological site is the R035XC315AZ site. The historic climax plant community for the R035XC315AZ site is primarily composed of grasses, such as Indian ricegrass, black grama, and blue grama with about a 25 percent cover of shrub species. As the site deteriorates, certain species are likely to increase or invade including, big sagebrush, sand sagebrush, rabbitbrush (*Chrysothamnus* spp.), broom snakeweed, sandhill muhly (*Muhlenbergia pungens*), and various annuals. Transects within this site encountered a plant community largely dominated by blackbrush and pricklypear. Other species include broom snakeweed, cryptantha, dropseed, and sixweeks fescue (*Vulpia octoflora*).

Compartment 46 (Transects 46-497 and 46-535)

Compartment	46
% Canopy	18
% Bare Ground	49
% Basal	1
Initial Carrying Capacity	989
Slope Adjusted Carrying Capacity	576

Ecological Site Summary

Ecological Site	# of Transects	Grazeable Acres	Available Forage	Stocking Rate	Initial Carrying Capacity
R035XA115AZ	1	312	0	0	0
R035XB204AZ	13	16496	30	79	209
R035XB206AZ	21	19846	16	144	137
R035XB226AZ	12	2252	8	298	8
R035XB230AZ	10	7282	17	140	52
R035XB234AZ	11	5499	4	555	10
R035XB251AZ	7	1861	15	160	12
R035XB255AZ	8	32072	1	1769	18
R035XC302AZ	22	47779	25	94	510
R035XC314AZ	36	8959	6	390	23
R035XC315AZ	4	2862	9	260	11

CONCLUSIONS AND RECOMMENDATION

6. CONCLUSIONS AND RECOMMENDATION

District 2 is composed primarily of sandstone canyons, mesas, and hills covered in pinyon/juniper woodland and sagebrush shrubland. Overall production is low and shrubs have increased on most ecological sites. Sites in the best condition are largely found in the upper reaches of the deeper canyons. Livestock do not tend to utilize these areas as much and these were the only locations where some of the more desirable species, such as black grama (*Bouteloua eriopoda*), were found. The most common shrub species in the northern part of the project area are black brush (*Coleogyne ramosissima*) and various species of pricklypear (*Opuntia* sp.). The southern half is dominated by big sagebrush (*Artemisia tridentata*).

Analysis of the various compartments revealed that moderate to severe deterioration has occurred in many areas of District 2. The southern ends of the Inscription House Community and the Shonto Community, particularly Compartments 4,5, and 6, have low forage production and a high amount of the invasive, annual, Prickly Russian thistle (*Salsola tragus*). This plant is less abundant in the northern half of the project area, but non-native annual grasses, especially red brome (*Bromus rubens*) and cheatgrass (*Bromus tectorum*), are much more abundant. The largest populations were encountered in Compartments 25, 39, and 46. The decline in plant communities is largely a result of continuous grazing pressure and past drought conditions. The following sections provide some recommendations regarding drought and grazing management, shrub reduction, weed control, and data analysis and monitoring.

6.1 Drought

Precipitation is one of the greatest obstacles to overcome when managing and restoring rangeland. Local precipitation monitoring stations recorded higher than average precipitation in the fall of 2013 and the spring of 2014. Despite this, precipitation levels throughout the southwest indicate ongoing long-term drought conditions (National Drought Mitigation Center [NDMC] 2014). 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 in a short 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. This increases soil loss while decreasing water retention. The potential for soil loss due to wind erosion is also very high as much of the project area contains unstable sandy soils. Sandy soils require a lot of plant cover to become stable. It may be necessary to encourage growth of less palatable species initially. Grasses such as sandhill muhly (*Muhlenbergia pungens*) and James' galleta (*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 (NDMC 2014). 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 District 2 as the majority of forage plants are warm-season grasses like James's galleta and blue grama (*Bouteloua gracilis*). 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 grazing plans. 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 much of the project area. The deeper canyons often have large populations of needle and thread (*Hesperostipa comata*) and black grama (*Bouteloua eriopoda*). Other areas often have additional perennial grasses like, muttongrass (*Poa fendleriana*), blue grama, James' galleta, and dropseed (*Sporobolus* spp.). Important forb and shrub species such as globemallow (*Sphaeralcea* spp.), fourwing saltbush (*Atriplex canescens*), jointfir (*Ephedra* spp.), and Stansbury cliffrose (*Purshia stansburiana*) are also 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 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 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 the 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 many parts of the project area. Populations of big sagebrush (*Artemisia tridentata*) are fairly dense in the southern half of the Shonto and Inscription House Communities, and broom snakeweed (*Gutierrezia sarothrae*) is abundant in most of the project area. Blackbrush (*Coleogyne ramosissima*) monocultures are present in the northern sections of all three communities.

In some cases, employing proper grazing management may be sufficient 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. However, it may become 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 project 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 project 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 (*Chrysothamnus greenei*) 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). Before implementing shrub control measures, consultation with experts is recommended to determine the best rates and timing for herbicide applications, to minimize impacts to non-target plant and wildlife species, and to explore alternate control methods.

Blackbrush is seldom used by livestock, but can provide a marginal amount of forage when other alternatives are unavailable, especially in the spring (Humphrey 1955; Bowns 1973). The forage value of this shrub has been improved by employing mechanical brush-beating techniques and subjecting stands to heavy browsing by goats. Both methods remove the spinescent growths and stimulate growth of new shoots (Bowns 1973; Provenza and Bowns 1985; Urness and Austin 1989). The use of fire to reduce blackbrush stands has had unpredictable results and it is not recommended. The likelihood of encouraging an invasion of exotic annual bromes (*Bromus* spp.) is high and the cryptogamic crusts usually found in these areas often are damaged beyond repair (Bowns 1973; Callison et al. 1985).

6.4 Invasive Species

Prickly Russian thistle (Salsola tragus)

Prickly Russian thistle is a drought tolerant, disturbance-loving species that does well in sandy soils. 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). However, 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 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 tansymustard (*Descurainia* spp.) (Chapman et al. 1969). 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.

Cheatgrass (Bromus tectorum) and red brome (Bromus rubens)

Exotic annual bromes occur fairly frequently in several of the northern compartments, especially in the Navajo Mountain Community. These are difficult grasses to control due to their ability to produce large quantities of seed, which either germinate in the fall or carry over in the seed bank to germinate in the following spring (Smith et al. 2008). Germination typically occurs well in advance of most native species, which works to deplete soil moisture (Floyd et al. 2006; Melgoza et al. 1990; Smith et al. 2008). Additionally, seedling emergence can occur under a variety of soil temperatures and plants germinating in the fall continue to experience root growth during the winter. This gives individuals a significant advantage the following spring (Beckstead et al 2007; Mack and Pike 1983; Meyer et al 2007; Thill et al. 1979). The best way to prevent the spread of annual bromes is to reestablish viable native plant communities. In invaded areas, use of the herbicide imazapic (Plateau®) has proven to be very effective control measure. A moderate application rate (0.6 L ha-1) was found to kill virtually all cheatgrass and red brome plants and seeds when applied in the fall to infestations in Zion Nation Park (Dela Cruz 2008, Brisbin et al. 2013). However, the control affected by this herbicide only provides a window of about 1-2 years. If alternate vegetation has not reestablished in sprayed areas at this time, it is very probable that bromes will reoccupy the area. A good practice is to spray in the fall and apply seeding treatments in the following late winter/early spring season. The NRCS is a valuable resource for obtaining site specific seed mixes as well as technical and financial support.

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 (*Achnatherum hymenoides*), needle and thread (*Hesperostipa comata*), James' galleta *(Pleuraphis jamesii*), tall dropseed *(Sporobolus contractus*), black grama (*Bouteloua eriopoda*), blue

grama (*Bouteloua gracilis*), and fourwing saltbush (*Atriplex canescens*). 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 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. Water sources and salt blocks can also 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 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).

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7. REFERENCES AND LITERATURE CITED

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