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USE OF EARTH RESOURCES TECHNOLOGICAL SATELLITE (ERTS) DATA IN A NATURAL RESOURCE INVENTORY

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Final Report covering the period August 1972 - September 1974

NASA Contract - NAS5-21820

July 1975

Original photography may be purchased from:
EROS Data Center
10th and Dakota Avenue
Sioux Falls, SD 57198

PREFACE

This report is a formal final report of work completed under NASA Grant No. NAS5-21820*. The study was undertaken to provide information and techniques for identifying basic site-vegetation units which are homogeneous enough that they provide reasonable sampling strata for resource managers and to relate these site-vegetation units in a hierarchical scheme of classification including units which can be identified and mapped on ERTS imagery at 1:1,000,000 and 1:500,000 scales.

Objectives

1. Develop ground truth and image class grouping criteria for the definition of a hierarchical classification system of site-vegetation units as a basis for natural resource inventory and monitoring using remote sensing techniques.

2. Develop imagery interpretation aides and keys to facilitate identification of legend subdivisions within the site-vegetation classification.

3. Develop methods of compiling and analyzing the resultant data to maximize the utility and acceptance of the techniques by natural resource managers.

Scope of work

The limits of the study area were defined as those areas of the Empire Valley underlain by alluvial valley fill. The limits of the area were mapped on ERTS imagery, but it was found that finer detail could not be reliably delimited on ERTS imagery.

*The NASA Technical Officer for this grant is Mr. G. R. Stonesifer, NASA, Code 430, GSFC, Greenbelt, Maryland 20771.

Further mapping of geomorphic-soil-vegetation units and selection of ground truth sample points was done on a black and white aerial photo mosiac at a scale of about 1:30,000. Forty-six mapping units were delineated and 304 sample points representing ridges, bottomlands and north and south slopes in each area selected. Field measurement of plant composition, cover, soil surface characteristics, slope, aspect and grazing use were collected. Each mapping unit was characterized according to a drainage density index and percent of area in ridges, north and south slopes and bottomland. However, these data proved inadequate to account for the occurrence of range sites in each mapping unit. Efforts were then directed at attempts to classify field data into plant associations identifiable on aerial infrared photos at a scale of about 1:120,000 (ERTS-1 Aircraft Support Flight No. 73-152).

An attempt was then made to classify sites based on vegetative characteristics (composition, dominance, etc.) using association tables and cluster analysis. For the most part, these groupings did not result in a classification which could be consistently identified on aerial photos or which was meaningful ecologically. A combination of site factors, plant cover, species constancy and importance values was then used to describe 23 range sites which could be identified reasonably well both on aerial photos and in the field and which had meaning for management purposes.

The first subdivision was into bottomland and upland. Bottomlands were further subdivided into "wet" or "mesic" bottoms, the former found to correlate well with gravel cover of more than 5 percent. The upland sites were subdivided into five classes based on amount of solar radiation possible as influenced by slope and aspect. One radiation class

was further subdivided into four slope classes to separate ridges and bajada surfaces and significant slope differences. All of these upland classes were divided into limy and non-limy soils, and in some cases, according to surface texture or rockiness. All 23 sites were described, characteristics listed, and a key to the sites developed.

A test was made of photo-interpretability of the various factors used in classifying the sites. Also, two of the original mapping units were sampled using aerial photos to characterize the area according to the proportion of different sites (or taxonomic units) occurring within them. This information could be used for land management purposes.

Conclusions

1. ERTS-1 satellite imagery was useful for initial separation of valley fill alluvium and bedrock areas. Some vegetation features within the valley fill could be seen, i.e. cienegas and fence-line contrasts, but consistent mapping at a level necessary for range management was not feasible.

2. Range sites could not be defined solely on the basis of vegetation associations. Classification based on site factors, e.g., topographic position, solar radiation, slope percentage, surface soil characteristic and limyness of parent material, gave meaningful groupings in terms of vegetation.

3. With considerable experience in the area, most, but not all, of the defining criteria for sites could be identified with reasonable success on 1:100,000 color infrared photos. Additional refinement of the distinguishing criteria and training in photo interpretation might improve the success.

4. It was not possible to map at the site level at a scale of 1:100,000. However, mapping units based on the pattern of drainage, land forms, soils and vegetation could be easily delineated on color IR photos of 1:100,000 scale and the proportion of sites in each mapping unit described with a reasonable degree of certainty through grid sampling on the photo.

The work initiated by this study is being continued under an Arizona Agricultural Experiment Station Project "Application of Remote Sensing for Natural Resource Analysis." Based on information gained from the NASA grant, this project is designed to initiate a systematic study and classification of range sites in Arizona to provide improved resource inventories and management.

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INTRODUCTION

A basic site-vegetation unit or taxonomic unit which is of significance in natural resource inventories is what Daubenmire (1968) designates as a habitat type: "All the area (sum of discrete units) that now supports, or within recent time has supported, and presumably is still capable of supporting, one plant association..." The habitat type is approximately equivalent to the range site of range scientists who identify this basic unit as a grouping of relatively homogeneous areas with soils and vegetation of similar potential for primary production and response to management.

When a range site occurs on a relatively large area, the site can be designated as a mapping unit, even on relatively small-scale imagery. If, however, the range sites are highly patterned because of site factors such as slope, aspect, soils, etc., the sites may not equate to mappable units except on very large-scale imagery. Thus, the mapping unit may be a combination of sites, but the arrangement and proportion of the individual sites within the mapping unit determine the value of the unit for specific uses such as livestock grazing, wildlife habitat, recreational use, or urban development. Inventory techniques should provide for recognition and sampling at the range site level.

The range site is the basic unit of a hierarchical natural resource classification system, and it is important that resource managers recognize these units, regardless of what scale the resource inventory is made. It is at the range site level that sampling can be accomplished without encountering undue variation and for which management outcomes can be predicted. The problem is to identify and describe the basic range sites, so natural resource managers can utilize this information in inventories

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and management.

OBJECTIVES

The objectives of this research were to:

1. develop ground truth and image class grouping criteria for the definition of a hierarchical classification system of site-vegetation units (legend) as a basis for natural resource inventory and monitoring using remote sensing techniques.

2. develop imagery interpretation aides and keys to facilitate identification of legend subdivisions within the site-vegetation systems.

3. develop methods of compiling and analyzing the resultant data to maximize the utility and acceptance of the techniques by the users (natural resource managers) for use in decision making.

STUDY AREA AND DATA COLLECTION

The Empire Valley which encompasses the headwaters of three drainages, Sonoita Creek, Cienega Creek, and Babocomari Creek, was chosen as the study area. This area contains a multitude of highly patterned site-vegetation units which have not been adequately described at the range site level. This study area is also within the broader southeastern Arizona test site utilized by Poulton, Schrumpf, Johnson, and Mouat in their evaluations of ERTS-1 imagery for inventory and monitoring natural vegetation, and their techniques and results were helpful in the conduct of our study.

The limits of the study area were established as the alluvial fill portion of the Empire Valley to the point on each of the three drainages where the stream channel intercepts bedrock. O'Donnell Canyon was

utilized as the boundary on the southeast, and the watershed boundary between the Empire Valley and Barrel Canyon was utilized as the north boundary. The boundary for the study area is shown in Fig. 1 as outlined on ERTS E-1030-17271-5 frame.

Alluvial valley fill areas and areas with bedrock near the surface are units of classification in a hierarchical scheme which are practical for mapping at the 1:1,000,000 and 1:500,000 scale. The distinction between these two classes of land can be identified on ERTS imagery, these units correspond to major mapping units of geologists and soil scientists and are classifications of land which are meaningful in determining the suitability of the land for various uses. As reported in our Progress Report (Type I) April 1, 1973 - May 31, 1973, the only landscape features within the study area which are prominent on ERTS imagery are the cienegas along Cienega and Babocomari Creeks. The ERTS imagery is useful in determining broad classification units of alluvium or bedrock and major drainages, but determination of range sites must be accomplished on larger scale aerial photographs.

Initial identification and mapping of geomorphic-soil-vegetation units and selection of ground truth sample points was accomplished on a black and white aerial photo mosaic at a scale of approximately 1:30,000 (Progress Report (Type II) October 1, 1972 - March 31, 1973). The main features evident on the black and white aerial mosaic are the patterns of ridges, drainages and slopes. Areas with similar topographical patterns were delineated into 46 mapping units. Sampling was stratified so that sample points for obtaining ground truth represented images of ridges, bottomlands, south slopes and north slopes within each mapping unit. Sample points were selected on the aerial photos and during 1972 and 1973, 304 samples

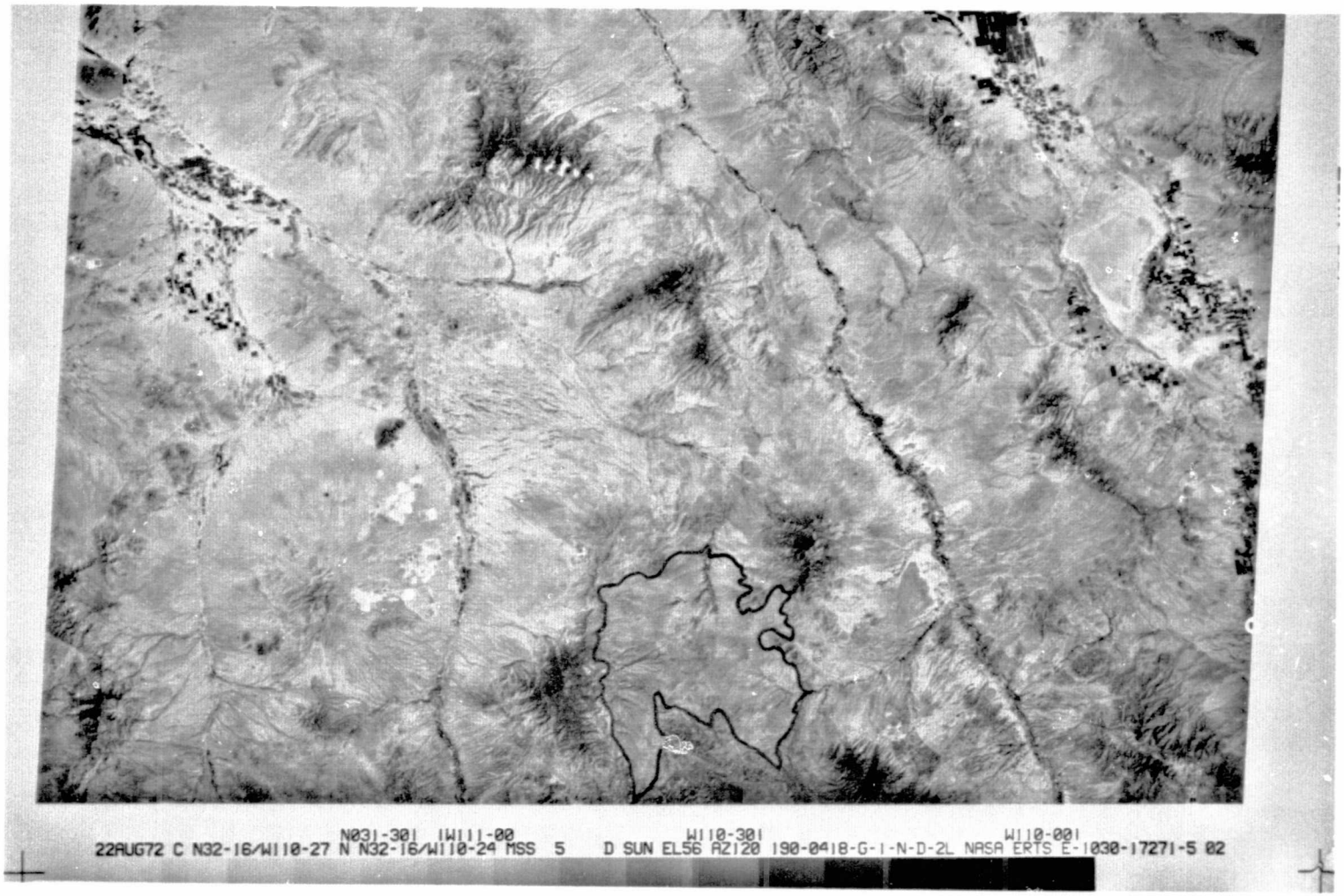

Fig. 1. NASA ERTS imagery with boundary of the Empire Valley study area designated.

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locations were visited and ground truth data collected.

Ground cover was estimated as percentage trees, shrubs, herbaceous plants, litter, cobbles (rocks >3 inches), and gravel (rocks <3 inches). Plant species were identified and assigned dominance rating within each vegetation layer. The dominance ratings were those used by Culver and Poulton (1968) and are shown in Table 1. Plant species also were estimated and rated as to the percentage each contributed to the composition of each layer of vegetation (Table 2). In addition to cover and plant species data collected at each sample location, aspect and slope were determined and apparent soil series and grazing influence recorded.

As reported in our Progress Report (Type II) for April 1, 1973 - September 30, 1973, mapping units as delineated on the 1:30,000 black and white photo mosaic were characterized by a drainage index and the proportion of ridges, south and north slopes, and bottomlands which were in each unit. The proportion of the area which is represented by each topographical position was determined by dot counts on an overlay grid. The drainage density index was determined on the imagery by counting the number of channels which intersect the line marking the circumference of a circle, this circumference representing one mile at the scale of the imagery. Intersecting channels are recorded according to stream order of one through X with one being the smallest recognizable channel on the imagery.

The drainage index when computed from all drainage intercepts, including the smallest recognizable, was generally a good measure of drainage pattern except that a high index is possible for a highly dissected unit as well as for an area of broader drainage pattern with small drainages off the side slopes. A limit on the smallest size or order of drainage considered as an intercept is necessary to provide indices which

Table 1. Dominance ratings used to classify plant species on ground truth plots (Culver and Poulton, 1968).

Rating	Description
5	Clearly a dominant species of the vegetation layer
4	Used to rate species when several species are codominant within a vegetation layer or if one or more species are slightly less abundant than the dominant species.
3	Species which are easily seen from a single sampling point but which are not dominant species or codominants.
2	Species which can generally be seen only by moving around the sample area to observe them.
1	Species which can only be observed by searching for them.

Table 2. Composition ratings used to classify plant species on ground truth plots.

Rating	Description
5	51% or greater of the percentage composition by weight of the layer of vegetation to which the species belongs.
4	31 to 50% of the percentage composition.
3	16 to 30% of the percentage composition.
2	6 to 15% of the percentage composition.
1	Less than 5% of the percentage composition.

characterize areas of similar drainage patterns.

Further efforts to characterize the mapping units on the black and white mosaic photos were abandoned. As we analyzed our ground truth data, reviewed the results of Shrumpf, Johnson, and Mouat (1973), and studied Aerochrome Infrared imagery of ERTS-1 Aircraft Support Flight No. 73-152, it became obvious that range site characterization must include more than a designation of topographical position within specific mapping units.

Ground truth data from 255 sample plots within the study area were punched on IBM cards and several techniques including sorting by dominant species, cluster analyses, and association tables were utilized to characterize plant associations. A few consistent plant associations such as sacaton, tobosa, and oak associations were identified, but we were unable to classify most of our field vegetation samples into associations of plants which were consistent with the image patterns which were identifiable on infrared imagery of approximately 1:120,000 scale. We, therefore, shifted our efforts to use of the Aerochrome Infrared imagery of ERTS-1 Aircraft Support Flight No. 73-152 for identification of range sites and development of criteria as described in the following section.

APPROACH TO SITE CLASSIFICATION

According to Major (1951) both vegetation and soil are developed in response to environmental factors as expressed in the equation,

v or s = f(cl, o, r, p, t), where:

v = the vegetative community (or some characteristic of it)

s = the soil individual (or some characteristic of it)

cl = the regional climate, natural fire included

o = organisms, including the potential flora, the fauna, activities of man and his domesticated animals

r = relief, including effects on solar insolation, runoff/runon, erosion, depth to water table, etc.

p = parent material or nature of substrate at time zero

t = time, all other factors interact through time until at climax a steady state is achieved.

In our previous discussion of the concept of range site it was stated that the potential vegetation and soil were reasonably uniform within a site. Therefore, all of the above "state factors", i.e., cl, o, r, p and t, must also be relatively constant within the site. However, man through his control of animals, fire and machines can cause reversible changes in vegetation and, to a lesser extent, soil. These reversible changes in vegetation do not change the potential of the site but may greatly alter its appearance. Irreversible changes in vegetation or soil, e.g., severe erosion, may change the potential of the site and make it, for all practical purposes, a different site.

Essentially all of the land in the study area has been grazed by livestock for many years. The intensity of grazing depends on many factors such as distance from water, land ownership, topography, etc., and site itself. In addition, some areas have been plowed, burned, contour furrowed, or seeded to exotic species at various times in the past. All of these influences have no doubt caused changes in the vegetation, but we do not know exactly where and how much change has taken place. We believe that these changes tend to weaken the correspondence of vegetation and plant species distribution with respect to environmental variables and, thus, present vegetation is not always a reliable indicator of the physical environment.

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This view is also held by many ecologists. Therefore, in our opinion, site classification should lean heavily on site factors which vary relatively little in response to grazing and other disturbance. Of course it is not possible, nor probably desirable, to ignore vegetation indicators particularly since many site factors are difficult to measure or to see on aerial photos.

Considering the factors in the equation | s or v = f(cl, o, r, p, t)|

1. Climate (cl) - was considered to be a constant in the study area.
2. Organisms (o) - considered to be a constant in the study area except for that part related to man's activities. This effect (grazing, etc.) was not constant but also not known a priori.
3. Time (t) - considered to be constant or relatively insignificant, i.e., most vegetation and soil differences are not assumed to be the result of different stages of primary succession but rather stages of retrogression or secondary succession associated with 2 above.
4. Parent material (p) - the study area was restricted to alluvium of two basic types - Recent and older alluvium or valley fill.
   a. Recent alluvium - unconsolidated, stratified deposits along bottoms and drainages ranging from about 10 m to 100+ m in width. Nature (texture, mineralogy, etc.) varies depending on source of stream, size of drainage, width of bottom, etc. Often gullied.
   b. Older alluvium - weakly- or un-consolidated sediments and valley fills of Quaternary or Tertiary age. Forms terraces, bajadas and fans from mountain fronts to main drainages. Sediment varies in texture and mineralogy depending on source of sediment, distances from mountain front, age of desposition, etc. Older surfaces have undergone more extensive weathering. Areas where soil is effervescent to the surface apparently reflect exposure of calcareous

sediments by erosion and dissection of older surfaces.

5. Relief (r) - accounts for most of the differences in microclimate due to:
   a. elevation - correlated with precipitation and temperature
   b. slope and aspect - related to solar radiation received, exposure to prevailing wind, etc.
   c. degree and length of slope - influences runoff and erosion
   d. depth to water table
   e. cold air drainage
   f. run-on moisture.

The approach used was to use measured site characteristics to define sites having similarities in terms of the state factors in the equation. In doing so, climate (cl) was considered to be a constant, time (t) was considered to have an insignificant influence within the range of conditions sampled and organisms (O), i.e., grazing, to cause unmeasured variation in the vegetation on the site and insignificant influences on physical factors. Thus parent material (p) and relief (r) were the two state factors assumed responsible for site differences. The effects of these two variables are expressed in several ways, most of which are either not easily measured in a direct fashion and/or are confounded with other effects.

Bottomlands and Uplands

The most obvious initial classification was to separate bottomland from upland. This separation reflects both parent material and relief. It is readily determined in the field or on aerial photos.

1. Bottomland - areas of Recent alluvium occupying floodplains along drainages. Slopes do not usually exceed 5%. In many cases the "floodplain" no longer floods due to extensive arroyo cutting. In the study area, these bottoms are several hundred meters wide on the lower

end of major drainages and gradually narrow upstream, eventually changing to ravines or narrow canyons. The three major drainages (Cienega, Babocomari and Sonoita Creeks) are protected from further downcutting by bedrock sills at the boundaries of the study area. All bottomlands are assumed to be affected by one or more of the following phenomena: (1) cold air drainage, (2) supplemental water from side slopes and/or overflow and recharge of alluvium, (3) possible influence of water table within reach of plant roots.

2. Upland - areas of older alluvium which forms terraces, bajadas and fans with general slopes of 3-10% away from the mountain fronts. Dissection of these surfaces results in sideslopes ranging from moderate to steep and, if dissection has progressed far enough, to a rolling topography. Soils are residual (except in swales) and development reflects age and stability of the geomorphic surface. Composition (size and mineralogy) of the parent material is related to (1) source of alluvium, (2) distance from source and (3) depositional environment. Moisture conditions are related to (1) elevation, (2) slope percentage, (3) slope aspect, (4) position on slope, (5) shape and length of slope and (5) texture of soil (including gravel or stone content).

Subdivision of Bottomlands

Since the range of elevations within the study area is limited and the expected increase in precipitation and decrease in temperature associated with increasing elevation is both limited and, to some extent, confounded with rain-shadow effects of neighboring mountains, the principal site differences within the bottomlands should be determined mostly by position of the water table and the addition of moisture through surface flooding and/or subsurface recharge of the alluvium. In some cases the nearness

of the water table or the frequency and amount of moisture storage in the alluvium is sufficient to support plants which cannot tolerate the long dry periods typical of the regional climate. In other cases the amount of additional moisture received is insufficient to support these plants because of lower frequency of flooding or the texture and depth of the alluvium does not allow adequate infiltration and storage of water.

There are three examples of the first case within the study area:

1. Marshes or cienegas - areas which support water-loving plants (such as cottonwoods, cattails, etc.) and have essentially year-round access to a free-water table. These occur near the bedrock sills on Cienega, Babocomari and Sonoita Creeks.

2. Streambanks - areas which due to frequent or long-duration surface and subsurface flow enjoy a moist environment. These extend out a short distance from the mountain front along stream channels which head at higher elevations in the mountains and may support trees such as sycamore, walnut, ash, etc. Other examples occur in the study area along bottoms, usually arroyos, of major drainages which head in the mountains and support narrow fringes of desert willow, tree-size mesquite, etc.

3. Floodplains - areas which store large amounts of moisture from flooding and recharge of the alluvium and which may have a local water table at depths of about 20-40 feet. The soil of these areas has a dry aspect most of the time. Deeprooted plants are subject to only short periods of moisture stress.

Marshes and streambank sites were not sampled or described in this study, since their occurrence is limited. The mesic floodplain site is common especially on larger bottoms. Since we did not measure any site characteristic which seemed to give an indication of a division point

between this site and drier conditions, we arbitrarily assumed that a dominance of sacaton and/or tree-size mesquite would indicate this site, (Site 4). This groups vegetation types designated by several authors as "mesquite bosque" or forest with those designated as "sacaton bottoms." This may be controversial but we have not found any site difference which can explain these two vegetation types. It seems probable that any area dominated by sacaton could support a heavy stand of tree-size mesquite. That many areas do not, is, in our opinion, probably a result of plant migration patterns, historical fire, or man's influence.

The bottomlands which do not fall in the above categories were called "dry bottoms." Although they do receive additional moisture through stream flooding or sideslope runoff, the duration, amount and depth of soil moisture storage is insufficient to support plants with significantly higher moisture requirements than found on adjacent upland areas. Sacaton and/or tree-size mesquite occurred on some dry bottoms but composed less than 50% of the compsoition (composition rating of 4 or less). These stands are borderline but in most cases appeared to be former examples of Site 4 which had deteriorated due to arroyo cutting. The "dry bottoms" were subdivided into those with estimated surface cover of gravel (<3" dia.) of 5% or more and those with none or only traces. We assumed that surface gravel reflects gravel in the soil profile, which in turn affects the depth of soil wetting and water-holding capacity per unit volume of soil. Generally, a given amount of water will wet a gravelly soil deeper than a non-gravelly soil so it may offer less water to shallow rooted plants and more to deep-rooted plants. Gravel content may also be related to stream regimen, width of bottom or slopes. At any rate our sampling showed more shrubs and trees but lower herbaceous cover on gravelly sites compared to non-gravelly. The dry bottom with

gravel is Site 3.

The non-gravelly bottoms were divided into those with clay loam or coarser texture (Site 2) and those with clay texture (Site 1). Only one location was sampled in Site 1 but our experience shows that tobosa grass seems to be a reliable indication of the site. Whether the dominance of tobosa grass on heavy soils is due to slow availability of moisture, poor aeration or possible salt buildup is not known, but the distinction between heavy and lighter-textured soils is useful for management.

Sub-division of Uplands

Because of the relatively limited range in elevations within the study area it was decided to make the initial breakdown of upland sites based on potential solar radiation values. The amount of solar radiation received is a function of slope and aspect for a given latitude and atmospheric conditions. It influences the effectiveness of precipitation received on a site and, heat conditions for plant growth. Using values for March 21/ Sept. 2 daily solar radiation from Buffo, et al. (1972), we established five radiation classes: 300-400, 400-500, 500-600, 600-700, and 700+ cal/cm^2/day. The basis for these classes are: (1) the range of slopes and aspects sampled is accommodated, (2) more than about 5 classes were considered unwildy, and (3) flat ground has a value of 650 which splits one of the classes. The range of slopes and aspects in each class are shown in Table 3. The March 21/September 21 data were chosen because these dates approximate the two growing seasons in the study area. However, yearly radiation values would probably work just as well.

Inspection of Table 3 shows that the 600-700 class has a much wider range of slopes than any others and even includes level land. It was decided a subdivision of this class based on slope would be useful to better

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Table 3. Range of slope percentages and slope aspect of sites within solar radiation classes.

Solar Radiation*	Aspect				
	S	SE SW	E W	NE NW	N
	Slope percentage				
700+	>18%	26-73%	-	-	-
600-700	0-18%	0-25%, >73%	0-53%	0-16%	0-11%
500-600	-	-	>53%	17-45%	12-32%
400-500	-	-	-	46-75%	33-51%
300-400	-	-	-	-	52-73%

*cal/cm^2/day on March 21 - September 21.

reflect landform effects on soil development and slope/moisture relationships. Slope classes of 0-5%, 6-15%, 16-75% and >25% were established for the 600-700 radiation class only. The 0-5% figure was chosen to separate ridges, terraces, bajadas, etc. from sideslopes. The other categories were chosen to roughly fit slope breaks by aspect shown in Table 3.

Each slope class within the 600-700 radiation class and the other four radiation classes were then broken into limy or non-limy categories. The limy sites were those on which the soil effervesces at or near the surface in response to HCl. This is characteristic of the Hathaway soil series (an Aridic Calciustoll) which usually occurs on ridges or side slopes where dissection has removed the more weathered materials. This soil usually produces a distintive vegetation. The non-limy sites are those which do not react to HCl on the surface and included soil series like Whitehouse, Bernadino, Caralampi, etc.

The sites within radiation class 600-700, 0-5% slope, limy or non-limy included areas on older terrace or bajada surfaces with well developed soils as well as younger terraces or ridges with younger soils. In an effort to separate these, as well as areas of coarser alluvium toward the upper and older surfaces, areas with less than 5% of the soil surface covered with cobbles (>3" dia.) were separated from those with 5% cobbles or more. The presence of cobbles or larger stones was considered to be related to effectiveness of soil moisture, i.e., moisture holding capacity, depth of penetration and depth to B2 or Cta horizons in the soil. In the case of non-limy sites it should make a separation between Caralampi, gravelly phases of Whitehouse or Bernadino and the finer-textured phases of Whitehouse and Bernadino.

The non-limy sites of the above class were further subdivided into

soils with clay surface texture supporting tobosa grass which occupy swales or clay lenses on terraces or bajada surfaces and those areas with clay loam or coarser surface texture.

A summary of these site classification is given in Table 4.

RESULTS OF SITE CLASSIFICATION

Twenty-three range sites were classified on the basis of physical site factors as discussed in the previous section. Field sample data were then summarized by site and the sites characterized as shown in the following Figs. 2 to 45 and site summaries. Constancy is the percentage of occurrence of a species among sample stands and is a measure of ubiquity of a species. The importance value for a species is the product of the composition rating (Table 2) for a species and the percentage cover of the vegetation layer of which the species is a component.

The combination of site factors, plant cover, species constancy and importance values serve to describe the range sites identified. Attempts to describe sites based on only vegetation associations resulted in groupings which could not be consistently identified on aerial photos and were not meaningful groupings in terms of known ecological relationships. The sites as we have identified them do provide meaningful groups. For instance, Schickedanz (1974) studied blue grama on Site 8 within our study area and found on this upland site that blue grama suffered high drought mortality during a dry fall-winter period. The importance value for blue grama on Site 8 is 64 and the constancy percentage is 86. Higher importance values and constancy percentages were found for blue grama on the bottom-land sites, presumably where moisture conditions were better for blue grama than on Site 8.

Table 4. Outline of Site Classification.

I. Bottomland	
A. Mesic - sacaton and/or tree-size mesquite >50% composition	Site 4
B. Dry - sacaton and/or tree-size mesquite <50% of composition	
1. Gravel (<3" dia.) covers >1% of soil surface	Site 3
2. Gravel (<3" dia.) covers <1% of soil surface	
a. Surface soil texture loamy clay or finer	Site 1
b. Surface soil texture clay loam or coarser	Site 2
II. Upland	
A. Radiation class 700+ (cal/cm^2/day)	
1. Soil not limy to surface	Site 6
2. Soil limy to surface	Site 7
B. Radiation class 600-700	
1. Slope 0-5%	
a. Soil not limy to surface	
(1) Cobbles (>3" dia.) occupy <5% of soil surface	
(a) Surface soil texture clay loam or coarser	Site 8
(b) Surface soil texture loamy clay or finer	Site 10
(2) Cobbles (>3" dia.) occupy 5% or more of soil surface	Site 11
b. Soil limy to surface	
(1) Cobbles occupy <5% of soil surface	Site 9
(2) Cobbles occupy 5% or more of soil surface	Site 12
2. Slope 6-15%	
a. Soil not limy to surface	Site 13
b. Soil limy to surface	Site 14
3. Slope 16-25%	
a. Soil not limy to surface	Site 15
b. Soil limy to surface	Site 16
4. Slope 26%	
a. Soil not limy to surface	Site 17
b. Soil limy to surface	Site 18
C. Radiation class 500-600	
1. Soil not limy to surface	Site 19
2. Soil limy to surface	Site 21
D. Radiation class 400-500	
1. Soil not limy to surface	Site 22
2. Soil limy to surface	Site 23
E. Radiation class 300-400	
1. Soil not limy to surface	Site 24
2. Soil limy to surface	Site 25

Black grama is known to grow on limy soils and this species has high constancy values for our limy upalnd sites. Texas bluestem and bullgrass are characteristic species of our low radiation range sites.

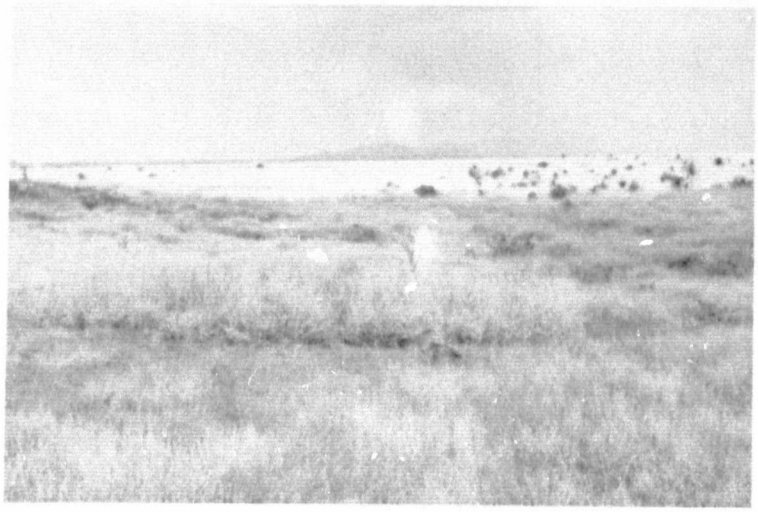

Figure 2. General view of stand 183 typical of Site 1

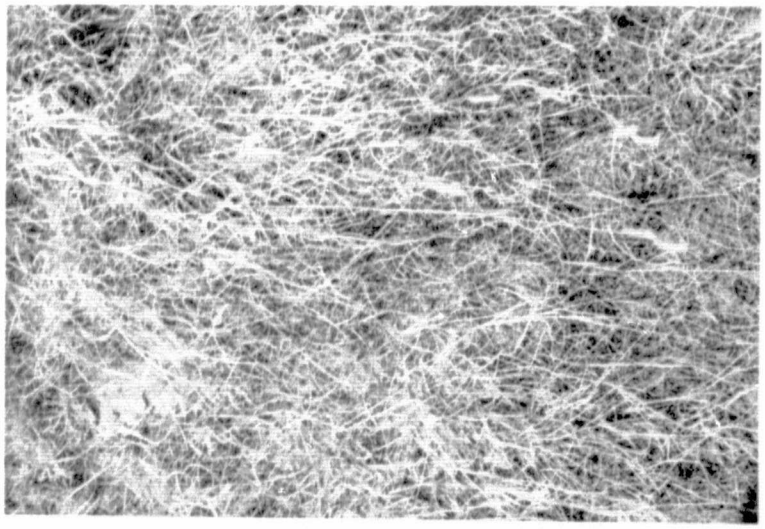

Figure 3. Closeup view of stand 183.

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Site No: 1 No. of stands 1

Site Designation: Bottomland - Dry, no gravel, clay

Site Characteristics:	Mean	Range
1. Radiation	651	--
2. Slope	1%	--
3. Elevation	4790'	--
4. Gravel	0%	--
5. Cobbles, rocks	0%	--

Soil & Landform Characteristics:
1. Parent material - Recent alluvium, clay
2. Landform - Floodplains along drainages
3. Soil - Guest or similar series

Vegetation Characteristics:

1. Cover	Mean	Range
a. Trees	0%	--
b. Shrubs	Trace	--
c. Herbaceous	50%	--
d. Litter	20%	--
e. Bare ground	30%	--

2. Composition	Constancy	Importance	Value
a. Perennial grasses	%	Mean	Range
1. Bogr - Blue grama	--	200	--
2. Hibe - Curly mesquite	--	200	--
3. Bocu - Sideoats grama	--	100	--
4. Himu - Tobosa grass	--	50	--
5. Anba - Cane beardgrass	--	50	--
6. Arte - Spidergrass	--	50	--
b. Forbs			
1. Hagr - Annual goldenweed	--	50	--
2. Erca - Horseweed	--	50	--
3. EUPH - Spurge	--	50	--
4. Soel - White horsenettle	--	50	--
c. Shrubs			
1. Prju - Velvet mesquite	--	5	--
2. Midy - Velvetpod mimosa	--	2	--
3. Selo - Longleaf senecio	--	1	--
d. Trees			
1. None			

Figure 4. General view of stand 46 typical of Site 2.

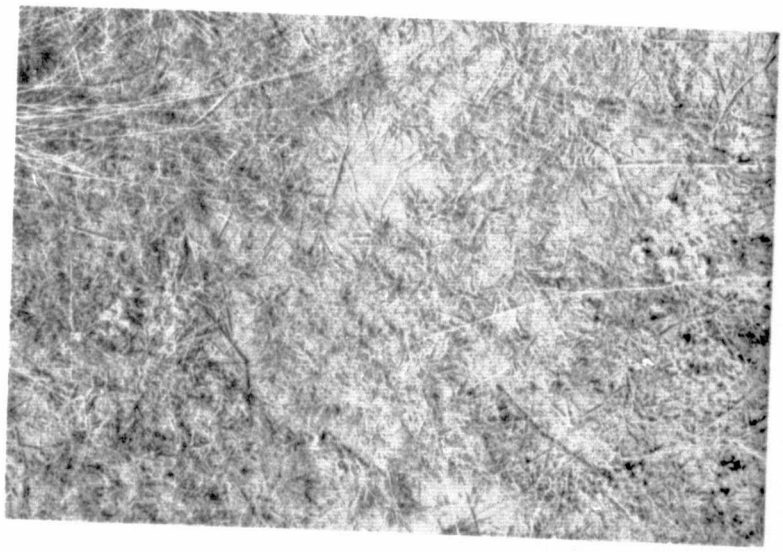

Figure 5. Closeup view of stand 46 (Note lack of gravel on surface).

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Site No: 2 No. of stands 15

Site Designation: Bottomland - Dry, no gravel, loamy

Site Characteristics:	Mean	Range
1. Radiation	651	651-651
2. Slope	1%	1-4%
3. Elevation	4820'	4480-5070'
4. Gravel	Trace	0-Trace
5. Cobbles, rocks	Trace	0-Trace

Soil & Landform Characteristics:
1. Parent material - Recent alluvium
2. Landform - Floodplains along drainages
3. Soil - Pima or similar series

Vegetation Characteristics:	Mean	Range
1. Cover		
a. Trees	Trace	0-Trace
b. Shrubs	1%	0-10%
c. Herbaceous	42%	15-70%
d. Litter	32%	15-50%
e. Bare ground	25%	5-65%

2. Composition	Constancy	Importance Value	
a. Perennial grasses	%	Mean	Range
1. Bogr - Blue grama	100	162	75-280
2. Anba - Cane beardgrass	87	47	0-140
3. Bocu - Sideoats grama	80	81	0-210
4. ARIS - Three-awn	40	31	0-135
5. Arte - Spidergrass	33	30	0-140
6. Spwr - Sacaton	33	13	0-45
7. Paob - Vine mesquite	27	25	0-135
b. Forbs			
1. ARGE - Prickly poppy	87	39	0-70
2. Hagr - Annual goldenweed	73	57	0-180
3. Plpu - Indian wheat	60	37	0-180
4. LEPI - Peppergrass	33	22	0-105
5. Depi - Tansy mustard	27	10	0-45
6. CIRS - Bull thistle	27	11	0-45
7. EVOL - Evolvolus sp.	27	11	0-60
c. Shrubs			
1. Prju - Velvet mesquite	40	3	0-30
2. Bapt - Yerba de pasmo	33	Trace	0-3
3. OPUN - Opuntia spp.	27	2	0-10
4. Selo - Longleaf senecio	27	3	0-30
d. Trees			
1. Quem - Emory oak	7	Trace	0-5

Figure 6. General view of stand 208 representing Site 3.

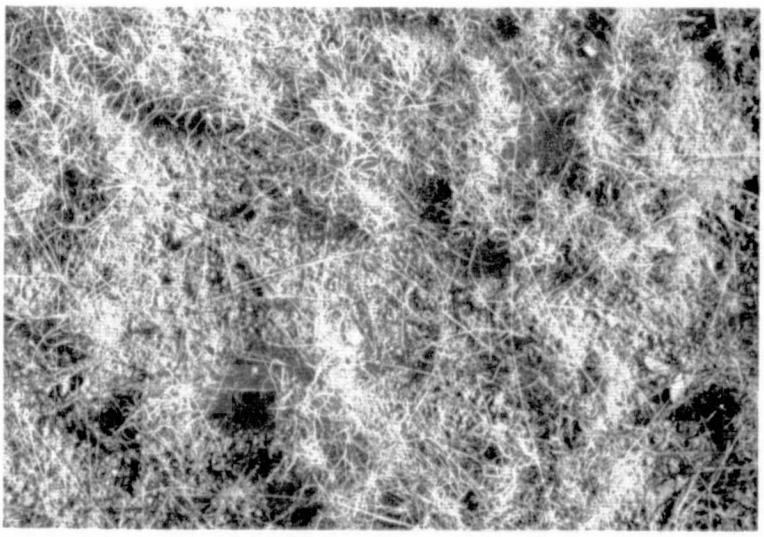

Figure 7. Closeup view of stand 208 (Note gravelly surface).

REPRODUCIBILITY OF THE
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Site No: 3 No. of stands 33

Site Designation: Bottomland - Dry, with gravel

Site Characteristics:	Mean	Range
1. Radiation	651	651-651
2. Slope	1%	1-5%
3. Elevation	4777'	4270-5160'
4. Gravel	16%	5-35%
5. Cobbles, rocks	1%	0-5%

Soil & Landform Characteristics:
1. Parent material - Recent alluvium
2. Landform - Floodplains along drainages
3. Soil - Comoro or similar series

Vegetation Characteristics:	Mean	Range
1. Cover		
a. Trees	Trace	0-5%
b. Shrubs	3%	0-15%
c. Herbaceous	25%	10-65%
d. Litter	27%	10-60%
e. Bare ground	28%	5-65%

2. Composition	Constancy	Importance	Value
a. Perennial grasses	%	Mean	Range
1. Bogr - Blue grama	100	104	15-325
2. ARIS - Three-awn	76	42	0-130
3. Anba - Cane beardgrass	70	27	0-105
4. Bocu - Sideoats grama	61	24	0-100
5. Spwr - Sacaton	33	13	0-135
6. Lyph - Wolftail	30	12	0-60
7. Bohi - Hairy grama	30	12	0-80
8. Erin - Plains lovegrass	27	9	0-65
9. Arte - Spidergrass	27	19	0-160
b. Forbs			
1. Hagr - Annual goldenweed	85	29	0-120
2. ARGE - Prickly poppy	82	21	0-65
3. Erca - Horseweed	52	14	0-40
4. CIRS - Bull thistle	24	7	0-65
5. AMBR - Ragweed	24	6	0-50
c. Shrubs			
1. Prju - Velvet mesquite	73	12	0-75
2. Selo - Longleaf senecio	45	4	0-50
3. Mibi - Wait-a-bit	33	2	0-25
4. OPUN - *Opuntia* spp.	30	1	0-5
5. Hate - Burroweed	30	3	0-20
d. Trees			
1. Quem - Emory oak	15	2	0-25
2. Prju - Velvet mesquite	9	Trace	0-5

Figure 8. General view of stand 290 representing Site 3 (Sacaton phase).

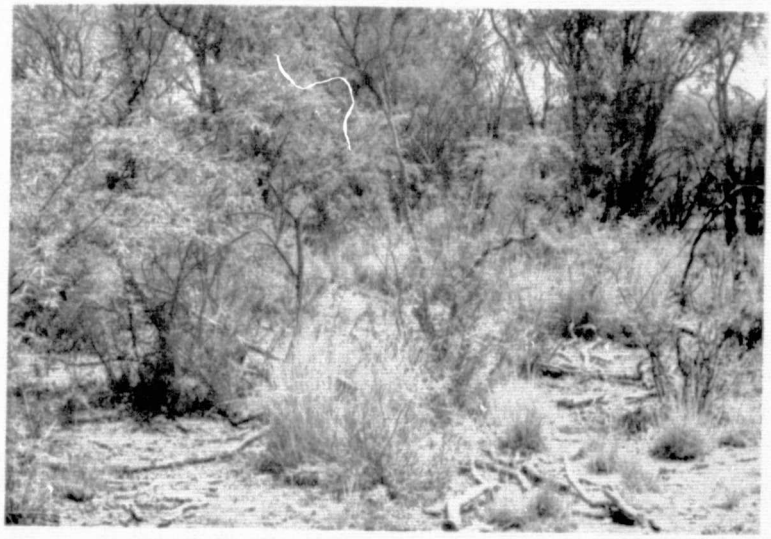

Figure 9. General view of stand 87 representing Site 3 (Mesquite bosque phase).

REPRODUCIBILITY OF THE
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Site No: 4 No. of stands 8

Site Designation: Bottomland - Mesic

Site Characteristics:	Mean	Range
1. Radiation	651	651-651
2. Slope	1%	1-1%
3. Elevation	4506'	4330-4630'
4. Gravel	2%	0-10%
5. Cobbles, rocks	1%	0-5%

Soil & Landform Characteristics:
1. Parent material - Recent alluvium
2. Landform - Floodplains along drainages
3. Soil - Pima or similar series

Vegetation Characteristics:	Mean	Range
1. Cover		
a. Trees	8%	0-40%
b. Shrubs	2%	0-10%
c. Herbaceous	29%	5-55%
d. Litter	31%	10-45%
e. Bare ground	28%	5-80%

2. Composition	Constancy	Importance	Value
a. Perennial grasses	%	Mean	Range
1. Spwr - Sacaton	100	145	10-275
2. Mure - Creeping muhly	50	27	0-90
3. Bogr - Blue grama	38	31	0-110
4. Paob - Vine mesquite	38	21	0-110
5. Bocu - Sideoats grama	25	14	0-90
b. Forbs			
1. ARGE - Prickly poppy	62	19	0-55
2. ASTR - Locoweed	62	18	0-45
3. Depi - Tansy mustard	38	14	0-75
4. CHEN - Goosefoot	25	4	0-25
5. DATU - Sacred datura	25	8	0-55
6. Vian - Annual goldeneye	25	10	0-45
c. Shrubs			
1. Selo - Longleaf senecio	38	2	0-5
2. Mibi - Wait-a-bit	38	1	0-5
3. LYCI - Wolfberry	25	8	0-50
4. Coly - Graythorn	25	4	0-25
5. Prju - Velvet mesquite	12	5	0-40
d. Trees			
1. Prju - Velvet mesquite	25	41	0-200

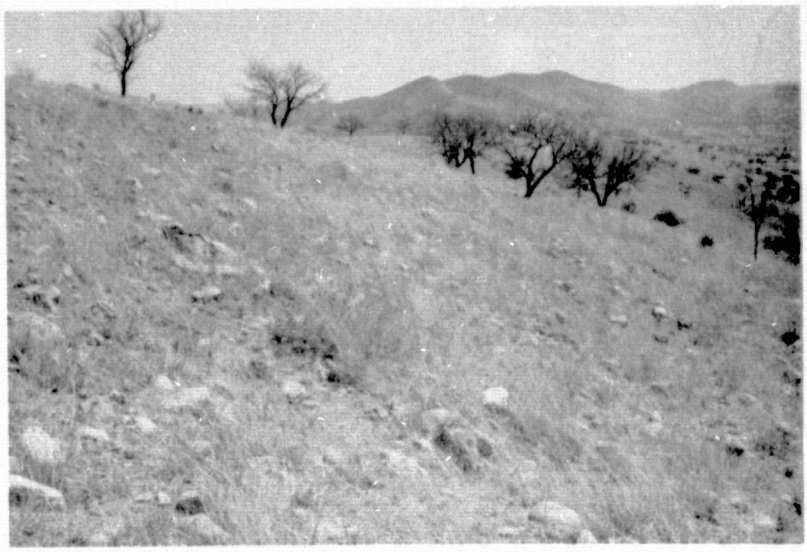

Figure 10. General view of stand 232 representing Site 6.

Figure 11. Closeup view of stand 232.

REPRODUCIBILITY OF THE
ORIGINAL PAGE IS POOR

Site No: 6 No. of stands 17

Site Designation: 700+, non-limy

Site Characteristics:	Mean	Range
1. Radiation	725	700-745
2. Slope	38%	20-70%
3. Elevation	4940'	4350-5380'
4. Gravel	33%	10-50%
5. Cobbles, rocks	14%	5-30%

Soil & Landform Characteristics:
1. Parent material - QTs alluvium
2. Landform - Slopes
3. Soil - Caralampi, Bernadino, Whitehouse or similar series

Vegetation Characteristics:	Mean	Range
1. Cover		
a. Trees	Trace	0-Trace
b. Shrubs	6%	Trace-15%
c. Herbaceous	22%	15-40%
d. Litter	14%	10-40%
e. Bare ground	11%	5-20%

2. Composition	Constancy	Importance	Value
a. Perennial grasses	%	Mean	Range
1. Bocu - Sideoats grama	100	65	15-120
2. Anba - Cane beardgrass	88	23	0-120
3. ARIS - Three-awn	82	24	0-50
4. Evin - Plains lovegrass	59	26	0-100
5. Heco - Tanglehead	53	24	0-120
6. Hibe - Curly mesquite	53	38	0-150
7. Boch - Sprucetop grama	41	26	0-140
8. Lyph - Wolftail	41	17	0-135
9. Bohi - Hairy grama	35	15	0-60
10. Bofi - Slender grama	29	11	0-60
b. Forbs			
1. Vian - Annual goldeneye	65	17	0-50
2. Hagr - Annual goldenweed	65	15	0-35
3. Plpu - Indian wheat	53	12	0-35
4. CROT - Croton spp.	23	5	0-35
c. Shrubs			
1. Caer - False mesquite	70	25	0-75
2. OPUN - Opuntia spp.	53	4	0-15
3. Prju - Velvet mesquite	41	4	0-15
4. Midy - Velvet pod mimosa	41	7	0-45
5. Bapt - Yerba de pasmo	35	3	0-15
6. AGAV - Agave	35	3	0-15
7. Erwr - Shrubby buckwheat	29	1	0-5
8. Mibi - Wait-a-bit	29	4	0-25
9. ECHI - Echinocactus	24	1	0-10
d. Trees			
1. Quob - Mexican blue oak	6	Trace	0-5

Figure 12. General view of stand 171 representing Site 7.

Figure 13. Closeup view of stand 171.

REPRODUCIBILITY OF THE
ORIGINAL PAGE IS POOR

Site No: 7 No. of stands 2

Site Designation: 700+, Limy

Site Characteristics:	Mean	Range
1. Radiation	712	700-723
2. Slope	22%	20-25%
3. Elevation	4690'	4480-4900'
4. Gravel	48%	45-50%
5. Cobbles, rocks	3%	1-5%

Soil & Landform Characteristics:
1. Parent material - QTs alluvium
2. Landform - Slopes
3. Soil - Hathaway series

Vegetation Characteristics:	Mean	Range
1. Cover		
a. Trees	0%	--
b. Shrubs	8%	5-10%
c. Herbaceous	18%	10-25%
d. Litter	12%	10-15%
e. Bare ground	12%	10-15%

2. Composition	Constancy	Importance	Value
a. Perennial grasses	%	Mean	Range
1. Boer - Black grama	100	50	50-50
2. Bocu - Sideoats grama	100	35	25-50
3. Hibe - Curly mesquite	50	62	0-125
4. Anba - Cane beardgrass	50	12	0-25
5. Bohi - Hairy grama	50	5	0-10
6. ARIS - Three-awn	50	5	0-10
7. Heco - Tanglehead	50	5	0-10
8. Lyph - Wolftail	50	5	0-10
9. Trpu - Fluffgrass	50	5	0-10
b. Forbs			
1. Hagr - Annual goldenweed	50	12	0-25
2. LUPI - *Lupinus* spp.	50	12	0-25
3. CONV - Bindweed	50	12	0-25
4. Deco - Bundleflower	50	12	0-25
5. EUPH - Spurge	50	12	0-25
6. LOTU - Deer vetch	50	12	0-25
7. SIDA - *Sida* sp.	50	12	0-25
8. Soel - White horsenettle	50	12	0-25
c. Shrubs			
1. AGAV - *Agave* spp.	50	5	0-10
2. Caer - False mesquite	50	25	0-50
3. Hate - Burroweed	50	10	0-20
4. Mibi - Wait-a-bit	50	5	0-10
5. Prju - Velvet mesquite	50	10	0-20
d. Trees			
1. None			

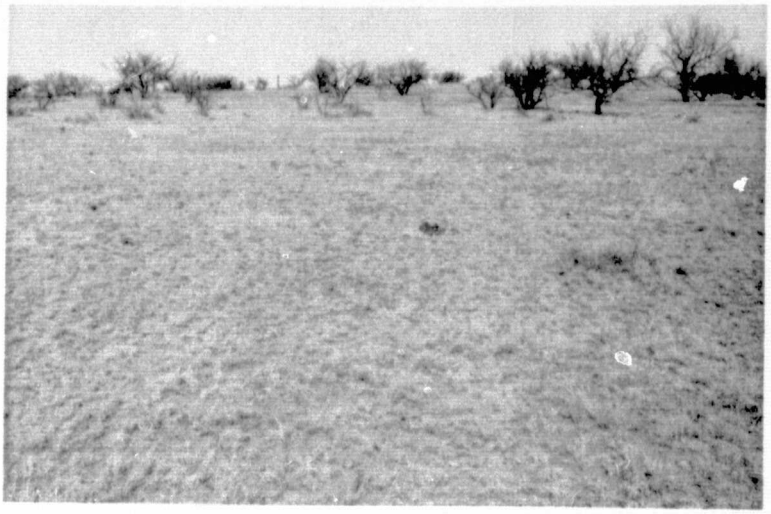

Figure 14. General view of stand 209 representing Site 8.

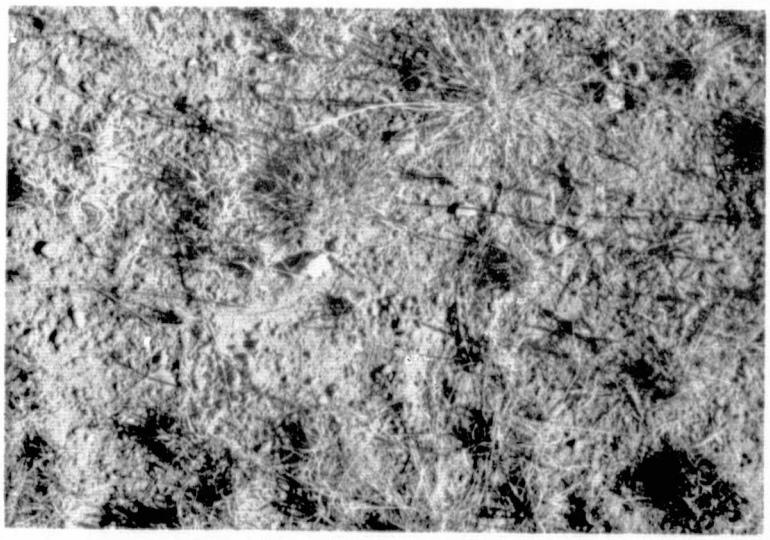

Figure 15. Closeup view of stand 209 (Note absence of cobbles).

REPRODUCIBILITY OF THE
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Site No: 8 No. of stands 44

Site Designation: 600-700, 0-5% slope, no cobbles, non-limy, loamy

Site Characteristics:	Mean	Range
1. Radiation	650	
2. Slope	2%	1-5%
3. Elevation	4773'	4360-5210'
4. Gravel	28%	Trace-60%
5. Cobbles, rocks	Trace	0-Trace

Soil & Landform Characteristics:
1. Parent material - QTs alluvium
2. Landform - Terrace, ridge, gentle slopes
3. Soil - Whitehouse, Bernadino or similar series

Vegetation Characteristics:	Mean	Range
1. Cover		
a. Trees	Trace	0-Trace
b. Shrubs	4%	Trace-25%
c. Herbaceous	23%	10-50%
d. Litter	15%	5-30%
e. Bare ground	30%	5-60%

2. Composition	Constancy	Importance	Value
a. Perennial grasses	%	Mean	Range
1. ARIS - Three-awn	89	51	0-120
2. Boar - Blue grama	86	64	0-200
3. Bohi - Hairy grama	64	31	0-225
4. Lyph - Wolftail	61	24	0-100
5. Boch - Sprucetop grama	59	36	0-120
6. Anba - Cane beardgrass	55	14	0-50
7. Bocu - Sideoats grama	43	18	0-140
8. Boer - Black grama	45	18	0-80
9. Hibe - Curly mesquite	45	28	0-150
b. Forbs			
1. Hagr - Annual goldenweed	89	28	0-90
2. Plpu - Indian wheat	43	12	0-75
3. EVOL - *Evolvolus* spp.	23	6	0-45
c. Shrubs			
1. Prju - Velvet mesquite	68	13	0-125
2. Hate - Burroweed	66	12	0-75
3. Bapt - Yerba de pasmo	50	2	0-25
4. Mibi - Wait-a-bit	43	3	0-25
5. Erwr - Shrubby buckwheat	34	3	0-50
6. Selo - Longleaf senecio	25	1	0-10
d. Trees			
Prju - Velvet mesquite	2	Trace	0-5

Figure 16. General view of stand 181 representing Site 9.

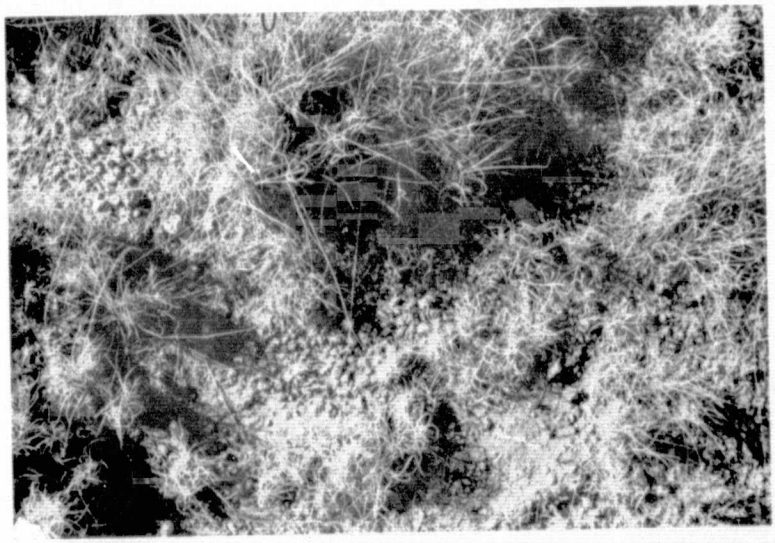

Figure 17. Closeup view of stand 181 (Note absence of cobbles).

REPRODUCIBILITY OF THE
ORIGINAL PAGE IS POOR

Site No: 9 No. of stands 11

Site Designation: 600-700, 0-5% slope, no cobbles, limy

Site Characteristics:	Mean	Range
1. Radiation	658	651-680
2. Slope	3%	1-5%
3. Elevation	4761'	4350-5010'
4. Gravel	31%	15-50%
5. Cobbles, rocks	Trace	0-Trace

Soil & Landform Characteristics:
1. Parent material - QTs alluvium
2. Landform - Terrace, ridge, gentle slopes
3. Soil - Hathaway series

Vegetation Characteristics:	Mean	Range
1. Cover		
a. Trees	Trace	0-5%
b. Shrubs	4%	Trace-10%
c. Herbaceous	23%	15-35%
d. Litter	15%	10-25%
e. Bare ground	27%	15-40%

2. Composition	Constancy	Importance Value	
a. Perennial grasses	%	Mean	Range
1. Bocu - Sideoats grama	82	49	0-120
2. ARIS - Three-awn	82	33	0-60
3. Boer - Black grama	73	36	0-75
4. Hibe - Curly mesquite	73	67	0-140
5. Bogr - Blue grama	64	29	0-120
6. Bohi - Hairy grama	55	23	0-60
7. Anba - Cane beardgrass	54	13	0-30
8. Boch - Sprucetop grama	27	22	0-140
9. Lyph - Wolf tail	27	10	0-60
10. Trpu - Fluffgrass	27	11	0-80
b. Forbs			
1. Hagr - Annual goldenweed	64	18	0-75
2. CROT - Croton spp.	36	7	0-25
3. Vian - Annual goldeneye	36	10	0-30
4. ASTR - Locoweed	27	0	0-30
c. Shrubs			
1. Mibi - Wait-a-bit	73	5	0-10
2. NOLI - Beargrass	45	12	0-50
3. Erwr - Shrubby buckwheat	36	4	0-25
4. YUCC - Yucca spp.	27	7	0-50
5. Krpa - Range ratany	27	2	0-10
6. Bapt - Yerba de pasmo	27	1	0-10
d. Trees			
1. Quem - Emory oak	9	2	0-25

Figure 18. General view of stand 175 representing Site 10.

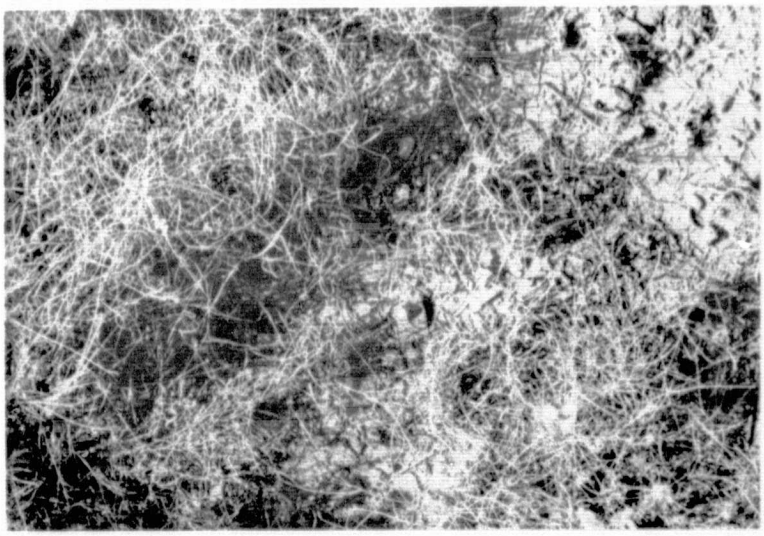

Figure 19. Closeup view of stand 175.

REPRODUCIBILITY OF THE
ORIGINAL PAGE IS POOR

Site No: 10 No. of stands 1

Site Designation: 600-700, 0-5% slope, no cobbles, non-limy, clay

Site Characteristics:	Mean	Range
1. Radiation	651	--
2. Slope	1%	--
3. Elevation	4680'	--
4. Gravel	5%	--
5. Cobbles, rocks	Trace	--

Soil & Landform Characteristics:
1. Parent material - QTs alluvium
2. Landform -- Swales on terraces
3. Soil - Guest or similar series

Vegetation Characteristics:	Mean	Range
1. Cover		
a. Trees	0%	--
b. Shrubs	Trace	--
c. Herbaceous	40%	--
d. Litter	35%	--
e. Bare ground	20%	--

2. Composition	Constancy	Importance	Value
a. Perennial grasses	%	Mean	Range
1. Himu - Tobosa grass	--	200	--
2. Bogr - Blue grama	--	80	--
3. Hibe - Curly mesquite	--	40	--
4. Boer - Black grama	--	40	--
5. Bocu - Sideoats grama	--	40	--
b. Forbs			
1. Hagr - Annual goldenweed	--	40	--
2. Vian - Annual goldeneye	--	40	--
3. CHEN - Goosefoot	--	40	--
4. Erca - Horseweed	--	40	--
5. ASTE - *Aster* spp.	--	40	--
c. Shrubs			
1. Prju - Velvet mesquite	--	5	--
2. Mibi - Wait-a-bit	--	1	--
3. LYCI - Wolfberry	--	1	--
d. Trees			
1. None			

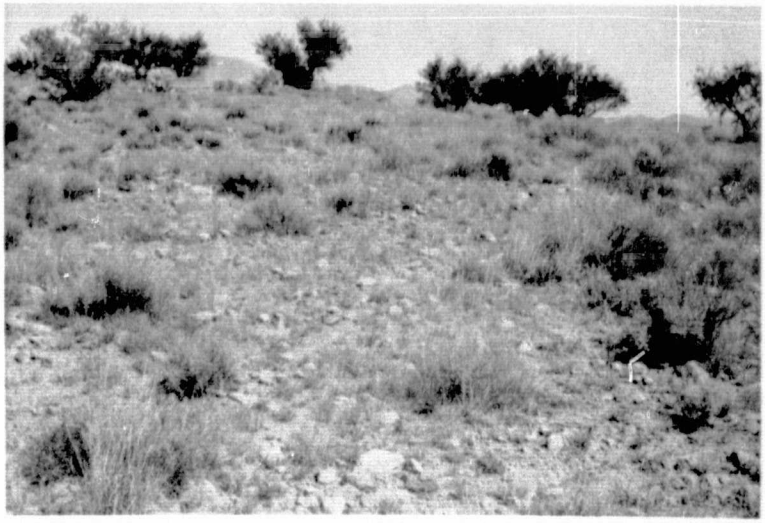

Figure 20. General view of stand 57 representing Site 11.

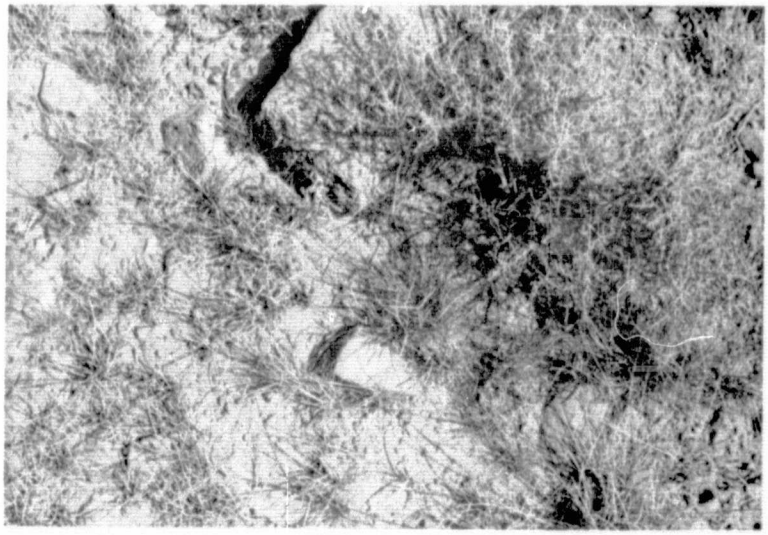

Figure 21. Closeup view of stand 57 (Note cobbles).

REPRODUCIBILITY OF THE
ORIGINAL PAGE IS POOR

Site No: 11 No. of stands 28

Site Designation: 600-700, 0-5% slope, with cobbles, non-limy

Site Characteristics:	Mean	Range
1. Radiation	654	615-680
2. Slope	2%	0-5%
3. Elevation	4936'	4310-5380'
4. Gravel	31%	15-60%
5. Cobbles, rocks	12%	5-30%

Soil & Landform Characteristics:
1. Parent material - QTs alluvium
2. Landform - Ridges, slopes, terraces
3. Soil - Caralampi, Bernadino, Whitehouse or similar series

Vegetation Characteristics:	Mean	Range
1. Cover		
a. Trees	Trace	0-Trace
b. Shrubs	6%	Trace-30%
c. Herbaceous	21%	10-40%
d. Litter	10%	5-25%
e. Bare ground	19%	5-50%

2. Composition	Constancy	Importance	Value
a. Perennial grasses	%	Mean	Range
1. Boch - Sprucetop grama	89	66	0-150
2. ARIS - Three-awn	89	42	0-120
3. Hibe - Curly mesquite	79	44	0-125
4. Erin - Plains lovegrass	68	19	0-75
5. Bocu - Sideoats grama	64	21	0-75
6. Bogr - Blue grama	61	28	0-120
7. Bohi - Hairy grama	57	32	0-120
8. Lyph - Wolftail	54	16	0-80
9. Anba - Cane beardgrass	50	11	0-30
10. Heco - Tanglehead	18	4	0-25
b. Forbs			
1. Hagr - Annual goldenweed	79	17	0-40
2. EVOL - Evolvolus spp.	46	11	0-40
3. Plpu - Indian wheat	43	11	0-50
4. CROT - Croton spp.	39	9	0-60
5. Deco - Bundle flower	29	7	0-40
6. Soel - White horsenettle	29	5	0-25
7. Vian - Annual goldeneye	25	6	0-30
8. AMBR - Ragweed	25	6	0-50
c. Shrubs			
1. Prju - Velvet mesquite	64	6	0-25
2. Hate - Burroweed	54	10	0-50
3. Midy - Velvet-pod mimosa	39	4	0-30
4. Mibi - Wait-a-bit	36	3	0-25
5. Caer - False mesquite	36	17	0-150
6. Bapt - Yerba de pasmo	36	3	0-25
7. Erwr - Shrubby buckwheat	32	3	0-30
8. AGAV - Agave spp.	32	2	0-15
9. OPUN - Opuntia spp.	25	1	0-10
d. Trees			
1. Prju - Velvet mesquite	4	Trace	0-5
2. Quob - Mexican blue oak	4	Trace	0-5

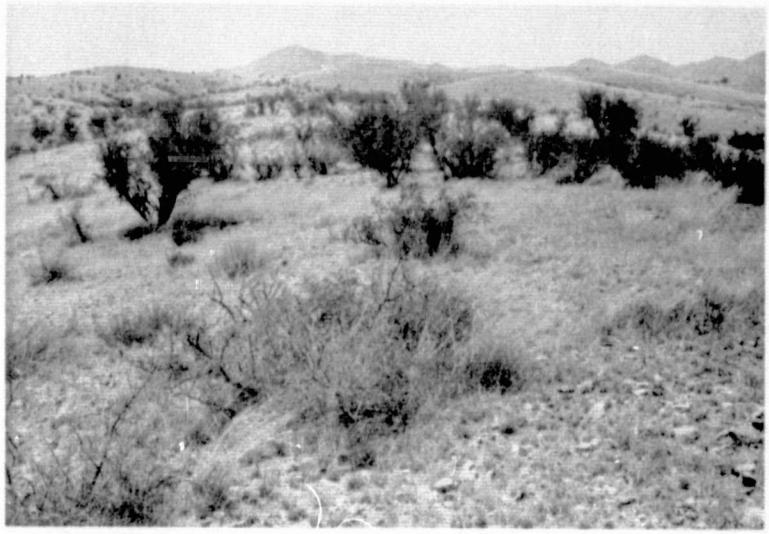

Figure 22. General view of stand 83 representing Site 12.

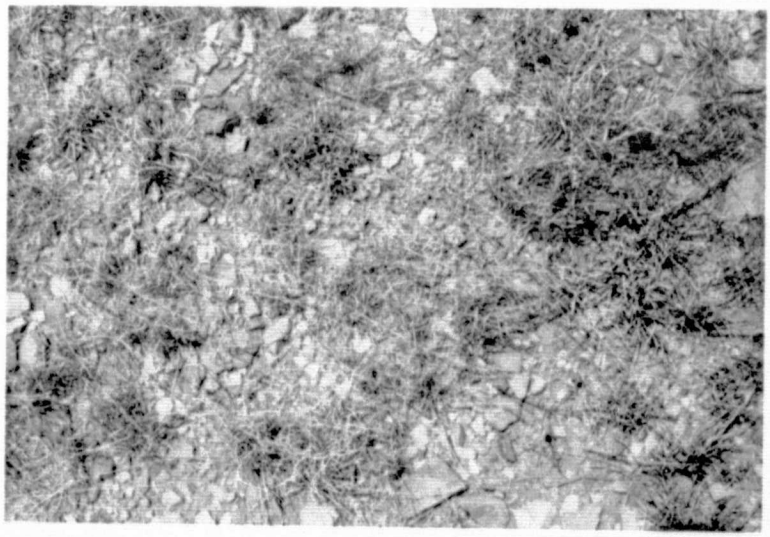

Figure 23. Closeup view of stand 83 (Note cobbles).

REPRODUCIBILITY OF THE
ORIGINAL PAGE IS POOR

Site No: 12 No. of stands 2

Site Designation: 600-700, 0-5% slope, limy, cobbles 5%+

Site Characteristics:	Mean	Range
1. Radiation	651	651-651
2. Slope	1%	1-1%
3. Elevation	5065'	4930-5200'
4. Gravel	35%	30-40%
5. Cobbles, rocks	5%	5-5%

Soil & Landform Characteristics:
1. Parent material - QTs alluvium
2. Landform - Ridges
3. Soil - Hathaway series

Vegetation Characteristics:	Mean	Range
1. Cover		
a. Trees	0%	--
b. Shrubs	12%	5-20%
c. Herbaceous	22%	20-25%
d. Litter	10%	10-10%
e. Bare ground	15%	15-15%

2. Composition	Constancy	Importance	Value
a. Perennial grasses	%	Mean	Range
1. Boer - Black grama	100	100	100-100
2. Bocu - Sideoats grama	100	70	40-100
3. ARIS - Three-awn	100	35	20-50
4. Trpu - Fluffgrass	100	25	0-50
5. Hibe - Curly mesquite	50	25	0-50
6. Boch - Sprucetop grama	50	25	0-50
7. Bogr - Blue grama	50	12	0-25
8. Bora - Purple grama	50	10	0-20
9. Lyph - Wolftail	50	10	0-20
b. Forbs			
1. ABRO - Sand verbena	50	12	0-25
2. Plpu - Indian wheat	50	12	0-25
3. ASTR - Locoweed	50	12	0-25
4. CROT - *Croton* spp.	50	12	0-25
c. Shrubs			
1. Come - Cliffrose	50	50	0-100
2. Prju - Velvet mesquite	50	12	0-25
3. NOLI - Beargrass	50	10	0-20
4. Bapt - Yerba de pasmo	50	10	0-20
5. AGAV - *Agave* spp.	50	10	0-20
6. Jude - Alligator juniper	50	10	0-20
d. Trees			
1. None			

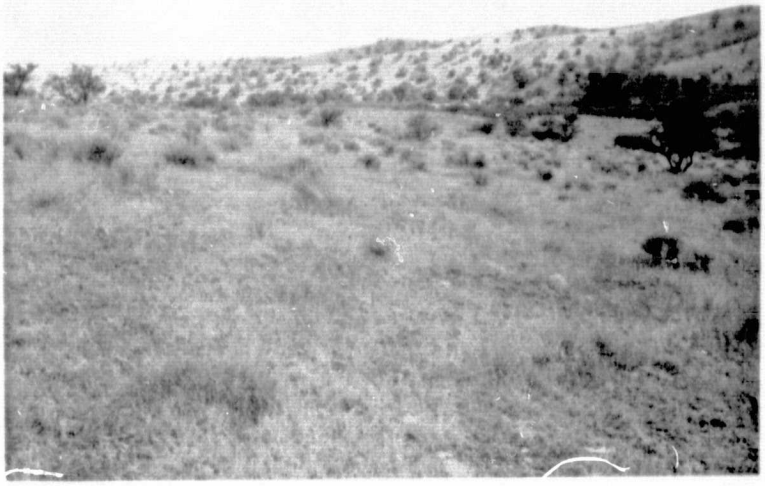

Figure 24. General view of stand 147 representing Site 13.

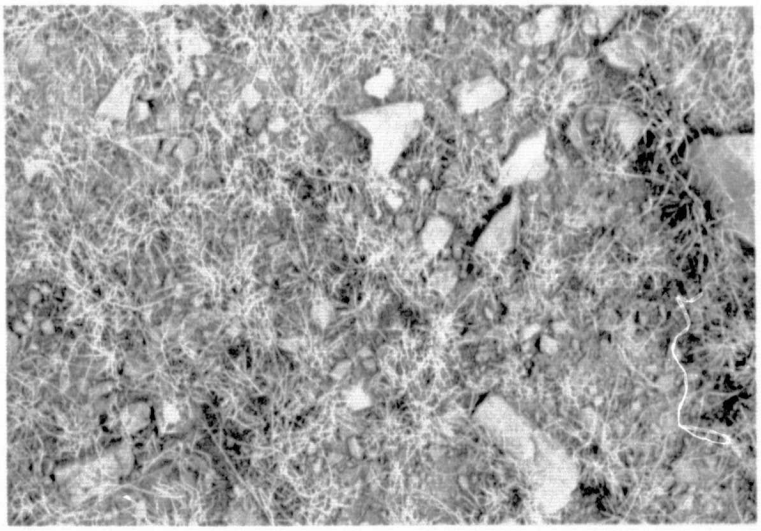

Figure 25. Closeup view of stand 147.

REPRODUCIBILITY OF THE
ORIGINAL PAGE IS POOR

Site No: 13 No. of stands 28

Site Designation: 600-700, 6-15% slope, non-limy

Site Characteristics:	Mean	Range
1. Radiation	648	600-680
2. Slope	12%	8-15
3. Elevation	4832'	4425-5250'
4. Gravel	36%	5-65%
5. Cobbles, rocks	6%	Trace-20%

Soil & Landform Characteristics:
1. Parent material - QTs alluvium
2. Landform - Slopes
3. Soil - Bernadino, Whitehouse, Caralampi or similar series

Vegetation Characteristics:	Mean	Range
1. Cover		
a. Trees	Trace	0-Trace
b. Shrubs	5%	Trace-20%
c. Herbaceous	26%	10-45%
d. Litter	14%	5-40%
e. Bare ground	14%	5-35%

2. Composition	Constancy	Importance Value	
a. Perennial grasses	%	Mean	Range
1. ARIS - Three-awn	93	46	0-140
2. Hibe - Curly mesquite	86	68	0-200
3. Bocu - Sideoats grama	82	36	0-180
4. Boch - Sprucetop grama	68	56	0-125
5. Anba - Cane beardgrass	64	20	0-60
6. Bohi - Hairy grama	64	38	0-140
7. Lyph - Wolftail	54	23	0-105
8. Boar - Blue grama	50	25	0-105
9. Erin - Plains lovegrass	46	19	0-180
b. Forbs			
1. Hagr - Annual goldenweed	82	24	0-45
2. Plpu - Indian wheat	46	15	0-45
3. Deco - Bundleflower	43	12	0-40
4. Soel - White horsenettle	36	9	0-40
5. Vian - Annual goldeneye	36	9	0-45
6. EVOL - Evolvolus spp.	32	8	0-30
7. CROT - Croton spp.	29	8	0-50
8. SIDA - Sida spp.	29	8	0-45
c. Shrubs			
1. Prju - Velvet mesquite	61	6	0-30
2. Hate - Burroweed	57	12	0-50
3. Bapt - Yerba de pasmo	57	4	0-25
4. Mibi - Wait-a-bit	43	6	0-100
5. Erwr - Shrubby buckwheat	29	2	0-15
6. Midu - Velvet-pod mimosa	29	5	0-100
7. Echi - Echinocactus	29	1	0-10
d. Trees			
1. Quem - Emory oak	4	1	0-25

Figure 26. General view of stand 300 representing Site 14.

Figure 27. Closeup view of stand 300.

Site No: 14 No. of stands 6

Site Designation: 600-700, 6-15% slope, limy

Site Characteristics:	Mean	Range
1. Radiation	636	600-670
2. Slope	10%	6-15%
3. Elevation	4813'	4470-5300'
4. Gravel	38%	25-75%
5. Cobbles, rocks	7%	0-20%

Soil & Landform Characteristics:
1. Parent material - QTs alluvium
2. Landform - Slopes
3. Soil - Hathaway series

Vegetation Characteristics:	Mean	Range
1. Cover		
a. Trees	Trace	0-Trace
b. Shrubs	8%	1-15%
c. Herbaceous	21%	15-40%
d. Litter	12%	5-20%
e. Bare ground	16%	5-25%

2. Composition	Constancy	Importance	Value
a. Perennial grasses	%	Mean	Range
1. Boer - Black grama	100	68	45-120
2. Bocu - Sideoats grama	100	42	15-120
3. ARIS - Three-awn	100	51	30-80
4. Bohi - Hairy grama	83	31	0-60
5. Hibe - Curly mesquite	67	48	0-80
6. Boch - Sprucetop grama	50	25	0-80
7. Anba - Cane beardgrass	50	12	0-40
8. Lyph - Wolftail	33	16	0-80
9. Trpu - Fluffgrass	33	5	0-15
b. Forbs			
1. CROT - Croton spp.	67	16	0-40
2. Deco - Bundle flower	33	10	0-40
3. Hagr - Annual goldenweed	33	10	0-40
4. Plpu - Indian wheat	33	10	0-40
5. ASTR - Locoweed	33	6	0-20
c. Shrubs			
1. YUCC - Yucca spp.	67	7	0-25
2. NOLI - Beargrass	50	16	0-50
3. Caer - False mesquite	50	9	0-30
4. Bapt - Yerba de pasmo	33	4	0-15
5. Prju - Velvet mesquite	33	13	0-75
6. Hate - Burroweed	33	3	0-15
7. Mibi - Wait-a-bit	33	2	0-10
8. Jude - Alligator juniper	33	4	0-15
d. Trees			
1. Quem - Emory oak	17	1	0-5

Figure 28. General view of stand 306 representing Site 15.

Figure 29. Closeup view of stand 306.

REPRODUCIBILITY OF THE
ORIGINAL PAGE IS POOR

Site No: 15 No. of stands 8

Site Designation: 600-700, 16-25% slope, non-limy

Site Characteristics:	Mean	Range
1. Radiation	673	638-700
2. Slope	21%	16-25%
3. Elevation	4892'	4340-5240'
4. Gravel	36%	25-50%
5. Cobbles, rocks	7%	0-10%

Soil & Landform Characteristics:
1. Parent material - QTs alluvium
2. Landform - Slopes
3. Soil - Caralampi, Bernadino, Whitehouse or similar series

Vegetation Characteristics:	Mean	Range
1. Cover		
a. Trees	1%	0-5%
b. Shrubs	5%	Trace-10%
c. Herbaceous	22%	15-30%
d. Litter	12%	5-20%
e. Bare ground	16%	10-30%

2. Composition	Constancy	Importance	Value
a. Perennial grasses	%	Mean	Range
1. Bocu - Sideoats grama	100	53	15-125
2. Hibe - Curly mesquite	100	54	25-100
3. Anba - Cane beardgrass	88	24	0-60
4. Boch - Sprucetop grama	75	54	0-120
5. Erin - Plains lovegrass	75	19	0-40
6. ARIS - Three-awn	63	26	0-100
7. Lyph - Wolftail	63	16	0-40
8. Bogr - Blue grama	38	25	0-100
9. Bohi - Hairy grama	38	7	0-25
10. Arte - Spidergrass	25	6	0-30
b. Forbs			
1. Hagr - Annual goldenweed	63	18	0-50
2. Plpu - Indian wheat	50	12	0-25
3. Deco - Bundle flower	50	12	0-30
4. EUPH - Spurge	50	11	0-25
5. Vian - Annual goldeneye	50	10	0-25
c. Shrubs			
1. Erwr - Shrubby buckwheat	75	6	0-20
2. Mibi - Wait-a-bit	63	7	0-20
3. Prju - Velvet mesquite	63	8	0-50
4. Bapt - Yerba de pasmo	50	6	0-30
5. Hate - Burroweed	50	7	0-40
6. OPUN - *Opuntia* spp.	50	3	0-10
7. Midy - Velvet-pod mimosa	38	6	0-30
8. Caer - False mesquite	38	8	0-40
9. AGAV - *Agave* spp.	38	3	0-10
d. Trees			
1. Prju - Velvet mesquite	13	1	0-5
2. Quem - Emory oak	13	1	0-10
3. Quob - Mexican blue oak	13	3	0-25

Figure 30. General view of stand 85 representing Site 16.

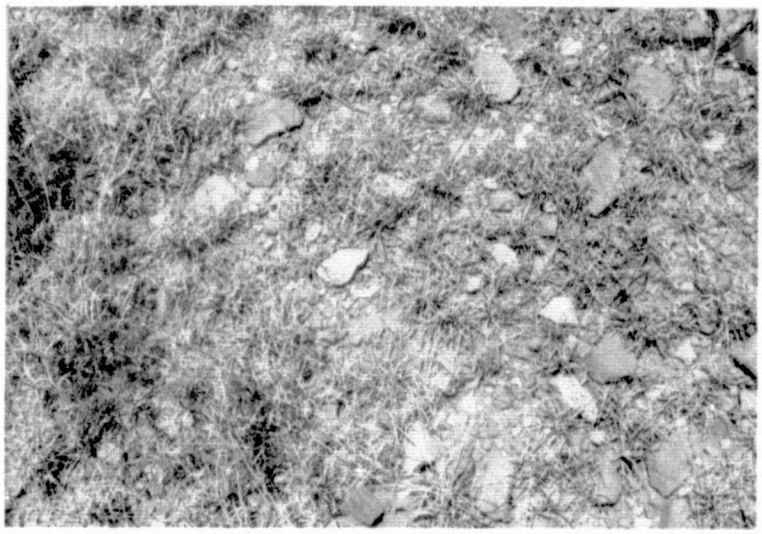

Figure 31. Closeup view of stand 85.

REPRODUCIBILITY OF THE
ORIGINAL PAGE IS POOR

Site No: 16 No. of stands 1

Site Designation: 600-700, 16-25% slope, limy

Site Characteristics:	Mean	Range
1. Radiation	638	--
2. Slope	20%	--
3. Elevation	4480'	--
4. Gravel	55%	--
5. Cobbles, rocks	1%	--

Soil & Landform Characteristics:
1. Parent material - QTs alluvium
2. Landform - Slopes
3. Soil - Hathaway series

Vegetation Characteristics:	Mean	Range
1. Cover		
a. Trees	0	--
b. Shrubs	5%	--
c. Herbaceous	25%	--
d. Litter	10%	--
e. Bare ground	5%	--

2. Composition	Constancy	Importance	Value
a. Perennial grasses	%	Mean	Range
1. Hibe - Curly mesquite	--	125	--
2. Boer - Black grama	--	75	--
3. Bocu - Sideoats grama	--	50	--
4. Boch - Sprucetop grama	--	25	--
5. Bohi - Hairy grama	--	25	--
6. ARIS - Three-awn	--	25	--
b. Forbs			
1. GOMP - Globe amaranth	--	25	--
2. ASTR - Locoweed	--	25	--
3. CROT - *Croton* spp.	--	25	--
4. EVOL - *Evolvolus* spp.	--	25	--
c. Shrubs			
1. Prju - Velvet mesquite	--	25	--
2. Caer - False mesquite	--	20	--
3. Hate - Burroweed	--	5	--
4. Acco - Whitethorn	--	5	--
5. Fosp - Ocotillo	--	5	--
d. Trees			
1. None			

Figure 32. General view of stand 234 representing Site 17.

Figure 33. Closeup view of stand 234.

Site No: 17 No. of stands 5

Site Designation: 600-700, >25% slope, non-limy

Site Characteristics:	Mean	Range
1. Radiation	622	618-638
2. Slope	38%	30-45%
3. Elevation	4796'	4300-5050'
4. Gravel	40%	40%-40%
5. Cobbles, rocks	4%	1%-10%

Soil & Landform Characteristics:
1. Parent material - QTs alluvium
2. Landform - Slopes
3. Soil - Caralampi series and similar soils

Vegetation Characteristics:	Mean	Range
1. Cover		
a. Trees	Trace	0-Trace
b. Shrubs	3%	Trace-10%
c. Herbaceous	25%	20-30%
d. Litter	18%	15-25%
e. Bare ground	12%	10-15%

2. Composition	Constancy	Importance	Value
a. Perennial grasses	%	Mean	Range
1. Bocu - Sideoats grama	100	92	40-150
2. Anba - Cane beardgrass	80	33	0-90
3. Erin - Plains lovegrass	80	21	0-30
4. Hibe - Curly mesquite	80	44	0-80
5. Lyph - Wolftail	60	17	0-30
6. Bohi - Hairy grama	60	33	0-75
7. Bogr - Blue grama	40	10	0-30
b. Forbs			
1. Hagr - Annual goldenweed	60	20	0-40
2. Vian - Annual goldeneye	60	23	0-60
3. GNAP - Cudweed	40	11	0-30
4. Plpu - Indian wheat	40	10	0-30
c. Shrubs			
1. Mibi - Wait-a-bit	60	9	0-40
2. Bapt - Yerba de pasmo	60	2	0-5
3. AGAV - *Agave* spp.	40	Trace	0-Trace
4. Caer - False mesquite	40	1	0-5
5. OPUN - *Opuntia* spp.	40	Trace	0-Trace
d. Trees			
1. Quob - Mexican blue oak	60	3	0-5

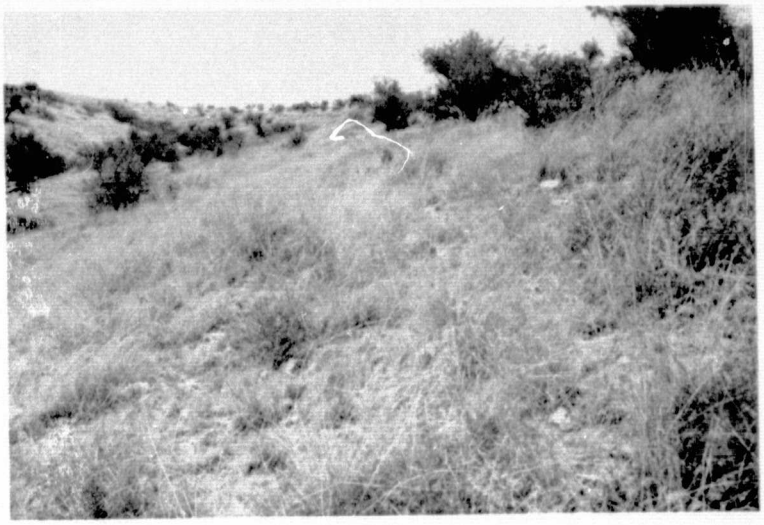

Figure 34. General view of stand 84 representing Site 18.

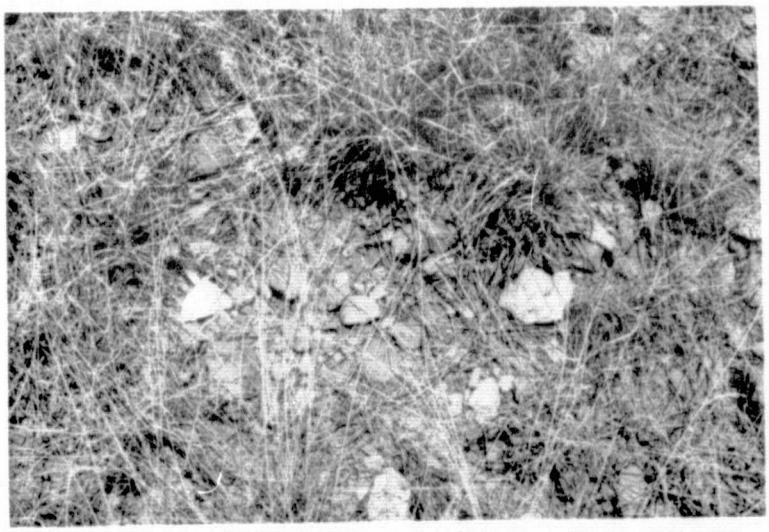

Figure 35. Closeup view of stand 84.

REPRODUCIBILITY OF THE
ORIGINAL PAGE IS POOR

Site No: 18 No. of stands 2

Site Designation: 600-700, >25% slope, limy

Site Characteristics:	Mean	Range
1. Radiation	628	618-638
2. Slope	35%	30-40%
3. Elevation	4385'	4300-4470'
4. Gravel	38%	35-40%
5. Cobbles, rocks	3%	1-5%

Soil & Landform Characteristics:
1. Parent material - QTs alluvium
2. Landform - Slopes
3. Soil - Hathaway series

Vegetation Characteristics:	Mean	Range
1. Cover		
a. Trees	0	--
b. Shrubs	15%	5-25%
c. Herbaceous	25%	15-35%
d. Litter	12%	10-15%
e. Bare ground	8%	5-10%

2. Composition	Constancy	Importance	Value
a. Perennial grasses	%	Mean	Range
1. Boer - Black grama	100	92	45-140
2. Bocu - Sideoats grama	100	92	45-140
3. ARIS - Three-awn	100	58	45-70
4. Hibe - Curly mesquite	100	25	15-35
5. Anba - Cane beardgrass	50	18	0-35
6. Erin - Plains lovegrass	50	18	0-35
7. Boch - Sprucetop grama	50	8	0-15
8. Paha - Halls panic	50	8	0-15
b. Forbs			
1. ASTR - Locoweed	50	18	0-35
2. CROT - *Croton* spp.	50	18	0-35
c. Shrubs			
1. Prju - Velvet mesquite	100	18	10-25
2. AGAV - *Agave* spp.	100	15	5-25
3. OPUN - *Opuntia* spp.	100	15	5-25
4. Mibi - Wait-a-bit	50	62	0-125
5. Krpa - Range ratany	50	12	0-25
6. Caer - False mesquite	50	12	0-25
d. Trees			
1. None			

Figure 36. General view of stand 198 representing Site 19.

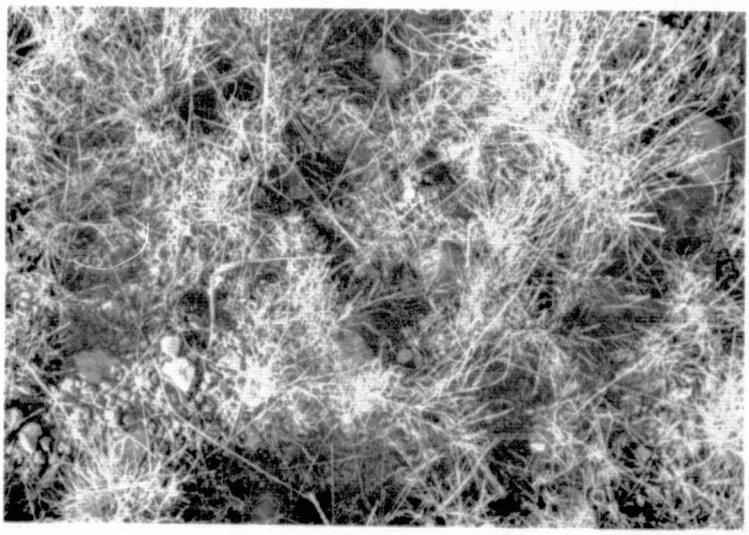

Figure 37. Closeup view of stand 198.

REPRODUCIBILITY OF THE
ORIGINAL PAGE IS POOR

Site No: 19 No. of stands 18

Site Designation: 500-600, non-limy

Site Characteristics:	Mean	Range
1. Radiation	542	510-570
2. Slope	26%	20-40%
3. Elevation	5046'	4630-5900'
4. Gravel	21%	Trace-35%
5. Cobbles, rocks	12%	Trace-30%

Soil & Landform Characteristics:
1. Parent material - QTs alluvium
2. Landform - Slopes
3. Soil - Caralampi, Bernadino and similar soils

Vegetation Characteristics:	Mean	Range
1. Cover		
a. Trees	9%	0-25%
b. Shrubs	3%	Trace-10%
c. Herbaceous	27%	15-55%
d. Litter	18%	10-35%
e. Bare ground	10%	5-20%

2. Composition	Constancy %	Importance Mean	Value Range
a. Perennial grasses			
1. Bocu - Sideoats grama	100	96	45-220
2. Erin - Plains lovegrass	100	45	15-75
3. ARIS - Three-awn	72	33	0-75
4. Anba - Cane beardgrass	61	19	0-50
5. Muem - Bullgrass	61	23	0-70
6. Anci - Texas bluestem	61	36	0-100
7. Bohi - Hairy grama	44	27	0-165
8. Hibe - Curly mesquite	44	37	0-150
9. Boch - Sprucetop grama	33	32	0-200
10. Bogr - Blue grama	33	16	0-70
11. Lyph - Wolftail	33	14	0-110
b. Forbs			
1. Arlu - Herbaceous sage	67	17	0-50
2. CIRS - Bull thistle	33	9	0-40
3. Hagr - Annual goldenweed	28	9	0-40
4. Plpu - Indian wheat	28	9	0-40
5. Vian - Annual goldeneye	28	8	0-35
c. Shrubs			
1. Bapt - Yerba de pasmo	56	3	0-10
2. OPUN - Opuntia spp.	50	3	0-10
3. Erwr - Shrubby buckwheat	33	4	0-25
4. Mibi - Wait-a-bit	33	2	0-10
5. Open - Prickly pear	33	2	0-10
6. Prju - Velvet mesquite	33	2	0-10
7. NOLI - Beargrass	33	2	0-5
d. Trees			
1. Quem - Emory oak	56	32	0-125
2. Quob - Mexican blue oak	39	14	0-75
3. Quar - Arizona white oak	39	18	0-60
4. Jude - Alligator juniper	33	14	0-60

Figure 38. General view of stand 69 representing Site 21.

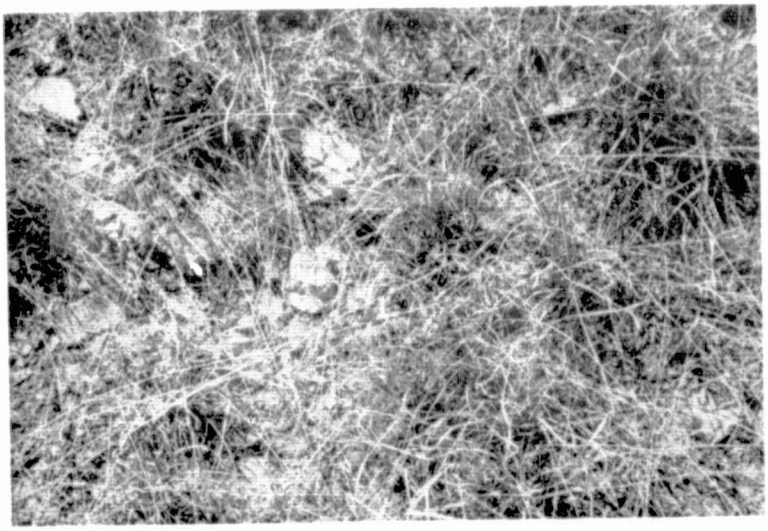

Figure 39. Closeup view of stand 69.

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Site No: 21 No. of stands 6

Site Designation: 500-600, limy

Site Characteristics:	Mean	Range
1. Radiation	552	510-576
2. Slope	44%	25-70%
3. Elevation	4778'	4530-4975'
4. Gravel	25%	5-40%
5. Cobbles, rocks	10%	1-25%

Soil & Landform Characteristics:
1. Parent material - QTs alluvium
2. Landform - Slopes
3. Soil - Hathaway series

Vegetation Characteristics:	Mean	Range
1. Cover		
a. Trees	1%	0-5%
b. Shrubs	6%	1-15%
c. Herbaceous	31%	20-45%
d. Litter	17%	10-30%
e. Bare ground	10%	5-15%

2. Composition	Constancy	Importance	Value
a. Perennial grasses	%	Mean	Range
1. Bocu - Sideoats grama	100	120	60-180
2. Anba - Cane beardgrass	100	31	20-45
3. ARIS - Three-awn	67	49	0-105
4. Bogr - Blue grama	67	22	0-135
5. Anci - Texas bluestem	50	30	0-100
6. Boch - Sprucetop grama	33	16	0-60
7. Boer - Black grama	33	17	0-60
8. Hibe - Curly mesquite	33	31	0-150
9. Ledu - Sprangletop	33	8	0-30
10. Lyph - Wolftail	33	10	0-30
11. Paha - Halls panic	33	8	0-30
12. Arte - Spidergrass	33	28	0-135
b. Forbs			
1. CIRS - Bull thistle	50	18	0-45
2. LUPI - Lupine	33		0-90
3. Arlu - Herbaceous sage	33	21	0-90
4. CROT - *Croton* spp.	33	8	0-30
c. Shrubs			
1. Mibi - Wait-a-bit	83	7	0-15
2. YUCC - *Yucca* spp.	67	5	0-15
3. Bapt - Yerba de pasmo	50	4	0-15
4. NOLI - Beargrass	50	6	0-15
5. Prju - Velvet mesquite	33	5	0-30
6. AGAV - *Agave* spp.	33	4	0-15
7. Caer - False mesquite	33	21	0-75
8. Erwr - Shrubby buckwheat	33	7	0-40
9. Hate - Burroweed	33	7	0-40
10. Open - Prickly pear	33	4	0-15
d. Tree			
1. Quem - Emory oak	17	1	0-5
2. Quob - Mexican blue oak	17	4	0-25

Figure 40. General view of stand 222 representing Site 22.

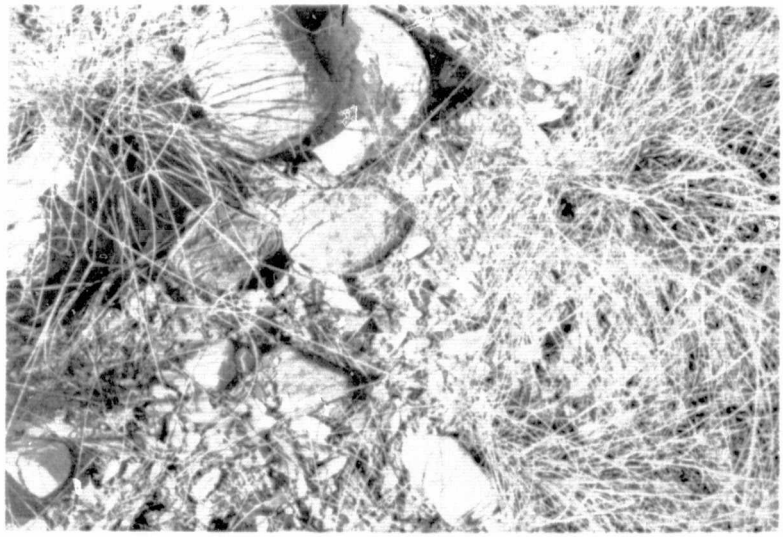

Figure 41. Closeup view of stand 222.

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Site No: 22 No. of stands 10

Site Designation: 400-500, non-limy

Site Characteristics:	Mean	Range
1. Radiation	450	410-455
2. Slope	42%	35-60%
3. Elevation	4917'	4690-5360'
4. Gravel	23%	Trace-40%
5. Cobbles, rocks	15%	Trace-25%

Soil & Landform Characteristics:
1. Parent material - QTs alluvium
2. Landform - Slopes
3. Soil - Caralampi and similar soils

Vegetation Characteristics:	Mean	Range
1. Cover		
a. Trees	9%	0-20%
b. Shrubs	2%	0-5%
c. Herbaceous	24%	15-40%
d. Litter	20%	10-35%
e. Bare ground	9%	Trace-20%

2. Composition	Constancy %	Importance Value Mean	Range
a. Perennial grasses			
1. Bocu - Sideoats grama	90	86	0-200
2. Erin - Plains lovegrass	80	35	0-75
3. ARIS - Three-awn	70	21	0-40
4. Muem - Bullgrass	70	20	0-50
5. Anba - Cane beardgrass	60	15	0-40
6. Anci - Texas bluestem	60	43	0-140
7. Bogr - Blue grama	50	24	0-100
8. Bora - Purple grama	40	10	0-30
9. Lyph - Wolftail	30	7	0-35
b. Forbs			
1. Arlu - Herbaceous sage	60	22	0-75
2. GNAP - Cudweed	50	14	0-40
3. Depi - Tansy mustard	40	8	0-25
4. Vian - Annual goldeneye	40	10	0-40
5. CIRS - Bull thistle	30	5	0-20
c. Shrubs			
1. YUCC - *Yucca* spp.	40	1	0-5
2. Midy - Velvet-pod mimosa	40	2	0-5
3. NOLI - Beargrass	40	4	0-25
4. OPUN - *Opuntia* spp.	40	1	0-4
5. Bapt - Yerba de pasmo	30	1	0-5
6. Mibi - Wait-a-bit	30	3	0-25
d. Trees			
1. Quem - Emory oak	80	28	0-100
2. Quar - Arizona white oak	50	14	0-50
3. Quob - Mexican blue oak	50	22	0-75
4. Jumo - One-seed juniper	40	6	0-30
5. Jude - Alligator juniper	40	9	0-60

Figure 42. General view of stand 68 representing Site 23.

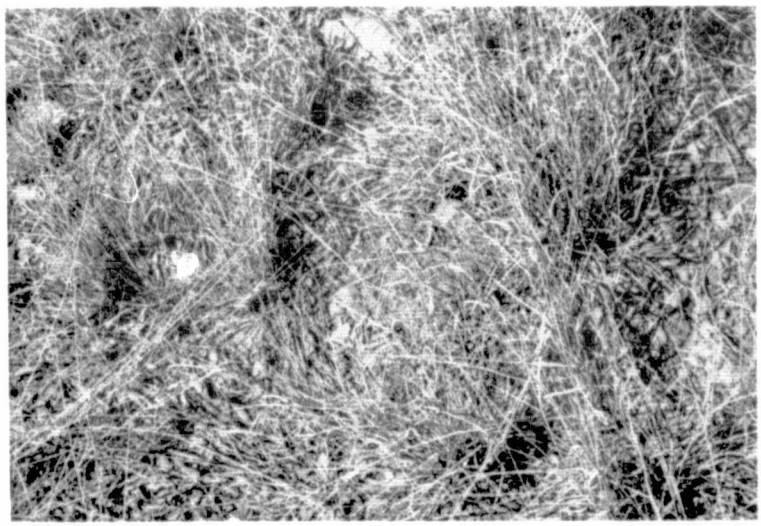

Figure 43. Closeup view of stand 68.

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Site No: 23 No. of stands 2

Site Designation: 400-500, limy

Site Characteristics:	Mean	Range
1. Radiation	455	455-455
2. Slope	38%	35-40%
3. Elevation	4775'	4630-4920'
4. Gravel	32%	25-40%
5. Cobbles, rocks	6%	Trace-10%

Soil & Landform Characteristics:
1. Parent material - QTs alluvium
2. Landform - Slopes
3. Soil - Hathaway series

Vegetation Characteristics:	Mean	Range
1. Cover		
a. Trees	2%	0-5%
b. Shrubs	Trace	Trace-Trace
c. Herbaceous	25%	25%-25%
d. Litter	22%	20-25%
e. Bare ground	12%	10-15%

2. Composition	Constancy	Importance	Value
a. Perennial grasses	%	Mean	Range
1. Bocu - Sideoats grama	100	100	100-100
2. Bogr - Blue grama	100	75	75-75
3. ARIS - Three-awn	100	50	25-75
4. Erin - Plains lovegrass	100	25	25-25
5. Boch - Sprucetop grama	50	38	0-75
6. Boer - Black grama	50	25	0-50
7. Anba - Cane beardgrass	50	12	0-25
8. Bohi - Hairy grama	50	12	0-25
9. Lyph - Wolftail	50	12	0-25
10. Muem - Bullgrass	50	12	0-25
b. Forbs			
1. GOMP - Globe amaranth	50	12	0-25
2. Hagr - Annual goldenweed	50	12	0-25
3. Arlu - Herbaceous sage	50	12	0-25
4. ASTR - Locoweed	50	12	0-25
5. CIRS - Bull thistle	50	12	0-25
6. PETA - Prairie clover	50	12	0-25
7. Vian - Annual goldeneye	50	12	0-25
c. Shrubs			
1. AGAV - *Agave* spp.	50	2	0-5
2. NOLI - Beargrass	50	2	0-5
3. Mibi - Wait-a-bit	50	1	0-2
4. Erwr - Shrubby buckwheat	50	Trace	0-1
5. OPUN - *Opuntia* spp.	50	Trace	0-1
d. Trees			
1. Quem - Emory oak	50	10	0-20
2. Jude - Alligator juniper	50	10	0-20

Figure 44. General view of stand 241 representing Site 24.

Figure 45. Closeup view of stand 241.

Site No: 24 No. of stands 6

Site Designation: 300-400, non-limy

Site Characteristics:	Mean	Range
1. Radiation	370	300-403
2. Slope	63%	55-80%
3. Elevation	4743'	4350-5120'
4. Gravel	22%	5-30%
5. Cobbles, rocks	12%	5-30%

Soil & Landform Characteristics:
1. Parent material - QTs alluvium
2. Landform - Slopes
3. Soil - Caralampi and similar series

Vegetation Characteristics:	Mean	Range
1. Cover		
a. Trees	15%	10-25%
b. Shrubs	8%	5-10%
c. Herbaceous	13%	10-20%
d. Litter	18%	10-40%
e. Bare ground	12%	5-20%

2. Composition	Constancy	Importance Value	
a. Perennial grasses	%	Mean	Range
1. Bocu - Sideoats grama	100	63	50-80
2. Muem - Bullgrass	67	12	0-30
3. Erin - Plains lovegrass	50	7	0-15
4. Anba - Cane beardgrass	50	11	0-45
5. Lyph - Wolftail	33	4	0-15
6. Anci - Texas bluestem	33	4	0-15
b. Forbs			
1. Arlu - Herbaceous sage	83	22	0-80
c. Shrubs			
1. NOLI - Beargrass	83	28	0-50
2. Rhtr - Skunkbush	67	14	0-25
3. Dawh - Sotol	50	5	0-10
4. Mibi - Wait-a-bit	50	5	0-20
5. Midy - Velvet-pod mimosa	33	8	0-40
6. YUCC - *Yucca* spp.	33	3	0-10
d. Trees			
1. Quob - Mexican blue oak	83	46	0-75
2. Quem - Emory oak	50	12	0-30
3. Quar - Arizona white oak	33	22	0-125
4. Jumo - One-seed juniper	33	5	0-15

Site No: 25 No. of stands 1

Site Designation: 300-400, limy

Site Characteristics:	Mean	Range
1. Radiation	380	--
2. Slope	55%	--
3. Elevation	4650'	--
4. Gravel	55%	--
5. Cobbles, rocks	10%	--

Soil & Landform Characteristics:
1. Parent material - QTs alluvium
2. Landform - Slopes
3. Soil - Hathaway series

Vegetation Characteristics:	Mean	Range
1. Cover		
a. Trees	0%	--
b. Shrubs	10%	--
c. Herbaceous	10%	--
d. Litter	5%	--
e. Bare ground	10%	--

2. Composition	Constancy	Importance	Value
a. Perennial grasses	%	Mean	Range
1. Bocu - Sideoats grama	--	50	--
2. Bohi - Hairy grama	--	20	--
3. Boer - Black grama	--	10	--
4. Anba - Cane beardgrass	--	10	--
5. Paha - Halls panic	--	10	--
b. Forbs			
1. PSOR - Scurf pea	--	20	--
2. Arlu - Herbaceous sage	--	10	--
3. ASTR - Locoweed	--	10	--
c. Shrubs			
1. NOLI - Beargrass	--	50	--
d. Trees			
1. None			

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PHOTO-INTERPRETATION SITES

Twenty-three taxonomic units (sites) were identified on alluvial parent materials within the study area according to a hierarchical classification (Table 4). A dichotomous key to these taxonomic units was constructed for use in identifying the units in the field or through photo-interpretation (Table 5).

In order to indicate the extent to which the sites could be identified on small scale aerial photos, a test was run comparing field measurements with photo-interpretation results. Color IR high-flights positive transparencies (Flight No. 73-152, RC-10, Film 2443, Scale ≈1:120,000, September 7, 1973) were used for the test. A set of 42 field plots were selected for a training set to represent the range of taxonomic units. The field locations of each field plot had previously been marked on B&W photos of scale ≈1:30,000. Using these locations, each plot was located in stereo and keyed out on the color IR transparency using 4.5X magnification. Identification was checked against field data after each determination. One person did the photo-interpretation work.

After this training, an additional 40 plots were selected by another individual at random across the range of taxonomic units. The photo-interpreter did not participate in sample selection and was given only the plot numbers. He then located and keyed out each plot as before. Results were checked against classification of the plots based on field data. Since there seemed to be little difference in accuracy obtained between the training set and the test set, the data were combined and the results based on combined data are shown in Table 6. The number of plots which were correctly placed are shown in the diagonal of the matrix. The numbers

Table 5. Key For Identification of Range Sites.
(Includes only sites on QTs or Recent Alluvium within Study Area)

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[a] 1. Bottomland - (Recent alluvium on floodplains).....2
1. Upland - (QTs alluvium - residual soils).....5

[b] 2. Mesic bottoms - sacaton or tree-size mesquite >50% of composition.....Site 4
2. Dry bottom - sacaton or tree-size mesquite <50% of composition.....3

[c] 3. Gravel (<3" dia.) covers 1% or more of soil surface.....Site 3
3. Gravel covers 1% or less of soil surface.....4

[d] 4. Soil surface texture moderate to coarse.....Site 2
4. Soil surface texture heavy (clay).....Site 1

[e] 5. North aspect, slope>52% (Radiation class 300-400).....6
5. Other aspects or North aspect with slope <52%.....7

[f] 6. Soil limy to surface.....Site 25
6. Soil not limy to surface.....Site 24

7. North aspect, slope 33-51%; or NE/NW aspect, slope 46-75% (Radiation class 400-500).....8
7. Aspects more southerly or North, slope <33%; or NE/NW, slope <46%.....9

8. Soil limy to surface.....Site 23
8. Soil not limy to surface.....Site 22

9. North aspect, slope 12-32%, NE/NW aspect, slope 17-45%; or E/W aspect, slope 54%+ (Radiation class 500-600).....10
9. Aspects more southerly or North, slope <12%; NE/NW, slope <17%; E/W, slope <54%.....11

10. Soil limy to surface.....Site 21
10. Soil not limy to surface.....Site 19

11. South aspect, slope 19%+; or SE/SW, slope 26-73% (Radiation class 700+).....12
11. All other slopes and aspects (Radiation class 600-700).....13

12. Soil limy to surface.....Site 7
12. Soil not limy to surface.....Site 6

[g] 13. Slope 0-5% (any aspect).....14
13. Slope 6%+ (any aspect).....18

14. Soil limy to surface.....15
14. Soil not limy to surface.....16

h/15. Cobbles or rock (>3" dia.) occupy 5%+ of soil surface.....Site 12
15. Cobbles or rocks occupy <5% of soil surface.....Site 9

16. Cobbles or rocks 5%+ of soil surface.....Site 11
16. Cobbles or rocks <5% of soil surface.....17

i/17. Soil surface texture clay loam or coarser.....Site 8
17. Soil surface texture clay.....Site 10

18. Soil limy to surface.....19
18. Soil not limy to surface.....21

19. Slope >25%.....Site 18
19. Slope 25% or less.....20

20. Slope 16-25%.....Site 16
20. Slope 6-15%.....Site 14

21. Slope >25%.....Site 17
21. Slope 25% or less.....22

22. Slope 16-25%.....Site 15
22. Slope 6-15%.....Site 13

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a/The difference in bottomland and upland is usually easy to distinguish under stereo due to slope break from adjacent slopes, lower position than adjacent river terraces, vegetation pattern, etc. Occassionally low terraces may be called bottom or vice-versa.

b/Mesquite and sacaton mesic sites usually show reddish on imagery. Presence of cottonwoods or other riparian vegetation showing red along stream channel is also good indicator of mesic bottoms. Bottoms are usually wide and toward lower end of major drainages.

Dry bottoms may be reddish, brown or gray on imagery. Reddish colors most pronounced on narrow, tributaries. No cottonwoods present on lower reaches but oaks, sycamores, walnuts, etc. may occur along stream in upper reaches. Dark gray tone may indicate tobosa grass or sacaton. If sacaton present, the bottom is usually gullied.

c/Gravel cannot be seen directly. Presence of oak trees, proximity of steep side slopes and tributaries and narrower bottoms toward upper end of drainages may roughly indicate presence of gravel.

d/Clay texture indicated by dominance of tobosa grass which shows dark gray color on imagery. May sometimes be confused with fairly thick stand of sacaton.

e/Aspect can be measured or easily estimated within 1/8 compass point. Wider slope classes (15% or more) can be fairly reliably estimated; errors usually occur on borderline cases.

f/ Limy sites can be identified by whitish or light gray colors on site or in nearby gullies, roadcuts, etc. Non-limy sites show yellowish to light brown on imagery (reddish soil colors). Most errors involve identification of limy sites as non-limy where vegetation is dense, grazing light, or a thin covering of reddish soil is on surface. The latter case most often occurs on gentle slopes or ridges.

g/ Slope classes within the 600-700 radiation class are difficult to interpret accurately but rarely are sites misplaced more than to the adjacent slope class.

h/ Cobbles/rocks cannot be interpreted directly. Location on ridges, steeper slopes, young terraces or high end of older terraces along with a rougher image texture (due either to rocks or shrubs) may indicate tendency to rockiness.

i/ Clay texture indicated by tobosa grass (dark gray on image).

Table 6. Results of photo-identification test based on 73 sample plots.

Placement based on photo-interpretation

Topographic Position	Bottomland				Upland																			
Limy/Non-Limy	NA				Non-Limy										Limy									
Radiation Class	NA				700	600	600	600	600	600	600	500	400	300	700	600	600	600	600	600	500	400	300	
Slope Class	NA				NA	0-5	0-5	0-5	6-15	16-25	>25	NA	NA	NA	NA	0-5	0-5	6-15	16-15	>25	NA	NA	NA	
Soil Surface	Clay	No Gravel	Gravel	Mesic	NA	No Cobbles	Clay-No Cobbles	With Cobbles	NA	NA	NA	NA	NA	NA	NA	No Cobbles	Cobbles	NA	NA	NA	NA	NA	NA	
Site Number	1	2	3	4	6	8	10	11	13	15	17	19	22	24	7	9	12	14	16	18	21	23	25	Total
1			1																					1
2		3						1																4
3		1	2																					3
4				3																				3
6					1																			1
8						1		3	1															5
10							1																	1
11								1	4															5
13								2	1	2														5
15								1	1	1	1	1												5
17										2	3													5
19											2	2										1		5
22													2	1							1		1	4
24												1		4										5
7															1									1
9								1	2							2								5
12								2																2
14																1	1	1	1					4
16									1															1
18										2														2
21											1	1								1	2			5
23													1								1			2
25																							1	1
	0	4	3	3	1	1	1	11	10	7	7	5	3	5	1	3	1	1	1	1	4	1	1	75

Placement based on field data

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above the diagonal are errors of omission; those below the diagonal are errors of commission. There were 32 correct placements (43%) out of 75 plots used in the combined tests (7 plots were deleted due to faulty location on photos or biased knowledge of interpreter).

Bottomland vs upland -- This separation was made correctly 10 times out of 11. The plot misplaced was on a low terrace just above the flood-plain.

Mesic vs dry bottoms -- Mesic bottoms were identified with 100% accuracy in this test although it is doubtful if this accuracy could be obtained with a larger sample.

Gravel on surface vs no gravel -- Two out of three plots with gravel and three out of four plots without gravel were correctly placed.

Clay vs coarser soil -- The one clay site was incorrectly placed. (Either not enough tobosa grass to give signature or was confused with dry sacaton).

Limy vs Non-Limy -- Of 66 upland plots, 51 (77%) were correctly placed (Table 7). Of the 15 plots incorrectly placed, 13 (87%) were called non-limy when they were considered limy in the field. The explanation for this is probably that some sites have a thin cover of non-limy reddish soil over limy material. This gives a photo-image more like a non-limy site but the vegetation is more typical of a limy site. Strict adherance to the criteria of soil effervescing on surface in reaction to HCl would probably tend to make photo-interpretation more accurate but might make less sense in the field. Other errors of omission are mostly due to heavy vegetation cover, especially on north slopes. Errors of commission are mostly due to low vegetative cover which results in light tone on the photo.

Table 7. Interpretability of non-limy vs limy sites (upland only).

		Photo interpretation		
		Limy	Non-Limy	Totals
Field Placement	Limy	12	13	25
	Non-Limy	2	39	41
	Totals	14	52	66

Slope and aspect -- Slope and aspect were estimated by photo-interpretation for each upland plot to the nearest 5% and 1/8 compass point, respectively (Table 8).

Slope was determined within 5% of the field measurement on 60% of the plots. There seemed to be no significant trend to over- or under-estimation. Aspect was determined within one class either side of the field measurement 91% of the time but on two of the plots with greater error (85 and 56) the result was apparently due to incorrect location of the plot on the photo. A principal factor leading to errors on both slope and aspect on photos of this scale is that the interpreter tends to average a larger slope than the field observer would.

Radiation Classes -- Plots were correctly assigned to radiation classes on 55 (83%) of 66 trials (Table 9). Of the 11 plots misplaced, seven were placed in the next higher class and one was placed two classes higher. Three plots were assigned to the next lower class. Errors are due both to mistakes on slope percentage and aspect. Errors were greatest in the 400-500 and 500-600 radiation classes, since both slope and aspect parameters are most critical in this range.

Slope classes within 600-700 radiation class -- Correct placement was made on only 18 (42%) of 43 plots (Table 10). However, of the 25 incorrectly placed, 23 were assigned to the slope class adjacent to the correct one. Two plots actually in the 500-600 radiation class were assigned to 25% class and one which should have been in the 16-25% class was assigned to 500-600 radiation class. The 0-5% class tended to be better placed than the middle classes probably because of its general coincidence with ridgetops or depositional surfaces which are easily identified on photos. The remaining slope classes are too narrow to be very accurately

Table 8. Interpretability of slope and aspect (upland only).

Plot No.	Slope % Photo	Slope % Field		Aspect Photo	Aspect Field	
301	10	<5	*	N	--	
83	5	<5		SE	--	
30	15	<5	*	S	--	
141	10	<5	*	SE	--	
146	10	<5	*	S	--	
83	5	<5		SE	--	
78	10	<5	*	S	--	
96	5	<5		NW	NW	
204	5	<5		SW	--	
260	0-5	<5		N	--	
289	0-5	2		NE	E	
67	0-5	3		--	N	
310	10	5		S	S	
109	>5	5		S	S	
305	15	10		NW	NE	*
300	5	10		N	NE	
93	15	10		NW	NW	
275	0-5	10	*	SE	SE	
242	0-5	10	*	E	SE	
34	10	15		S	SE	
64	0-5	15	*	E	S	*
110	25	15	*	SE	E	
306	25	20		W	W	
85	15	20		SE	W	*
52	20	20		NE	N	
36	40	20	*	N	N	
56	25	20		NE	SW	*
72	30	20	*	W	NW	
225	30	20	*	S	S	
61	25	25		E	E	
151	20	25		W	SW	
71	30	25		E	SE	
84	25	30		W	W	
166	50	30	*	E	E	
127	20	35	*	N	N	
252	25	35	*	SW	W	
101	35	40		NE	NE	
207	40	40		NW	N	
165	45	40		W	NW	
233	45	40		W	NW	
266	55	55		N	N	
48	45	60	*	N	NW	

Table 8. (continued)

Plot No.	Slope % Photo	Slope % Field	Aspect Photo	Aspect Field
164	60	60	N	N
170	55	65 *	E	E
243	40	80 *	NW	NW

*Indicates samples where error on slope was greater than 5% or error on aspect greater than 1/8 compass point.

Table 9. Interpretability of radiation classes (upland only).

		Photo placement					
		700	600	500	400	300	Totals
Field Placement	700	2					2
	600		40	1			41
	500		4	5	1		10
	400			3	3	1	7
	300			1		5	6
	Total	2	44	10	4	6	66

Table 10. Interpretability of slope classes in 600-700 radiation class.

		Photo placement					
		0-5%	6-15%	16-25%	25%+	500-600	Total
Field Placement	0-5%	12	7				19
	6-15%	4	2	3			9
	16-25%	1	2	1	1	1	6
	25%+			4	3		7
	500-600				2	--	2
	Total	17	11	8	6	1	43

placed on this scale of photography.

Cobbles vs no cobbles -- Only seven plots in the 0-5% slope class had cobbles; three were correctly placed and the other four were placed in the 6-15% slope class. Of the eleven plots with no cobbles, only four were correctly placed; four were put in the 0-5%, with cobbles class and three in the 6-15% slope class. The main criteria for selecting sites 11 and 12 in favor of 8, 10 or 9 was occurrence on a ridge position rather than bajada or terrace surface. Apparently this will over-estimate plots with cobbles on the surface.

Clay vs loamy texture -- Only one plot occurred in site 10 and was correctly placed. With tobosa grass as an indicator, this distinction can be reliably made.

Conclusions -- The results discussed above are not based on thorough testing, since training was minimal; the sample size small and the interpretation was done only once by one interpreter. However, the results do indicate approximately how well the sites and higher categories in the hierarchical system can be identified.

Although less than half the plots were correctly classified at the Site level, the accuracy at higher levels was well over 50%. Careful study of the matrix in Table 6 and referral to site descriptions show that (1) most errors involved placement in adjacent slope classes or in detection of limyness and (2) the implications of these errors in terms of site or vegetative characteristics is not too great in most cases. We believe that, if comparable accuracy were obtained, an area could be adequately characterized for most management purposes by photo-interpretation of numerous points. The accuracy could probably be increased by using larger scale photography and/or by some re-arranging of site criteria.

It should be pointed out that this site classification and key are not expected to work outside the study area without modification.

USE OF RESULTS IN NATURAL RESOURCE INVENTORY

The ultimate taxonomic unit in any classification of landscape, vegetation or soil is basically determined by the scale at which the classifier must work and is thus arbitrary. The sites we have classified could be further subdivided or grouped and we may do this on some of them. However, these sites are about as finely subdivided as is practical. That is, the scale of human activity (houses, machines, research plots, etc.) is such that further subdivision would probably not add much of practical significance.

The sites (or taxonomic units) as we have defined them cannot be mapped individually in the study area except on large scale photos (1:10,000 or larger), which is impractical except where very small areas are involved. (In areas of more uniform topography, parent material, etc., taxonomic units of the type we defined might be mapped at somewhat smaller photo scales). Obviously mapping of sizeable areas must be done at some higher level of generalization than the taxonomic units. When a hierarchical classification of vegetation or other site indicators is available, mapping at a category or level higher than the taxonomic unit would seem to be a logical step. This has been done for vegetation by Brown (1973), for example. In this case the map designation is the one dominant unit, all others being considered as inclusions. In our opinion, this type of mapping, at pracitical scales, is not adequate for intensive land management because of information lost through generalization.

A better approach is to map patterns or associations of sites

(taxonomic units) at a scale appropriate to the management problem. This approach is similar to that taken by soil scientists in mapping soil associations or the Australians in their "land-system" mapping (Christian and Stewart, 1968). Mapping units designate a group of sites occurring in a similar pattern or proportion. The pattern of occurrence is related to geomorphology (substrate, land form and drainage characteristics), local climate and hydrological conditions. The scale of mapping depends upon the level of internal variation acceptable and the scope of the map desired. Each mapping unit may be considered as unique or possibly combined with similar units for characterization of the mapped area. At this time, we do not consider the mapping units as a classification system but rather as a means of organizing observations and data for management decisions. An example of how this approach could be used in a natural resource inventory is described below.

The first step was stratification based on gross physiographic, climatic, vegetation and soil features. The study area was delineated in this step as an area relatively homogeneous with respect to macro-relief, geologic structure and elevation when compared to adjacent areas which are higher or lower in elevation, generally hilly to mountainous and composed of igneous, metamorphic or sedimentary rocks. Vegetation of the study area is mostly grassland with some oak or mesquite savanna and soils are mapped in two related associations on the statewide soils map. Mapping of "natural areas" at this scale is convenient where a whole state or part of a state is involved and can be quite readily done on cloud-free ERTS imagery. We consider the color composites to be most useful along with supplemental information from state or county maps of geology, climate, soils, elevation, etc. Thus the study area would be one mapping unit on

a map of about 1:500,000 - 1:1,000,000 scale.

This mapping unit (the study area) was then mapped into 21 sub-units representing similar patterns of drainage density, land form, dissection, vegetative pattern, etc. (Fig. 46). This mapping was done on the color IR positive transparencies of 1:120,000 scale. The black and white mosaics on which the mapping units are delineated in Fig. 2 was provided to us by the Oregon State research group. The number of mapping sub-units was arbitrary. The sub-units were mapped to give a reasonably homogeneous internal pattern at this scale. Some could be further subdivided and some similar areas (e.g., I & J; or A & E) could be grouped. However, this mapping level is considered to be useful for medium-scale management considerations (e.g., a National Forest District or BLM Resource Area). It could also be used to characterize a grazing allotment or ranch although a further subdivision on larger scale photos based on site patterns or fenced pastures might be desirable.

The mapping sub-units were also delineated on B & W photography at 1:30,000 scale for measurement of drainage density as we reported in our progress report of October, 1973. However, as our work progressed we have placed less emphasis on the utility of drainage density to characterize the units.

The final step was to characterize the mapping sub-units in terms of the proportions of each comprised by the 23 range sites (taxonomic units) which were identified in the study area. This was done by laying a dot grid over the color IR transparency and identifying the range site at each dot by stereoscopic photo interpretation at 4.5 power magnification. An example, comparing two fairly dissimilar units, H and G, is shown in Table 11.

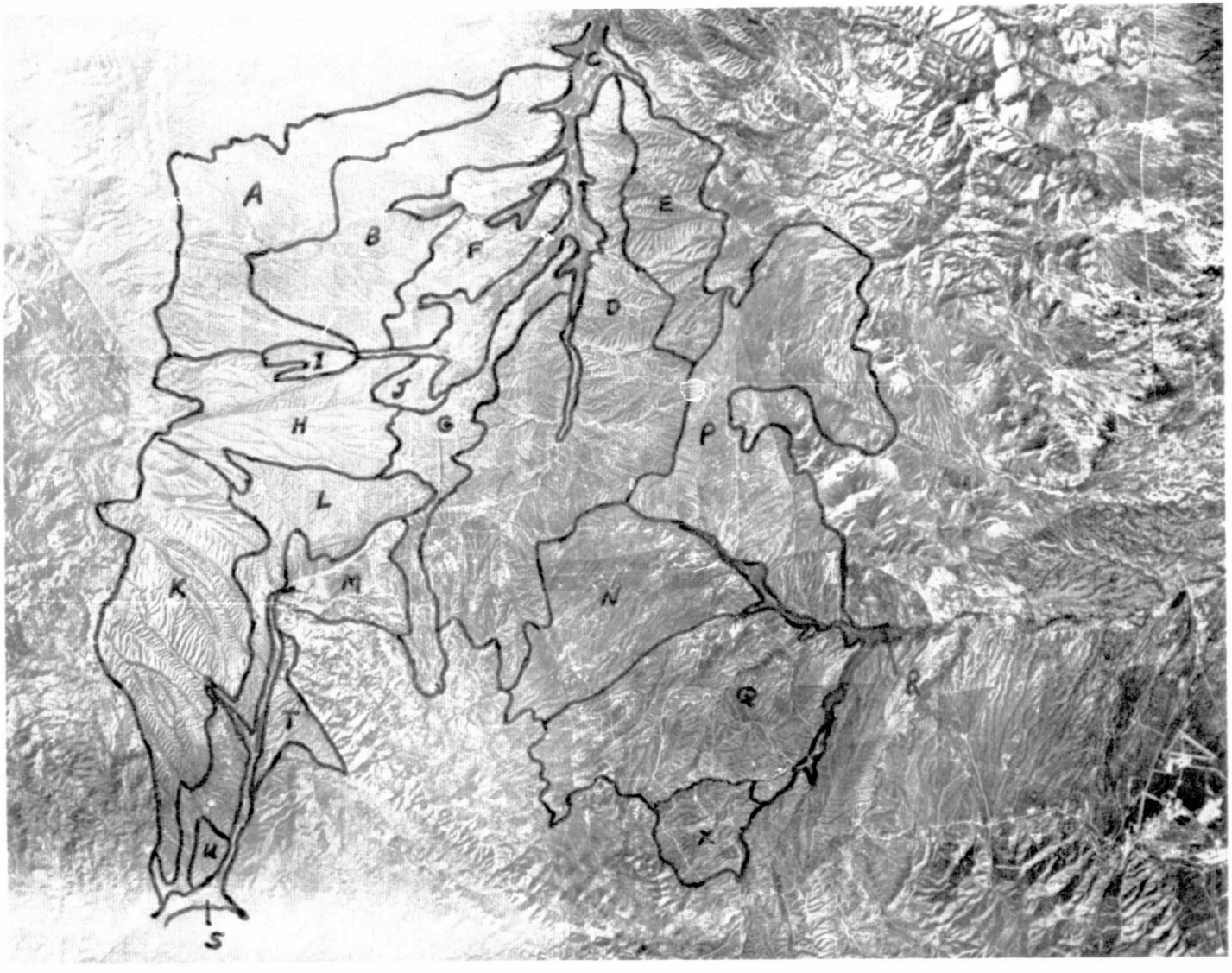

Figure 46. Mosaic of Empire Valley study area showing mapping sub-units in organizing range site data. Approximate scale: 1:240,000.

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Table 11. Characterization of range sites in two mapping units by photo interpretation.

Number-Site	Unit H No. Hits	Unit H %	Unit G No. Hits	Unit G %
1. Clay bottom	--	--	3	2.3
2. Loam bottom	9	4.2	27	20.9
3. Gravelly bottom	26	12.2	1	.8
4. Mesic bottom	--	--	1	.8
6. 700+, non-limy	34	16.0	--	--
7. 700+, limy	9	4.2	1	.8
8. 0-5%, loam, non-limy	39	18.3	36	27.9
9. 0-5%, loam, limy	--	--	14	10.9
10. 0-5%, clay, non-limy	--	--	5	3.9
11. 0-5%, cobbles, non-limy	14	6.6	7	5.4
12. 0-5%, cobbles, limy	2	.9	5	3.9
13. 6-15%, non-limy	21	9.9	7	5.4
14. 6-15%, limy	5	2.3	19	14.7
15. 16-25%, non-limy	5	2.3	1	.8
16. 16-25%, limy	--	--	--	--
17. >25%, non-limy	2	.9	--	--
18. >25%, limy	2	.9	--	--
19. 500-600, non-limy	8	3.8	--	--
21. 500-600, limy	10	4.7	2	1.6
22. 400-500, non-limy	13	6.1	--	--
23. 400-500, limy	6	2.8	--	--
24. 300-400, non-limy	6	2.8	--	--
25. 300-400, limy	2	.9	--	--
TOTAL	213	99.8%	129	100.1%
Area	8520 acres		5160 acres	

Summarization of the data in Table 11 show bottomland to occupy 16.4% of H and 24.8% of G. Site H has 20.2%, 42.1%, 8.5%, 8.9% and 3.7% and G has .8%, 72.9%, 1.6%, 0% and 0% in the 700+, 600-700, 500-600, 400-500 and 300-400 radiation classes, respectively. Site H has 16.7% of limy uplands and G has 31.9%. Clearly, the two areas are different with respect to the sites which occur in each and the relative proportions.

This characterization, coupled with information about the potential of each site for a given use, could be very useful to the resource manager. For instance, the potential production of vegetation, which is a site characteristic, could be estimated for each mapping unit. The useability of this vegetative production as livestock forage would be higher in area G than in H because of the gentler terrain in G and the difficulty of obtaining good livestock distribution in topography like that in H. The information obtained through this photo interpretation could also be used as a basis for proportional field sampling for range condition, etc. and, along with information on location of fences, water, etc. as a basis for extrapolating the results of field sampling.

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APPENDIX

Scientific and Common Names of Plant Species in the Study Area[1/]

	Symbol	Scientific Name	Common Name
Perennial Grasses	Anba	Andropogon barbinodis	Cane beardgrass
	Anci	Andropogon cirratus	Texas bluestem
	ARIS	Aristida spp.	3-Awns
	Arte	Aristida ternipes	Spidergrass
	Bach	Bouteloua chondrosioides	Sprucetop grama
	Bocu	Bouteloua curtipendula	Sideoats grama
	Boer	Bouteloua eriopoda	Black grama
	Bofi	Bouteloua filiformis	Slender grama
	Bogr	Bouteloua gracilis	Blue grama
	Bohi	Bouteloua hirsuta	Hairy grama
	Bora	Bouteloua radicosa	Purple grama
	Elba	Elyonurus barbiculmis	Wooly bunchgrass
	Erin	Eragrostis intermedia	Plains lovegrass
	Erle	Eragrostis lehmanniana	Lehmann lovegrass
	Heco	Heteropogon contortus	Tanglehead
	Hibe	Hilaria belangeri	Curly mesquite
	Himu	Hilaria mutica	Tobosa grass
	Kocr	Koeleria cristata	Prairie junegrass
	Ledu	Leptochloa dubia	Green sprangletop
	Lyph	Lycurus phleoides	Wolftail
	Muem	Muhlenbergia emersleyi	Bullgrass

[1/] Scientific nomenclature follows Kearney, T. H. and R. H. Peebles. 1969. Arizona flora. Univ. of Calif. Press. 1085 pp.

	Symbol	Scientific Name	Common Name
Perennial Grasses	Mure	Muhlenbergia repens	Creeping muhly
	Muwr	Muhlenbergia wrightii	Spike muhly
	ORYZ	Oryzopsis	Ricegrass
	Pabu	Panicum bulbosum	Blub panicum
	Paha	Panicum hallii	Halls panicum
	Paob	Panicum obtusum	Vine mesquite
	Sema	Setaria macrostachya	Plains bristlegrass
	Sihy	Sitanion hystrix	Squirreltail
	Spco	Sporobolus contractus	Spike dropseed
	Spcr	Sporobolus cryptandrus	Sand dropseed
	Spwr	Sporobolus wrightii	Sacaton
	STIP	Stipa spp.	Needle grass
	Stnm	Stipa neomexicana	New Mexico feathergrass
	Trca	Trichachne californica	Fluffgrass
	TRID	Tridens	
	Trpu	Tridens pulchellus	Fluffgrass
Annual Grasses	Arad	Aristida adscensionis	6-Weeks 3-Awn
	ERIO	Eriochloa spp.	Cupgrass
	Feoc	Festuca octoflora	6-Weeks fescue
	Paca	Panicum capillare	Witchgrass
Perennial Forbs	AMBR	Ambrosia spp.	Ragweed
	ARGE	Argemone spp.	Prickly poppy
	Arlu	Artemisia ludoviciana	Herbaceous sage
	ASCL	Asclepias spp.	Milkweed

	Symbol	Scientific Name	Common Name
Perennial Forbs	ASTR	Astragalus spp.	Locoweed
	Boco	Boerhaavia coccinea	Spiderling
	Brde	Brayulinea densa	Matweed
	BRIC	Brickellia spp.	Brickellia
	CAMP	Campanulaceae spp.	
	CARE	Carex spp.	Sedge
	CIRS	Cirsium spp.	Bullthistle
	COMM	Commelina spp.	Dayflower
	CONV	Convolvolus spp.	Bindweed
	CROT	Croton spp.	Croton
	CUCU	Cucurbita spp.	Gourd
	CYPE	Cyperus spp.	Nutgrass
	Daal	Dalea albiflora	Dalea
	DATU	Datura spp.	Sacred datura
	Deco	Desmanthus cooleyi	Bundleflower
	EVOL	Evolvolus spp.	Evolvolus
	EUPH	Euphorbia spp.	Spurge
	LOTU	Lotus spp.	Deer vetch
	LYGO	Lygodesmia spp.	Skeleton plant
	MIRA	Mirabalus spp.	4-O'clock
	NOTH	Notholaena spp.	Cloak fern
	OENO	Oenothera spp.	Evening primrose
	PENS	Penstemon spp.	Beardtongue
	PERE	Perezia spp.	Desert holly
	PETA	Petalostemum spp.	Prairie clover
	PHAC	Phacelia spp.	Phacelia

	Symbol	Scientific Name	Common Name
Perennial Forbs	POLY	Polygala spp.	Milkwort
	POLYP	Polypodiaceae spp.	Fern
	PORT	Portulaca spp.	Portulaca
	PSOR	Psoralea spp.	Scurfpea
	Rico	Ricinus communis	Castorbean
	RUME	Rumex spp.	Dock
	SIDA	Sida spp.	
	SPHA	Sphaeralcea spp.	Globe mallow
	Soel	Solanum elaeagnifolium	White horse nettle
	TALI	Talinum spp.	
	VERB	Verbena spp.	
	Vian	Viquiera annua	Annual goldeneye
	Vico	Viquiera cordifolia	
	Zigr	Zinnia grandiflora	
	Zipu	Zinnia pumila	
Annual Forbs	ABRO	Abronia spp.	Sand verbena
	ASTE	Aster spp.	Aster
	ASTR	Astragulus spp.	Locoweed
	BIDE	Bidens spp.	Spanish needles
	CHEN	Chenopodium	Goosefoot
	Depi	Descurainia pinnata	Tansy Mustard
	ECHI	Echinocactus spp.	Cactus
	Erca	Erigeron canadensis	Horseweed
	ERIA	Eriastrum spp.	Eriastrum
	ERIG	Erigeron spp.	Horseweed, Daisy

	Symbol	Scientific Name	Common Name
Annual Forbs	ERIO	Eriogonum spp.	Annual Buckwheat
	GAIL	Gaillardia	Blanket flower
	GAUR	Gaura spp.	Gaura
	GILI	Gilia spp.	Gilia
	GNAP	Gnaphalium spp.	Cudweed
	COMP	Gomphrena	Globe amaranth
	Hagr	Haplopappus gracilis	Annual goldenweed
	LEPI	Lepidium spp.	Pepper-grass
	LINU	Linum spp.	Flax
	LITH	Lithospermum spp.	Stone weed
	LUPI	Lupine spp.	Lupine
	PHYS	Physalis spp.	Ground-cherry
	Plar	Plagiobothrys arizonicus	Blood-weed
	Plpu	Plantago purshii	Indian-wheat
	Saka	Salsola kali	Russian thistle
Shrubs	Acco	Acacia constricta	Whitehorn
	AGAV	Agave spp.	Century plant
	Arpu	Arctostaphylos pungens	Pointleaf manzanita
	Bapt	Baccharis pteronoides	Yerba de pasmo
	Basa	Baccharis sarothroides	Desert broom
	Caer	Calliandra eriophylla	False-mesquite
	Cebr	Cercocarpus brevifolius	Mountain mahogany
	Cegr	Ceanothus greggii	Buckbrush
	Chvi	Chrysothamnus viscidiflorus	Rabbitbrush
	Coly	Condalia lycioides	Graythorn

	Symbol	Scientific Name	Common Name
Shrubs	Come	Cowania mexicana	Cliffrose
	Dawh	Dasylirion wheeleri	Sotol
	ECHI	Echinocactus spp.	Cactus
	Eptr	Ephedra trifurca	Mormon tea
	Erwr	Eriogonum wrightii	Shrubby buckwheat
	Fewi	Ferocactus wislizenii	Barrel cactus
	Fosp	Fouquieria splendens	Ocotillo
	Gawr	Garrya wrightii	Silk tassel
	GUTI	Gutierrezia spp.	Snakeweed
	Hate	Haplopappus tenuisectus	Burroweed
	Jude	Juniperus deppeana	Alligator juniper
	Jumo	Juniperus monosperma	1-seed juniper
	Krpa	Krameria parvifolia	Range ratany
	LYCI	Lycium spp.	Wolfberry
	MAMM	Mammillaria spp.	Pin cushion cactus
	MIMO	Mimosa spp.	Mimosa
	Mibi	Mimosa biuncifera	Wait-a-bit
	Midy	Mimosa dysocarpa	Velvet pod mimosa
	Mosc	Mortonia scabrella	Scurfy mortonia
	NOLI	Nolina spp.	Beargrass
	OPen	Opuntia spp.	
	OPEN	Opuntia engelmannii	Prickly pear
	Pain	Parthenium incanum	Mariola
	Prju	Prosopis juliflora	Velvet mesquite
	Rhmi	Rhus microphylla	
	Rhtr	Rhus trilobata	Skunkbush

	Symbol	Scientific Name	Common Name
Shrubs	Selo	*Senecio longilobus*	Thread-leaf groundsel
	YUCC	*Yucca* spp.	Yucca
Trees	Jude	*Juniperus deppeana*	Alligator juniper
	Jumo	*Juniperus monosperma*	One-seed juniper
	Pice	*Pinus cembroides*	Mexican pinyon
	Prju	*Prosopis juliflora*	Velvet mesquite
	Quar	*Quercus arizonica*	Arizona white oak
	Quem	*Quercus emoryi*	Emory oak
	Quob	*Quercus oblongifolia*	Mexican blue oak