COOPERATIVE AGREEMENT NO. DACA87-94-H-0001
LEGACY RESOURCE MANAGEMENT PROGRAM

AN ECOSYSTEM SURVEY OF MELROSE AIR FORCE RANGE, CANNON AFB, NEW MEXICO: DEVELOPMENT OF A GEOGRAPHICAL INFORMATION SYSTEM (GIS)

Submitted by:

Robert R. Parmenter, Ph.D., Program Director
Esteban Muldavin, Ph.D., Ecologist
Patricia Mehlhop, Ph.D., Director, NMNHP
James W. Brunt, M.S., Data Manager
Gregg MacKeigan, GIS Specialist
Brett Pickering, Wildlife Biologist
Elizabeth R. Milford, Botanist
Sarah K. Berckman, Botanist
Sanam E. Radjy, Botanist

Department of Biology and New Mexico Natural Heritage Program
University of New Mexico, Albuquerque, New Mexico 87131

31 January, 1997

Table of Contents

List of Tables

List of Figures

I. Introduction to the GIS Development Project

The objective of this work was to develop a Geographical Information System (GIS) for the Melrose Air Force Range, that would incorporate all available natural resources databases. The project was a collaboration of The Nature Conservancy, the University of New Mexico Department of Biology, which includes the New Mexico Natural Heritage Program, and the Department of Defense, U.S. Air Force, Cannon Air Force Base. The GIS database for vegetation ecosystem classification (based on LandSat Satellite Imagery) would be verified quantitatively in the field using percentage cover measurements for each species in various representative habitat types. The Air Force property on the Melrose Bombing Range was sampled systematically for flora and fauna. Personnel from the Natural Heritage Program and the Department of Biology produced vegetation location maps of the sites, and personnel from the Biology Department's Museum of Southwestern Biology sampled and quantified species of vertebrate wildlife on the sites. In nine major habitat types, abundance estimates of vertebrates were made. A Geographical Information System was developed that included the following databases: Topography, streamcourses, roads, buildings, soil types, vegetation and wildlife population sampling locations, and vegetation classifications based on Landsat Satellite Imagery. In addition, wildlife density estimates were derived for the nine major vegetation classification types. The GIS was developed in ARC/INFO software, and data files were transferred to the U.S. Air Force.

II. Methods

The development of the GIS entailed the acquisition of a variety of map coverages and field data of the site. All resulting coverages are projected to meters in zone 13 of the Universal Transverse Mercator coordinate system using the 1927 North American Datum. Unless otherwise noted, all original map scales are 1:24,000. The sources and/or methods used to derive each coverage are described below:

1. Topography: Manually digitized from USGS 7.5" topographic quadrangles. Five maps were joined to compose the complete coverage. Each map was published in 1987 with photorevisions made from aerial photography taken during 1983. This coverage represents the general relief of the area as a contour map. Contours are recorded at ten foot intervals. Augmenting coverages exist for fence lines, the bombing impact area, the firebreak line and the surrounding Melrose Air Force Range property lines.

2. Streamcourses: Manually digitized from USGS 7.5" topographic quadrangles. Five maps were joined to compose the complete coverage. Each map was published in 1987 with photorevisions made from aerial photography taken during 1983. This coverage represents water drainages as depicted on the maps.

3. Roads: Manually digitized from USGS 7.5" topographic quadrangles. Five maps were joined to compose the complete coverage. Each map was published in 1987 with photorevisions made from aerial photography taken during 1983. This coverage represents secondary highways, light-duty improved roads and light-duty unimproved roads as depicted on the maps.

4. Buildings: Manually digitized from USGS 7.5" topographic quadrangles. Five maps were joined to compose the complete coverage. Each map was published in 1987 with photorevisions made from aerial photography taken during 1983. This coverage represents housing structures as single points where they are positioned on the maps.

5. Soil Types: Electronically reproduced from the "General Soil Map of New Mexico" published by the Earth Data Analysis Center (EDAC) in 1974. The source data were supplied by the USDA Soil Conservation Service at a scale of 1:1,000,000. This coverage represents general soil descriptions of the broader area.

6. Vegetation and Wildlife Sampling Locations: Generated from Global Positioning System (GPS) survey measurements taken at each site and differentially corrected for field errors. The control point used for correction was National Geodetic Survey point PID 683, located just southeast of the Melrose Air Force Range. This coverage represents the location of flora and fauna samples taken over the period of the study.

7. Vegetation Classification.

Vegetation Map. In order to develop a map which accurately depicts patterns of vegetation over the Melrose Bombing Range, a strategy was used that combines field vegetation surveys with digital Thematic Mapper (TM) satellite image analysis (Fig. 1). A preliminary vegetation map was developed from ground vegetation survey data using a supervised image classification stratified by landscape units. This preliminary vegetation map, where each map class is represented by a particular ground sampling point, was in turn defined in terms of community types of the NMNHP vegetation classification. Individual map classes were then aggregated into final map units based on vegetation composition, spatial continuity and similar landscape structure, with the final vegetation map with a legend then generated.

Ground Survey Data. The basis for the image classification is field vegetation plot data. To ensure wide coverage over the entire study area, potential field plot locations were identified using the GIS. Based on an initial unsupervised classification of the satellite imagery (see below), large polygons of uniform spectral characteristics were identified for sampling.

In 1995, field crews implemented the design within the constraints of scheduling and the NMNHP sampling protocols calling for plots to be located within large stands of more or less uniform vegetation (minimum 1 ha in size). In 1996, after the development of the Preliminary Vegetation Map based on the 1995 data, areas were targeted for sampling which were not spectrally or spatially covered in the previous data set.

Vegetation plots were generally 400 sq. meters in size and square in shape (20 meters on a side). Occasionally, other shapes and sizes were used to fit the community in question; for example, the long and thin communities stretched out along arroyos. Within each plot a complete list of vascular plant species was taken, stratified by tree, shrub, grass, and forb layers. Unknown species were vouchered for later identification. Visual estimates of percent canopy cover relative to the plot area were taken for each species. Total cover for each of

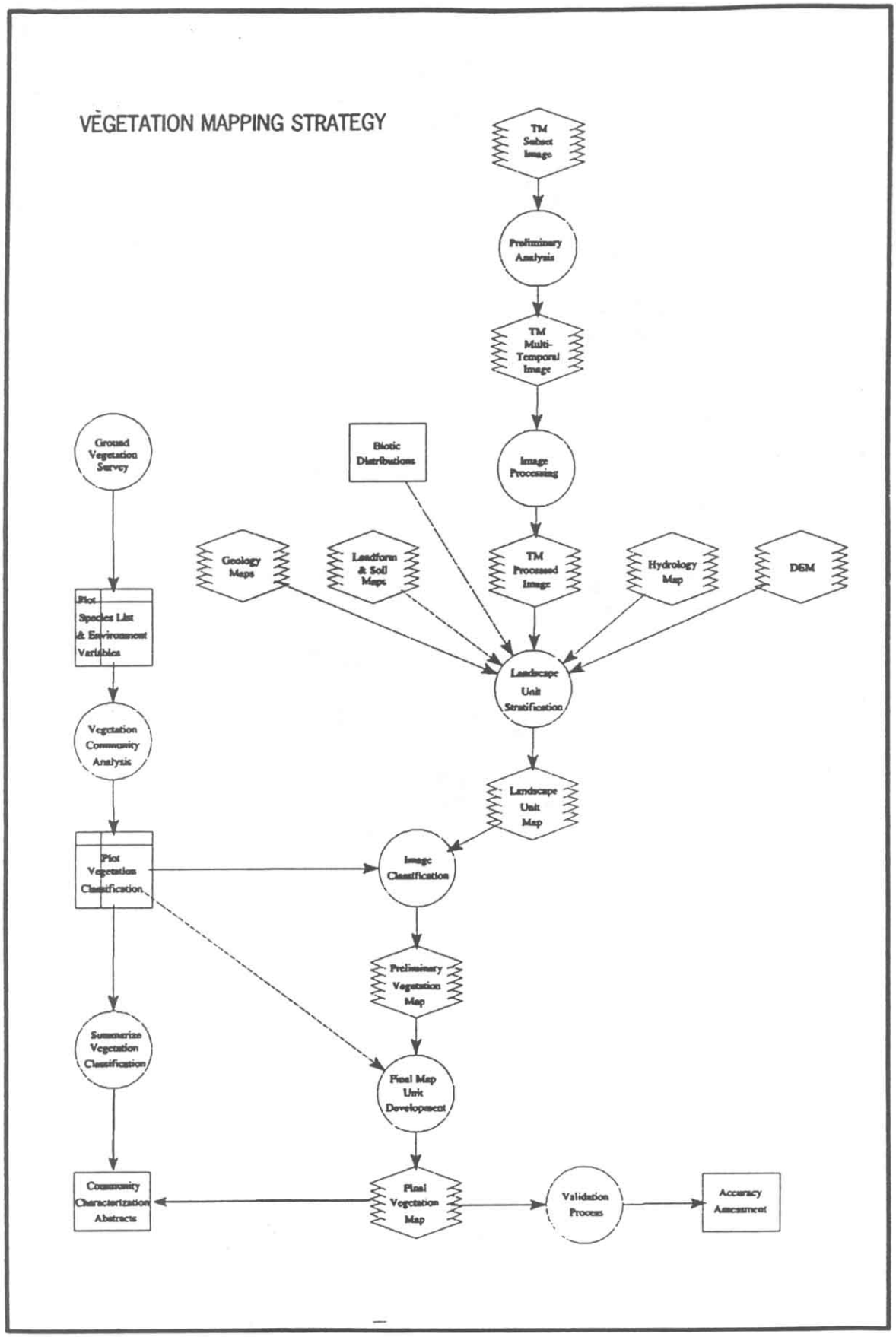

Figure 1. Flow chart detailing the mapping strategy used to develop the Melrose Bombing Range Vegetation Map.

the structural layers was also recorded.

A wide range of site attributes was also recorded: aspect, slope, elevation, ground cover (percent rock, gravel, soil basal area, and litter), slope position and shape, landform, parent material, horizon angles, erosion type, erosion potential, disturbance indicators, animal use evidence, occurrence size, occurrence condition, adjacent HTs, and landscape relationships in general.

A Global Positioning System (GPS) was used to record the highly accurate plot locations necessary for use in the image analysis. GPS positions were post-processed to +/- 10 m accuracy using base station data collected from known local benchmarks, or when possible from the base station the National Park Service, Southwest Geographic Information Center in Albuquerque, NM.

There were a total of 300 plots available for map development and validation. This data resides in the NMNHP Biological and Conservation Database on a Microsoft Access platform and was exported to image processing software as needed. A point coverage of selected field plots was developed in ERDAS and Arc-Info and attributed with salient plot characteristics, such as species abundance values and vegetation type according to the NMNHP vegetation classification. This file also served to hold attribute information for the subsequent image analysis and map unit development.

Satellite Imagery. Landsat Thematic Mapper (TM) satellite imagery was selected for mapping the natural vegetation cover chosen over aerial photography for a variety of reasons. The cost per square mile for satellite data is less than that for aerial photography, both in terms of direct costs and in the ensuing map development. It takes less than one full scene to cover the study area, and imagery comes in a digital form suitable for analytical and computerized map production. The satellite imagery, with its stable sensor platform, is relatively easy to geometrically correct to known coordinates of a base map, thus avoiding the complex geometry of ortho-rectifying and making mosaics of dozens of aerial photos. Further, the height of the sensor above the Earth (705 km for Landsat) negates most parallax problems which are associated with aerial photography (parallax is the apparent change in positions of stationary objects affected by the viewing angle – creating greater distortions at greater distances from the center of an aerial photo). Also, satellite data do not have the radiometric problems of air photos, such as hot spots, dark edges, or different contrasts for each photo due to sun-angle changes during the overflight.

The quantitative spectral and spatial aspects of TM imagery add particularly important dimensions to the mapping process. Multi-spectral satellite imagery records the variable reflection of natural radiation of surface materials such as rocks, plants, soils, and water. These groups have different chemical compositions so that incident radiation will react differently. Variations in plant reflection and absorption due to biochemical composition will register distinct spectral "signatures" (Wickland 1991, Lillesand and Kiefer 1987). These signatures provide a quantitative measure of reflectance of specific wavelengths which can then be statistically analyzed to develop a vegetation map of spectrally similar plant communities.

Landsat TM has the highest spectral discrimination, with six spectral bands and one thermal band, among commercially available space-based sensors. Each band represents a specific range of light wavelength. For vegetation mapping, bands 2, 3, 4, and 5 are particularly useful. TM bands 3, 5 and 7 are useful for detecting variations in surface geology. Surface geology and soil discrimination are important to developing mapping units of the vegetation communities in sparsely vegetated areas that commonly occur on Melrose Bombing Range. Table 1 summarizes the function of each band.

TM integrates the spectral characteristics of each band over the Instantaneous Field of View (IFOV) of an area of 28.5 m x 28.5 m; this is the smallest area resolvable by the sensor and is represented on the computer screen by individual "pixels" (picture elements). Individual occurrences of plants are not resolved by the sensor; therefore, TM is particularly suited for evaluating and quantitatively identifying more generalized vegetation "community" occurrence patterns and their associated surface substrate characteristics.

There are constraints to using TM imagery. Some of the principal problems occur when vegetation is not the major cover type and differential reflectances of various geologic substrates dominate. As with aerial photography, topographic effects creating shadows within narrow valleys and steep escarpments can also cause problems. A proper combination of field sampling and image processing techniques helps to alleviate many problems. Furthermore, the sensor cannot penetrate clouds or snow, but other TM images covering the same area free of clouds or snow can be acquired to fill these "gaps" in coverage. Finally, because of edge effects among a small number of spatially contiguous pixels, small occurrences of vegetation types are difficult to reliably map. Hence the minimum mapping unit polygon size is normally 0.5 ha or larger.

The first step was the acquisition and processing of Landsat Thematic Mapper (TM) imagery over Melrose Bombing Range. Two scenes were acquired representing two different seasons, Summer and Spring. These were used in order to further enhance the vegetation discrimination capabilities of the TM imagery. The Spring image was expected to highlight evergreen shrubs, such as sand sagebrush, and the green-up of cool season grasses. In contrast the Summer image was expected to enhance deciduous shrubs, such as honey mesquite, and the green-up of warm season grasses.

In order to attain complete satellite coverage of Melrose Air Force Range, two Landsat Thematic Mapper (TM) scenes from the Landsat 5 (L5) satellite were acquired over the region. One was acquired on August 17, 1992 (heretofore known as the "Summer image"); the other on April 20, 1995 (heretofore known as the "Spring image"). The images were purchased directly from Earth Observation Satellite Company (EOSAT) and are archived at Earth Data Analysis Center at the University of New Mexico. EOSAT is a private corporation that offers Landsat TM data on a scene basis covering a 185 km x 185 km area, with repetitive coverage over the same scene area every 16 days. The scenes chosen had the least cloud cover and no noticeably apparent sensor errors (scan lines).

The images were then processed to account for geometric and radiometric distortions of the raw imagery.

Terrain Models. A surface terrain model was created by digitizing the contours and hydrology of the 9 US Geological Survey (USGS) 7.5-minute quads that cover the study area (Krider, Gammil Well, Gammil Well NE, Melrose West, Tolar, Tolar SE, Tolar SW, Tule and Upton). An elevation value was interpolated for each pixel of the surface terrain model by calculating the distances from that point to known values and weighting the values inversely as a function of distance. The hydrology file was used to set boundaries to the interpolation process in order to preserve the change in elevation caused by drainages.

Image Processing: Radiometric Corrections. The TM scenes acquired from EOSAT were imported into ERDAS Imagine (Version 8.2) where all raster processing and analysis was done. The overall image quality was good for both scenes, but there was still radiometric distortion inherent in the imagery. A radiometric correction was performed on all TM bands to account for the systematic signal distortion of the sensor. One major source of distortion that occurs is the sensor offset, the residual "black noise" that is recorded by the sensor when there is no input signal (Lillesand and Kiefer 1987). The other major distortion is from the channel gain, which is the slope transfer relation between the signal received and the sensor's response. Differential offsets and gains between bands will cause problems when comparing their responses to a certain feature, so it is necessary to calibrate all the bands to each other. Gain and offset coefficients for each band are provided for by EOSAT for Landsat TM5 in the original image header. The effect of these deviations on the original data can be modeled as:

$$L = (DN * Gain) + Offset \qquad \text{(Eq. 1)}$$

where L is the radiometrically corrected signal and DN is the input pixel digital number value. The gains and offsets found in Table 2 were used to transform the image DN values.

Image Processing: Geometric Corrections. The Summer image was rectified to a map-based coordinate system using a nearest neighbor interpolation. This process makes the image planimetric so that area, direction, and distance measurements can be performed. The image-to-map rectification process involves selecting a point on the map with its coordinate and the same point on the image with its x and y coordinate. The root mean square error (RMS_{error}) is computed to determine how well the map and image coordinates fit in a least-squares regression equation. The RMS_{error} for this image was less than 1.00 pixel error (or approximately 28.5 m). The Summer image was projected into Universal Transverse Mercator, Zone 13, using the 1927 North American Datum and the Clarke 1866 Spheroid. The Spring image was registered using the Summer image as the master image to which points in the Spring image were matched with less than a 1.00 pixel RMS_{error}. The Spring image was projected into the same coordinate system as the Summer image using a nearest neighbor interpolation.

Table 1. Landsat Thematic Mapper bands, their spectral ranges, and principal remote sensing applications for earth research (derived from Lillesand and Kiefer 1987).

Band	Wavelength (microns)	Spectral location	Principal applications
1	0.45-0.52	Blue	Designed for water body penetration, making it useful for coastal water mapping. Also useful for soil/vegetation discrimination, forest type mapping, and cultural feature identification.
2	0.52-0.60	Green	Designed to measure green reflectance peak of vegetation for vegetation discrimination and vigor assessment. Also useful for cultural feature identification.
3	0.63-0.69	Red	Designed to sense in a chlorophyll absorption region aiding in plant species differentiation. Also useful for cultural feature identification.
4	0.76-0.90	Near-infrared	Useful for determining vegetation types, vigor, and biomass content, for delineating water bodies, and for soil moisture discrimination.
5	1.55-1.75	Mid-infrared	Indicative of vegetation moisture content and soil moisture. Also useful for differentiation of snow from clouds.
6	10.4-12.5	Thermal infrared	Useful in vegetation stress analysis, soil moisture discrimination, and thermal mapping applications.
7	2.08-2.35	Mid-infrared	Useful for discrimination of mineral and rock types. Also sensitive to vegetation moisture content.

Table 2. Gains and Offsets used in the radiometrically calibrate of the image data.

	TM1	TM2	TM3	TM4	TM5	TM7
OFFSET	-0.15	-0.280487	-0.119403	-0.15	-0.014999	-0.014999
GAIN	0.0602436	0.1175036	0.0805971	0.0815399	0.0108074	0.0056984

Table 3. PCA transformation matrix between the Spring and Summer images.

Band	Season	PC1	**PC2**
TM1	SUMMER	0.5874	-0.8093
	SPRING	0.8093	0.5874
TM2	SUMMER	0.6079	-0.7939
	SPRING	0.7939	0.6079
TM5	SUMMER	0.7378	-0.6751
	SPRING	0.6751	0.7378
TM7	SUMMER	0.7700	-0.6380
	SPRING	0.6380	0.7700
NDVI	SUMMER	0.9916	-0.1296
	SPRING	0.1296	0.9916

Normalized Difference Vegetation Index. The Normalized Difference Vegetation Index (NDVI) was created for each date using Equation 2:

$$NDVI = (TM4 - TM3)/(TM4 + TM3) \qquad \text{(Eq. 2)}$$

Where: $TM4$ = near infrared band, $TM3$ = green band.

The NDVI enhances green vegetation over other major surface features. It was believed that the NDVI would help emphasize vegetation response patterns in the classification over soil responses. The NDVI also allows quick assessment of class signatures; for example a riparian area should have a higher NDVI response than a senescent grassland. Each NDVI was combined with TM1, TM2, TM5, and TM7 of the same date into one image file. The thermal band, TM6, was not used due to its coarser resolution (120 meters) and small dynamic range. The other two bands, TM3 and TM4, were not used as they were used to create the NDVI and were considered redundant.

Principal Components Analysis. The original image data is usually highly correlated with each channel representing a number of possible surface responses (Table 1). The Principal Components Analysis (PCA) uses a linear transformation to split the image data into the same number of individual components, as there were channels with each component uncorrelated with each other. The resulting components can be displayed as image bands. Interpretation of what each component means is done using the eigen-, or transformation, matrix. The transformation matrix places the input image channels against the output components and varies between +1 and -1; a number close to +1 indicates a high correlation with an input channel, a number close to -1 indicates an inverse relationship with the input channel, and 0 indicates no correlation with the input channel. These components usually represent major surface features, such as soil or vegetation, which allows it to act as a data reduction tool.

In this study, each of the individual channels from the different dates were paired together. A PCA was then done on the channel pairs. For each of the TM pairs, the PCA created a first component which emphasized where the two channels had similar responses (Table 3). The second component emphasized the differences between the two channels with this component loading positively with the Spring image. The PCA on the NDVIs had a different result, as the first component was strongly correlated with the Summer NDVI only and the second component was strongly correlated with the Spring NDVI only.

Upon analysis of the image and the resulting transformation matrix, it was considered that the first component for each of the TM channel pairs represented similar surface responses, mainly due to soil and geology. The second component represented a change between the two dates, mainly due to seasonal vegetation differences, but also due to disturbance. Therefore, only the second components of the TM channel pairs were considered important for vegetation mapping.

Both of the NDVI components were considered important, especially as they emphasized the vegetation differences between two seasons. This became obvious in the display of the image

in which the first NDVI component had a higher response near The Mesa, an area dominated by deciduous shrubs and warm season grasses, as opposed to the second NDVI component which had a higher response in the sandhills, an area dominated by cool season grasses and evergreen shrubs. As a result both of the NDVI components were combined with the second components of the TM channel pairs.

Image Classification: Supervised Strategy and Seeding. The image classification procedure synthesizes satellite image data with field plot data and ancillary data derived principally from Geographic Information System (GIS) coverages. The underlying concept of the mapping procedure is the digital integration of multiple, spatially related data sets. Initially, various digital data layers are created, followed by an interactive process of deriving statistical signatures from the image data, and finally an iterative process is used to create a preliminary vegetation classification.

Two principal data sets were used, the satellite image and the database information containing field plot data. These were converted into a spatially related data layer in the GIS along with DEMs, slopes, aspects, roads, hydrology, and elevation contours. These coverages were used interactively throughout the classification process, in order to verify field plot distributions, accuracy check, and ultimately to characterize mapping units.

A supervised classification strategy was then adopted to create a preliminary vegetation map based on vegetation community types of Melrose Bombing Range. The supervised strategy develops spectral classes based on precise ground locations with known characteristics such as vegetation composition, rock type and landscape context.

In a supervised classification strategy, the field data is applied to the TM image through an interactive process called "seeding." In the seeding process, a pixel at the field plot location was selected in the imagery and its spectral characteristics were used to gather other similar contiguous pixels to create a statistical model or "seed" of the field plot. The seeding algorithm searches around that point within user-defined parameters which contain a seed within: 1) a certain distance, (2) a certain area, and (3) a certain spectral distance defined as:

$$SD = \sqrt{\Sigma(\mu - X)^2} \qquad \text{(Eq. 3)}$$

where SD is the spectral distance between a new pixel and the mean of the current seed group pixels across all bands, μ is the mean of the seed pixel group for each TM band, and X is the spectral value of the new pixel for each TM band.

In an iterative process, the best seed models were constructed by adjusting the parameters and comparing the resulting pixel distributions against the terrain models and the original imagery. A seed was developed for each field plot using the plot GPS location and associated field information. The seed's maximum area was initially defined by the size of the vegetation community occurrence as determined in the field. The actual seed was then defined by increasing the spectral distance iteratively until the spectral signature collected within the seed generated a covariance matrix which could be inverted, a requirement for the maximum likelihood decision rule used later in the actual classification.

The seed shape and location was checked against field notes and maps, and by direct interpretation of the seed in the TM image on the screen in conjunction with the terrain models. Each seed is saved in a signature file with its field plot number, mean values for each image band, variance, number of pixels that were used to create the seed, and minimum and maximum value.

This process was repeated for all of the potential seed plots. The seed potential of each field plot was assessed on the basis of occurrence size indicated in the field and classification confidence in terms of vegetation type. Those plots from small and/or ill defined stands were rejected in the seeding process. Small stand plots were kept for later map validation routines.

Image Classification: Supervised Classification. A supervised classification was performed using the statistics gathered in the seeding process, and is based on a maximum likelihood decision rule. The maximum likelihood decision rule also contains a Bayesian classifier which uses probabilities to weight the classification towards particular classes. In this study the probabilities were unknown, so the maximum likelihood equation for each of the classes is given as:

$$D = -[0.5ln(cov_c)] - [0.5(X - M_c)^T * (cov_c^{-1}) * (X - M_c)] \qquad \text{(Eq. 4)}$$

where D is the weighted distance, cov_c is the covariance matrix for a particular class, X is the measurement vector of the pixel, M_c is the mean vector of the class and ^{T} is the matrix transpose function (ERDAS, 1994). Each pixel is then assigned to the class with the lowest weighted distance. This technique assumes the statistical signatures have a normal distribution.

This decision rule is considered the most accurate, because it not only uses a spectral distance (as the minimum distance decision rule), but it also takes into account the variance of each of the signatures. The variance is important when comparing a pixel to a signature representing, for example, a sand sagebrush shrubland community which might be fairly heterogeneous, to a water class, which is more homogeneous.

Despite using the temporal difference images, different vegetation classes had similar spectral signatures in some cases due to confounding effects of environmental features. To alleviate this problem to some degree, smaller subset landscape units were delineated within the image on the basis of relatively homogeneous topography, elevation, slope, aspect, geologic surface substrate, and known biotic distributions. The classification was redone within these landscape units with classes representing the expected vegetation. These new classifications were mosaicked back into the preliminary classification. This preliminary map had as many map classes as seeds used to develop it.

Final Map Unit Development. The seed map classes were aggregated into a limited number of mapping units (MU's) for the final map based on floristic composition, landscape position, spatial contiguity, and spectral similarity, e.g. floristically similar seed classes which had similar landscape positions and were spatially near each other, were grouped into a mapping unit. This was an iterative process based on informal accuracy checking where seed

classes were grouped into the most consistent and accurate mapping units. Using an average linkage clustering method, mapping units were also checked for the degree of spectral homogeneity within a unit and to detect any outliers or potential groupings not previously recognized. The cluster analysis was performed on the spectral means of the individual classes from the preliminary vegetation map.

Final Vegetation Map. To create the final map, a filtering process was applied to create a minimum mapping unit size of 0.5 hectares. The procedure eliminates the "speckle" created by spatially solitary mapping units which have less than six contiguous pixels. The eliminated areas are then filled in by the majority of surrounding pixels using a 3 pixel x 3 pixel majority filter (a majority filter replaces the middle pixel of a 3 x 3 kernel with the class which is the majority within that kernel). The filtered file was substituted into the map wherever there were clusters of pixels of a particular class which covered less than 0.5 hectares.

Roads, military cantonment, fields and other highly disturbed areas were digitized and masked out (these areas were not sampled and therefore had no spectral class representing their distribution). Contiguous pixels are affected by the diffuse reflection (Lambertian reflection) from these areas, therefore, a buffer area was also assigned to compensate for these errors. However, some military disturbance sites and barren areas were sampled in the field and those were included in the classification process.

Map Validation. Throughout the map analysis process, the map was accuracy "checked" using aerial photos and other available ground data. A more formal accuracy "test" was performed using field plots which were not used in the classification process. A buffer of 12 pixels around a ground assessment point was evaluated for the level of vegetation accuracy based on the NMNHP vegetation classification.

Software and Hardware Used. ERDAS Imagine, version 8.2 was the principal software used throughout the mapping process. All digital imagery and GIS coverages were either processed, manipulated, or used as overlays for analysis within the Imagine environment. The ERDAS Imagine software was loaded on a SUN workstation using a SUNOS Unix Operating System.

Arc/Info, version 7.03 was used to create, import, and manipulate vector coverages and Microsoft Access database ASCII files.

PC based Microsoft Access, version 2.0 was used to store and manipulate all field data and to integrate ancillary data from other software sources.

Trimble's Pfinder, version 2.0 PC software was used to differentially correct GPS data collected in the field to account for position errors due to Selective Ability (SA).

The Statistical Applications Software (SAS), Statgraphics and Systat for Windows statistical packages were used to manipulate image statistics and field data. The SAS program resides on the University of New Mexico network and Statgraphics and Systat were loaded in a PC network environment.

8. Wildlife Density Estimations: Field sampling for wildlife population densities took place during the summer of 1995. The field crew consisted of 4-6 scientists and technicians, who sampled all terrestrial vertebrate groups at the designated study sites. The crew was composed of "specialists" in the various vertebrate groups (mammals, birds, and reptiles). Previous surveys of the area had been conducted in 1993, and complete species lists for each wildlife group had been compiled (Parmenter et al. 1994).

Sampling sites were based on the vegetation classification of community types using the New Mexico Natural Heritage Program's statewide vegetation classification and associated protocols. This provides a heirarchial classification of communities from formation (grassland, shrublands, etc.) down to the community types (associations). Thus every site received a community type designation, and was associated with a particular vegetation species composition.

Rodents were sampled in each designated habitat type using two replicate trapping webs (Anderson et al. 1983, Buckland et al. 1993). The trapping web design was selected over the more traditional trapping grid design because accurate absolute densities (number of animals per hectare) could be estimated from the distance data generated on the webs, and because the estimation procedures required few assumptions about capture probabilities and animal movement patterns (see Buckland et al. 1993 for detailed discussions). Accuracy assessments of density estimates using trapping webs in both computer simulations and field studies have shown excellent correspondence between actual and estimated densities of organisms (Wilson and Anderson 1985, Parmenter et al. 1989). Each web consisted of twelve 100-m long radial lines of trap stations, with each line having 12 stations (Fig. 2). The first four trap stations were at 5 m intervals from the center, and the last eight stations were at 10 m intervals. A single Sherman live trap was placed at each station, with four Sherman traps at the web center. Each trapping web covered an area of 3.14 ha. Webs were separated from one another by large distances to preclude animals from being sampled on both webs.

Webs were trapped for three consecutive nights during July or August, 1995. Traps were baited with rolled oats. Traps were checked early each morning, and periodically during the day in order to retrieve diurnal species. Data collected on each rodent included species identification, measurements of total length, tail, hind foot, ear, body mass, sex, reproductive status, and presence of scars or wounds. Each rodents was then marked with a colored dye on its abdominal fur, and released at its original point of capture. Mammal species nomenclature followed Findley et al. (1975).

Rodent density estimates (no. rodents/ha) were calculated from the trap location data using Program DISTANCE (Laake et al. 1994). The calculations were based on model selection routines within the DISTANCE program, and the best-fit model was used for further analyses of densities. The models used in the density estimation procedures were the uniform, half-normal, and hazard models (Buckland et al. 1993). Akaike's Information Criterion values provided the basis for model comparisons and selection (Burnham and Anderson 1992). In cases where insufficient numbers of rodents were collected to run the program DISTANCE, a density estimate was calculated by dividing the number of animals on a web by an area of 7.07 hectares; this value is the area of the web (100 meter radius) plus a 50-meter buffer zone outside the web, from which animals would likely be collected by the

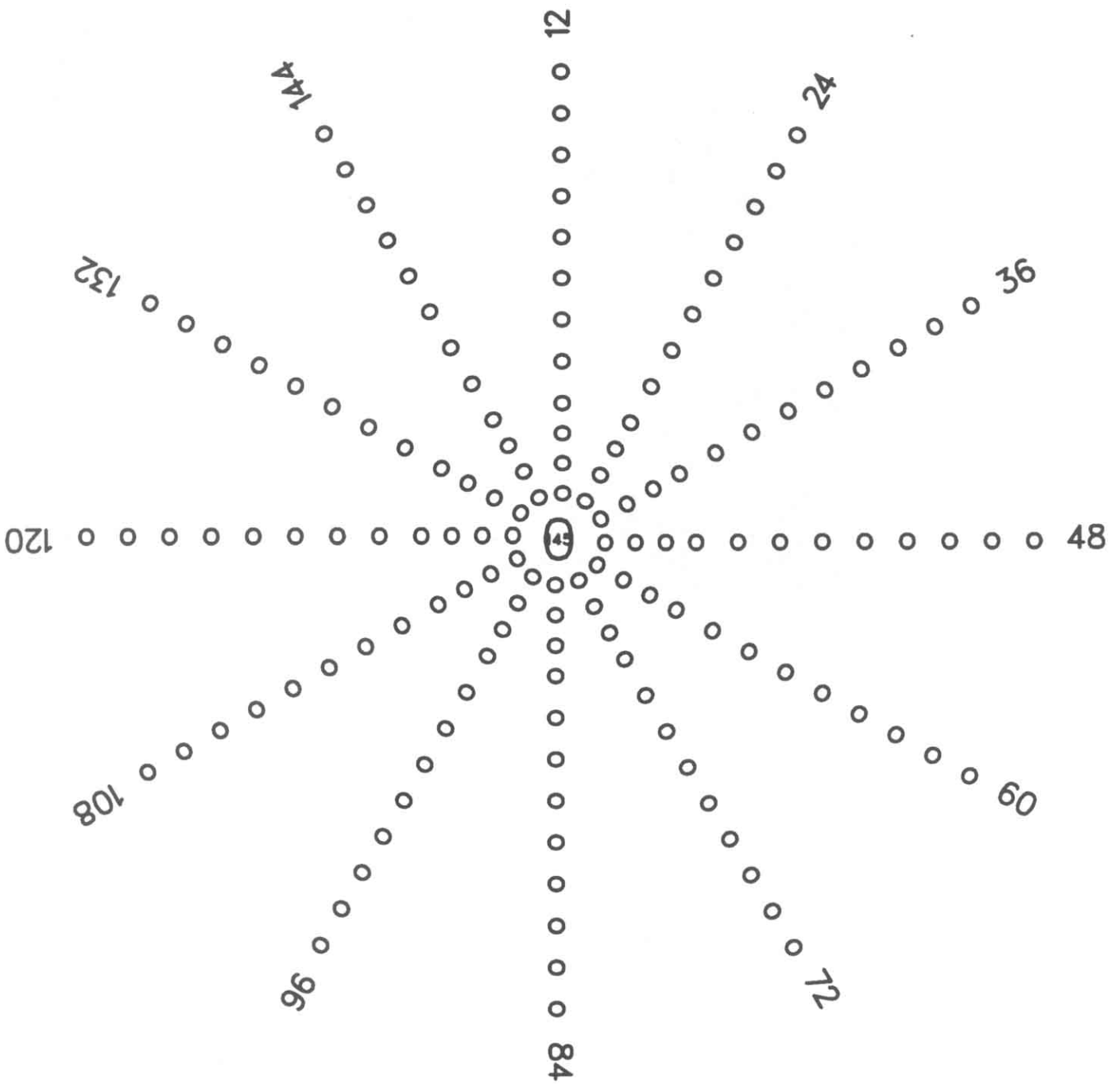

Figure 2. Diagram of trap distributions on a trapping web. Each location had a single Sherman trap present; total web diameter was 200 meters. Bird samples were taken at the center of each web. Reptile strip transects were conducted on the north-south line of traps (200 m long).

web's outermost traps. Hence, we assumed that a circular area of 150 meters radius was effectively sampled at each web point.

Rabbits were sampled over the entire site by nocturnal spotlight surveys. Surveys were conducted by driving a pick-up truck along the site roads at a speed of 10 miles per hour, and using spotlights (1 million candlepower "Q-Beam" spotlights) to illuminate rabbits near the roadway. In total, the rabbit survey was conducted over 27.5 miles of roads. Two observers, each with a spotlight, stood in the back of the pick-up truck, and scanned each side of the road. The spotlights illuminated an area of approximately 75 to 100 meters from the roadway. When a rabbit was observed, one of the technicians measured the perpendicular distance from the middle of the road to the spot where the rabbit was first noted. This distance, plus the species of the rabbit, were recorded. From the distance data, program DISTANCE was used to calculate absolute densities of rabbits; the model selection routines and analysis were identical to those described for rodent densities.

Other species of mammals, such as bats, antelope, mule deer, coyotes and other predators, were deemed to be extremely mobile and occupied virtually all areas of the Melrose Air Force Range. While certain habitats appeared to be frequented more often by various species, a detailed analysis (e.g., from radio-telemetry data) would be required to determine micro-habitat use by each species; this level of study was beyond the scope of the present project.

Birds were sampled in the various habitats on study site were tallied using circular plot sampling methods similar to Robbins et al. (1986). All major habitat types were sampled during the breeding (summer) period. An observer (Michael Friggens) stood at the center of each rodent trapping web and identified and counted birds within a 200-meter radius circle for a period of 9 minutes (after a 5 minute waiting period to allow the birds to recover from the disturbance of the observer walking onto the web). Birds were detected by either sight or sound. Age and sex class were noted whenever possible. Counts were conducted from approximately 30 minutes before sunrise to no more than 3 hours post-sunrise. This time period accounted for generally equivalent bird behavior among sites, as most species sang and were active during early morning hours. Species nomenclature was based on Hubbard's "Revised Check-list of the Birds of New Mexico" (1978). Bird densities were estimated by dividing the number of individuals of each species by 12.57 hectares (the area of a circle with a radius of 200 m).

Reptiles were sampled on strip transects located on each rodent trapping web. Two of the trap "spokes" of the web (one going north, the other going south) were walked during late morning when reptiles were active. Each strip transect was 100 m long (200 m per web), and was 10 meters wide. All reptiles occurring within the strip were identified and recorded. Density estimates were derived by dividing the number of reptiles observed on each web by 0.2 ha (the area of the two transects per web). Reptile nomenclature followed Degenhardt et al. (1996).

III. Summary of Findings

1. Vegetation Map. A vegetation map based on supervised classification using 131 ground survey points has been integrated into the GIS, and is presented as a separate, hard copy map. There were 15 map units developed for the map as outlined in Table 4. The final map unit polygon size is 0.5 hectares. For each map unit, the major vegetation communities are listed that comprise 10% or more of the unit. The major inclusions are also listed, but each accounts for less than 10%. Community type names follow that NMNHP state-wide vegetation classification system where the first species represents the dominant (Series or Cover Type) and the second name either a co-dominant or indicator species. A list of plant species encountered in ground survey is provided in Appendix 1. A summary table of community type composition and abundance by species is given in Appendix 2.

Ten of the units are primarily grassland units dominated by either blue grama (*Bouteloua gracilis*), buffalograss (*Buchloe dactyloides*), hairy grama (*Bouteloua hirsuta*) or sand dropseed (*Sporobolus cryptandrus*), and occasionally by sideoats grama (*B. curtipendula*), New Mexico needlegrass (*Stipa neomexicana*), silver beardgrass (*Bothriochloa laguroides*) or little bluestem (*Schyzachyrium scoparium*). Map unit (MU) 1 is dominated by the short grass plains blue grama-buffalograss community. It is predominant on clay and clay loam soils throughout the southern two-thirds of the study area and comprises the largest acreage. Along the northern fringe of the unit, honey mesquite (*Prosopis glandulosa*) becomes more prevalent, giving way to MU 2 which is also dominated by blue grama and buffalograss, but with a honey mesquite phase indicating a shrub cover between 5 and 10%. Black grama (*Bouteloua eriopoda*) is also more common in MU 2. On very clayey soils, MU 5 co-dominated by tobosa grass (*Hilaria mutica*), blue grama and buffalograss becomes more prevalent. The close cropped grassland vegetation of active prairie dog towns is represented by MU 24.

Where honey mesquite exceeds 10% cover, the shrub dominated MU 19 is depicted, forming a band from east to west through the center of the study area. To the north of this band, the soils become increasingly sandier with a distinct shift in vegetation composition. Map Units 7, 11 and 14 are grasslands dominated by hairy grama, sand dropseed, little bluestem or New Mexico Needle grass with scattered soaptree yucca (*Yucca glauca*), forming a complex mosaic in the northern third of the study area. As soils become sandier, sand sagebrush (*Artemisia filifolia*) becomes more prevalent as in MU 10 where it is generally between 5% and 10% cover. When it exceeds 10% cover the shrubland map units 8 and 11 are depicted. Both MUs 11 and 14 are characterized by New Mexico needlegrass and are more restricted to sand dune areas in the far northern extension of the study area.

Agricultural areas are extensive in the study area. MU 3 represents old fields that have been re-colonized by silver beardgrass and various grama grasses. MU 29 are fields that appear to be currently under active crop rotation. MU 20 is barren ground that can represent various highly disturbed sites such as wells and tanks, but also includes some fields.

Table 4. Annoted legend for the Melrose Air Force Range Vegetation Map. Map units are ordered by GIS digital number with aerial coverage in acres (ac) and hectares (ha) as derived from the GIS. For each unit, the major community types (CT's) listed in order of importance within the unit along with known inclusions (<10% coverage). Coummunity types are given in common names along with scientific name and NMNHP arconym following NMNHP conventions.

==========

1. Blue Grama - Buffalo Grass Grassland [24,437 ac; 9,893 ha]

   Major Cts: Blue Grama-Buffalograss
   (*Bouteloua gracilis-Buchloe dactyloides*; BOUGRA-BUCDAC)

   Inclusion: Blue Grama/Small Soaptree Yucca
   (*Bouteloua gracilis/Yucca glauca*; BOUGRA/YUCGLA)

   Black Grama-Blue Grama
   (*Bouteloua eriopoda-Bouteloua gracilis*; BOUERI-BOUGRA)

2. Blue Grama Grassland with Moderate Mesquite [2,670 ac; 1,081 ha]

   Major CT: Blue Grama-Buffalograss
   (*Bouteloua gracilis-Buchloe dactyloides*; BOUGRA/BUCDAC)

   Honey Mesquite Phase (*Prosopis glandulosa* phase; PROGLA)

   Inclusion: Black Grama-Blue Grama
   (*Bouteloua eriopoda-Bouteloua gracilis*; BOUERI-BOUGRA)

   Honey Mesquite Phase (*Prosopis glandulosa* phase; PROGLA)

3. Silver Beardgrass - Sand Dropseed - Mixed Grama Old Field [1,919 ac; 777 ha]

   Major CTs: Silver Beardgrass-Sideoats Grama
   (*Bothriochloa laguroides-Bouteloua curtipendula*; BOTLAG-BOUCUR)

   Old Field Phase (Old cultivated field phase; OLDFIELD)

   Silver Beardgrass-Hairy Grama
   (*Bothriochloa laguroides-Bouteloua hirsuta*; BOTLAG-BOUHIR)

   Old Field Phase (Old cultivated field phase; OLDFIELD)

   Silver Beardgrass-Blue Grama
   (Bothriochloa laguroides-Bouteloua gracilis; BOTLAG-BOUGRA)

   Old Field Phase (Old cultivated field phase; OLDFIELD)

4. Buffalo Grass Grassland [743 ac; 1,834 ha]

   Major CT: Buffalograss/Montotypic Stand
   (*Buchloe dactyloides*/Monotypic; BUCDAC-MONTYP)

   Inclusions: Buffalograss/Small Soaptree Yucca
   (*Buchloe dactyloides/Yucca glauca*; BUCDAC/YUCGLA)

Table 4. Annoted legend for the Melrose Air Force Range Vegetaion Map (continued).

5. Blue Grama - Tobosa Grassland [1,261 ac; 3,115 ha]

Major Cts: Blue Grama-Buffalograss
(*Bouteloua gracilis-Buchloe dactyloides* BOUGRA-BUCDAC)

Tobosagrass Phase (*Hilaria mutica* phase; HILMUT)

Tobosagrass-Blue Grama
(*Hilaria mutica-Bouteloua gracilis*; HILMUT-BOUGRA)

6. Hairy Grama - Feather Plume Grassland [740 ac; 1,829 ha]

Typical Phase (Typic phase;TYPIC)
Purple Threeawn Phase (*Aristida purpurea* phase; ARIPUR)
Sideoats Grama Phase (*Bouteloua curtipendula* phase; BOUCUR)
New Mexico Needlegrass Phase (*Stipa neomexicana* phase; STINEO)

Major CTs: Hairy Grama/Featherplume
(*Bouteloua hirsuta/Dalea formosa*; BOUHIR/DALFOR)

Inclusion: Hairy Grama-Sideoats Grama
(*Bouteloa hirsuta-Bouteloua curtipedula*; BOUHIR-BOUCUR)

Purple Threeawn Phase (*Aristida purpurea* phase; ARIPUR)

7. Hairy Grama - Sand Dropseed - Soaptree Yucca Grassland [3,310 ac; 1,340 ha]

Major Cts: Hairy Grama/Small Soapweed Yucca
(*Bouteloua hirsuta/Yucca glauca*; BOUHIR/YUCGLA)

Typical Phase (Typic phase; TYPIC)
Purple Threeawn Phase (*Aristida purpurea* phase; ARIPUR)
Blue Grama Phase (*Bouteloua gracilis* phase; BOUGRA)

Hairy Grama-Sideoats Grama
(*Bouteloua hirsuta-Bouteloua curtipendula*; BOUHIR-BOUCUR)

Typical Phase (Typic phase; TYPIC)
Purple Threeawn Phase (*Aristida purpurea* phase; ARIPUR)

Little Bluestem/Small Soaptree Yucca
(*Schizachyrium scoparium/Yucca glauca*; SCHSCO/YUCGLA)

Hairy Grama-Blue Grama/Small Soapweed Yucca
(*Bouteloua hirsuta-Bouteloua gracilis/Yucca glauca*; BOUHIR/YUCGLA)

Table 4. Annoted legend for the Melrose Air Force Range Vegetaion Map (continued).

8. Sandsage - Soaptree Yucca Grassland [5,010 ac; 2,028 ha]

Major CTs: Sand Sagebrush/Hairy Grama
(*Artemisia filifolia/Bouteloua hirsuta*; ARTFIL/BOUHIR)

Little Bluestem Phase (*Schizachyrium scoparium* phase; SCHSCO)
Sand Dropseed Phase; (*Sporobolus cryptandrus* phase; SPOCRY)

Sand Sagebrush/Sand Dropseed
(*Artemisia filifolia/Sporobolus cryptandrus* ; ARTFIL/SPOCRY)

Sand Dropseed/Small Soaptree Yucca
(*Sporobolus cryptandrus/Yucca glauca*; SPOCRY/YUCGLA)

Sand Sagebrush Phase (*Artemisia filifolia* phase; ARTFIL)
Purple Threeawn Phase (*Aristida purpurea* phase; ARIPUR)

Hairy Grama/Small Soapweed Yucca
(*Bouteloua hirsuta/Yucca glauca*; BOUHIR/YUCGLA)

Red Lovegrass Phase (*Eragrostis secundiflora* phase; ERASEC)

10. Hairy Grama - Sand Dropseed - Soaptree Yucca Grassland with Moderate Sandsage [5,565 ac; 2,253 ha]

Major Cts: Hairy Grama/Small Soapweed Yucca
(*Yucca Bouteloua hirsuta/Yucca glauca*; BOUHIR/YUCGLA)

Sand Sagebrush Phase (*Artemisia filifolia*; ARTFIL)

Sand Dropseed/Small Soaptree Yucca
(*Sporobolus cryptandrus/Yucca glauca*; SPOCRY/YUCGLA)

Sand Sagebrush Phase (*Artemisia filifolia* phase; ARTFIL)
Purple Threeawn Phase (*Aristida purpurea* phase; ARIPUR

Tumble Lovegrass/Small Soaptree Yucca
(*Eragrostis sessilispica/Yucca glauca*; ERASES/YUCGLA)

Typical Phase (Typic phase; TYPIC)
Sand Sagebrush Phase (*Artemisia filifolia* phase; ARTFIL)

Inclusions: Sideoats Grama/Small Soaptree Yucca
(*Bouteloua curtipendula/Yucca glauca*; BOUCUR/YUCGLA)

New Mexico Needlegrass/Featherplume
(*Stipa neomexicana/Dalea formosa*; STINEO/DALFOR)

11. Sandsage - New Mexico Needlegrass Shrubland [720 ac; 291 ha]

Major Cts: Sand Sagebrush/New Mexico Needlegrass
(*Artemisia filifolia/Stipa neomexicana*; ARTFIL/STINEO)

Table 4. Annoted legend for the Melrose Air Force Range Vegetation Map (continued).

13. Alkali Sacaton -Common Rush Grassland [217 ac; 88 ha]

Major Cts: Common Rush-Alkali Sacaton
(*Juncus effusus-Sporobolus airoides*; JUNEFF-SPOAIR)

Alkali Sacaton-Lovegrass
(*Sporobolus airoides-Eragrostis spp.*; SPOAIR-ERAGRO)

14. New Mexico Needlegrass - Soapweed Yucca Grassland [1,067 ac; 432 ha]

Major CTs: New Mexico Needlegrass/Small Soaptree Yucca
(*Stipa neomexicana/Yucca glauca*; STINEO/YUCGLA)

Typical Phase (Typic phase;TYPIC)
Blue Grama Phase (*Bouteloua gracilis* phase; BOUGRA)

19. Mesquite - Blue Grama Open Shrubland [3,489 ac; 1,413 ha]

Major CTs: Honey Mesquite/Blue Grama
(*Prosopis glandulosa/Bouteloua gracilis*; PROGLA/BOUGRA)

Typical Phase (Typic phase;TYPIC)
Black Grama Phase (*Bouteloua eriopoda* phase; BOUERI)

Honey Mesquite/Blue Grama-Buffalograss
(*Prosopis glandulosa/Bouteloua gracilis-Buchloe dactyloides*; PROGLA/BOUGRA-BUCDAC)

Typical Phase (Typic phase;TYPIC)
Black Grama Phase (*Bouteloua eriopoda* phase; BOUERI)

Inclusions: Honey Mesquite/Black Grama
(*Prosopis glandulosa/Bouteloua eriopoda*; PROGLA/BOUERI)

Blue Grama-Sideoats Grama
(*Bouteloua gracilis-Bouteloua curtipendula*; BOUGRA-BOUCUR)

Mesquite Treatments

20. Barren or Sparsely Vegetated Ground [856 ac; 346 ha]

24. Praire Dog Town - Blue Grama Grassland [1,069 ac; 433 ha]

Major Cts: Blue Grama-Buffalograss/Prairie Dog Town
(*Bouteloua gracilis-Buchloe dactyloides*/Dogtown; BOUGRA- BUCDAC/DOGTOWN)

29. Recent or Current Agricultural Fields [2,850ac; 1,154 ha]

Major CTs: Agricultural Crops, Bare Ground

Inclusion: Sand Dropseed-Sideoats Grama
(*Sporobolus cryptandrus-Bouteloua curtipendula*; SPOCRY-BOUCUR)

Old Field Phase (Old cultivated field phase; OLDFIELD)

The southwest portion of the study area is characterized by a large elevated mesa. The slopes and shoulders of this mesa are dominated by hairy grama/featherplume (*Dalea formosa*) grasslands on shallow, gravely soils and are represented by MU 6.

Wetland areas dominated by common rushes (*Juncus effusus*) and alkali sacaton (*Sporobolus airoides*) are represented by MU 13, and occur primarily along the east to west-tending valley bottom in the northern portion of the study area.

Our accuracy assessment indicates that at 88% of the validation points hit the target within map units of the vegetative dominant at the Series level or lower units of the vegetation classification such as the community type and phase within community type (Table 5). The Error Index measures the degree of deviation from the target components of the map units. A value of 0.0 indicates that a validation point hit the target element of the map unit. A value of 1.0 indicates that a validation point missed the target by one level of the vegetation classification hierarchy, for example between community type and Series (vegetative dominant); a value of 2.0 means two levels and so forth. The average error index indicated that validation points missed the target of the map unit on average by only 0.48 of a level, usually between Community Type and Phase of Community Type, or between Community Type and Series.

Some units appear to perform better than others, but the sample size for some units is two small to draw statistically significant conclusions from. MU 1 had the highest sample number because it the largest unit and it had a very low error index level (0.28) and validation points hit the target community type 92% of the time. In contrast, in MU 8 the validation points failed to hit at the targeted community type level 50% of time for an error index of 1.19. It still hit at the Series level 75% of time, only 5% off the target 80% accuracy at the Series level set initially for the project. The higher error rates of MU 4 suggest that there is problem resolving this smaller unit (only 743 total acres) inside the matrix of the larger units 1,2 and 5, where it is usually found. But the validation sample size is two low to draw definite conclusions.

Overall, the map provides a good overview of vegetation distribution of the range with acceptable levels of accuracy. It should, in the context of the GIS applications, serve planning efforts well into the future.

Table 5. Vegetation Map error matrix. Classification level refers to hierarchical level of the NMNHP vegetation classification. N/A indicates that the map unit was either not defined or not tested at that level.

Map Unit	N	Classification Level: Phase	CT	Series	Biome	Formation	Error Index
1	39	N/A	92	3	2.5	2.5	0.28
2	6	67	33				0.33
3	4	75	25				0.00
4	5	N/A		40	60		1.60
5	5	20	80				0.80
6	3	N/A	66		33		0.66
7	6	N/A	56	34	16		0.83
8	8		50	25	12.5	12.5	1.60
10	10	30	40	20	10		0.45
11	0						
13	1	N/A	100				0.00
14	2	N/A	50		50		1.50
19	3	N/A	66			33	2.00
20	0						
24	1	N/A	100				0.00
29	2	N/A	50	50			0.75
Count	95	11	62	10	9	3	Avg. 0.48
% of Total		12	65	11	9	3	
Cumm %		12	77	88	97	100	

2. Wildlife Densities. A total of nine major habitat types were sampled for wildlife species densities during the summer of 1995. These habitats included (1) Grazed Mesquite–Blue Grama Open Shrubland, (2) Ungrazed Mesquite–Blue Grama Open Shrubland, (3) Grazed Blue Grama–Buffalo Grass Grassland, (4) Ungrazed Blue Grama–Buffalo Grass Grassland, (5) New Mexico Needlegrass–Soapweed Yucca Grassland, (6) Sandsage–New Mexico Needlegrass Shrubland, (7) Alkali Sacaton–Common Rush Grassland, (8) Barren or Sparsely-Vegetated Ground, and (9) Recent–Current Agricultural Fields. These nine habitats made up the vast majority of land area on the Melrose Air Force Range.

Table 6 summarizes the results for the 10 species of small mammals, 15 species of birds, and 8 species of reptiles that were trapped or observed on the study plots. Tables 7 through 15 provide the detailed data from the replicated webs in each habitat type. Appendices 3-5 provide common and scientific species names of the wildlife of the Melrose Air Force Range.

Densities of rabbits varied considerably across the Melrose Air Force Range, but did not seem to be habitat specific. The average density estimate for the entire area was calculated to be 21.4 jackrabbits (*Lepus californicus*) per square kilometer, and 14.5 cottontails (*Sylvilagus auduboni*) per square kilometer.

From these results, it is clear that the various habitat types support different assemblages of vertebrates, and that the abundances (densities) vary considerably from site to site. For example, the greatest densities of small mammals and reptiles were found on the Recent–Current Agricultural Fields; however, this site supported the fewest bird species. In contrast, the Alkali Sacaton–Common Rush Grassland supported the most bird species, but only a few mammals and no reptiles (the small mammals on this site were captured near the edge of the rush areas, not actually inside the dense rush stands). The effects of grazing on the wildlife were habitat-specific; in the Blue Grama–Buffalo Grass Grassland, birds were more diverse and abundant on ungrazed areas than on grazed areas. However, in the Mesquite–Blue Grama Open Shrubland, the grazed areas had slightly more species of vertebrates than the ungrazed areas.

Table 6. Summary listing of wildlife species and estimated densities (numbers per hectare) observed in various habitat types on the Melrose Air Force Range, Clovis, NM, in 1995.

Species Name	SS/NS	AS/RG	N/SYG	RC/AF	U/MBG	G/MBG	B/SVG	G/BBG	U/BBG
MAMMALS									
Silky pocket mouse	0.36		0.58	0.14	1.10	1.14	0.42	0.28	
Plains pocket mouse	0.22								
Hispid pocket mouse		0.07	0.58	0.27	2.38	0.78			
Ord's kangaroo rat	0.28	0.21	0.86	4.62					
Northern grasshopper mouse	0.50	0.07	1.01	0.55	0.21	1.36			0.07
Western harvest mouse		0.07							
Plains harvest mouse						0.14			
Plains wood rat					0.95	0.72			
Spotted ground squirrel	0.44		0.15	2.14		0.35	0.35		
Thirteen-lined ground squirrel					0.07			0.35	0.28
BIRDS									
Eastern meadowlark	0.28			0.04		0.28	0.08		0.08
Western meadowlark		0.40	0.08					0.24	0.04
Horned lark									
Western kingbird		0.08					0.04		
Western flycatcher									
Loggerhead shrike		0.08							
Chipping sparrow		0.08	0.04			0.24			
Lark sparrow						0.08	0.04		
Lark bunting					0.48	0.48	0.24		0.32
Cactus wren									0.04
Barn swallow		0.08							
Morning dove	0.20	0.04	0.12						
Scaled quail					0.04				0.48
Common nighthawk	0.04	0.08				0.04			
Swainson's hawk					0.04		0.04		
REPTILES									
Western box turtle			2.50						5.00
Eastern fence lizard			2.50						
Lesser earless lizard				2.50		2.50			
Texas horned lizard				2.50	5.00		5.00	2.50	
Six-lined racerunner					5.00	2.50			
Great Plains skink				10.00		2.50			
Many-lined skink				2.50					
Western rattlesnake	2.50								

Habitat Key:
SS/NS = Sandsage–New Mexico Needlegrass Shrubland
AS/RG = Alkali Sacaton–Common Rush Grassland
N/SYG = New Mexico Needlegrass–Soapweed Yucca Grassland
RC/AF = Recent–Current Agricultural Fields
U/MBG = Ungrazed Mesquite–Blue Grama Open Shrubland
G/MBG = Grazed Mesquite–Blue Grama Open Shrubland
B/SVG = Barren or Sparsely-Vegetated Ground
G/BBG = Grazed Blue Grama–Buffalo Grass Grassland
U/BBG = Ungrazed Blue Grama–Buffalo Grass Grassland

Table 7. Wildlife species, numbers observed, estimated site densities (numbers per hectare), and mean habitat densities within the Sandsage–New Mexico Needlegrass Shrubland habitat type, Melrose Air Force Range, Clovis, NM.

Species Name	Site 1 No. Observed	Site 1 Density (No./Ha)	Site 2 No. Observed	Site 2 Density (No./Ha)	Mean Density
MAMMALS					
Silky pocket mouse	2	0.58	1	0.14	0.36
Plains pocket mouse	1	0.29	1	0.14	0.22
Ord's kangaroo rat	1	0.29	2	0.28	0.28
Northern grasshopper mouse	3	0.87	1	0.14	0.50
Spotted ground squirrel	3	0.87	0	0.00	0.44
BIRDS					
Eastern meadowlark	4	0.32	3	0.24	0.28
Morning dove	1	0.08	4	0.32	0.20
Common nighthawk	0	0.00	1	0.08	0.04
REPTILES					
Western rattlesnake	0	0.00	1	5.00	2.50

Table 8. Wildlife species, numbers observed, estimated site densities (numbers per hectare), and mean habitat densities within the Alkali Sacaton–Common Rush Grassland habitat type, Melrose Air Force Range, Clovis, NM.

Species Name	Site 1 No. Observed	Site 1 Density (No./Ha)	Site 2 No. Observed	Site 2 Density (No./Ha)	Mean Density
MAMMALS					
Hispid pocket mouse	1	0.14	0	0.00	0.07
Ord's kangaroo rat	3	0.42	0	0.00	0.21
Northern grasshopper mouse	1	0.14	0	0.00	0.07
Western harvest mouse	1	0.14	0	0.00	0.07
BIRDS					
Western meadowlark	5	0.40	5	0.40	0.40
Morning dove	1	0.08	0	0.00	0.04
Common nighthawk	0	0.00	2	0.16	0.08
Western kingbird	2	0.16	0	0.00	0.08
Loggerhead shrike	1	0.08	0	0.00	0.08
Chipping sparrow	1	0.08	0	0.00	0.08
Barn swallow	1	0.08	0	0.00	0.08
REPTILES					
None observed	0	0.00	0	0.00	0.00

Table 9. Wildlife species, numbers observed, estimated site densities (numbers per hectare), and mean habitat densities within the New Mexico Needlegrass–Soapweed Yucca Grassland habitat type, Melrose Air Force Range, Clovis, NM.

Species Name	Site 1 No. Observed	Site 1 Density (No./Ha)	Site 2 No. Observed	Site 2 Density (No./Ha)	Mean Density
MAMMALS					
Silky pocket mouse	3	0.86	1	0.29	0.58
Hispid pocket mouse	0	0.00	4	1.16	0.58
Ord's kangaroo rat	6	1.73	0	0.00	0.86
Northern grasshopper mouse	3	0.86	4	1.16	1.01
Spotted ground squirrel	1	0.29	0	0.00	0.15
BIRDS					
Western meadowlark	2	0.16	0	0.00	0.08
Morning dove	2	0.16	1	0.08	0.12
Chipping sparrow	0	0.00	1	0.08	0.04
REPTILES					
Eastern fence lizard	0	0.00	1	5.00	2.50
Western box turtle	1	5.00	0	0.00	2.50

Table 10. Wildlife species, numbers observed, estimated site densities (numbers per hectare), and mean habitat densities within the Recent/Current Agricultural Fields habitat type, Melrose Air Force Range, Clovis, NM.

Species Name	Site 1 No. Observed	Site 1 Density (No./Ha)	Site 2 No. Observed	Site 2 Density (No./Ha)	Mean Density
MAMMALS					
Silky pocket mouse	1	0.28	0	0.00	0.14
Hispid pocket mouse	0	0.00	1	0.54	0.27
Ord's kangaroo rat	12	3.21	11	6.04	4.62
Northern grasshopper mouse	0	0.00	2	1.10	0.55
Spotted ground squirrel	14	3.74	1	0.54	2.14
BIRDS					
Eastern meadowlark	1	0.08	0	0.00	0.04
REPTILES					
Texas horned lizard	0	0.00	1	5.00	2.50
Great Plains skink	2	10.00	2	10.00	10.00
Many-lined skink	1	5.00	0	0.00	2.50
Lesser earless lizard	1	5.00	0	0.00	2.50

Table 11. Wildlife species, numbers observed, estimated site densities (numbers per hectare), and mean habitat densities within the Ungrazed Mesquite–Blue Grama Open Shrubland habitat type, Melrose Air Force Range, Clovis, NM.

Species Name	Site 1 No. Observed	Site 1 Density (No./Ha)	Site 2 No. Observed	Site 2 Density (No./Ha)	Mean Density
MAMMALS					
Silky pocket mouse	2	1.91	2	0.28	1.10
Hispid pocket mouse	5	4.77	0	0.00	2.38
Plains wood rat	2	1.91	0	0.00	0.95
Northern grasshopper mouse	0	0.00	3	0.42	0.21
Thirteen-lined ground squirrel	0	0.00	1	0.14	0.07
BIRDS					
Scaled quail	1	0.08	0	0.00	0.04
Lark Bunting	12	0.96	0	0.00	0.48
Swainson's hawk	1	0.08	0	0.00	0.04
REPTILES					
Texas horned lizard	1	5.00	1	5.0	5.00
Six-lined racerunner	1	5.00	1	5.0	5.00

Table 12. Wildlife species, numbers observed, estimated site densities (numbers per hectare), and mean habitat densities within the Grazed Mesquite–Blue Grama Open Shrubland habitat type, Melrose Air Force Range, Clovis, NM.

Species Name	Site 1 No. Observed	Site 1 Density (No./Ha)	Site 2 No. Observed	Site 2 Density (No./Ha)	Mean Density
MAMMALS					
Silky pocket mouse	3	0.86	2	1.43	1.14
Hispid pocket mouse	3	0.86	1	0.71	0.78
Plains harvest mouse	1	0.29	0	0.00	0.14
Northern grasshopper mouse	2	0.58	3	2.14	1.36
Spotted ground squirrel	0	0.00	1	0.71	0.35
Plains wood rat	0	0.00	2	1.43	0.72
BIRDS					
Eastern meadowlark	6	0.48	1	0.08	0.28
Lark sparrow	2	0.16	0	0.00	0.08
Chipping sparrow	4	0.32	2	0.16	0.24
Lark bunting	0	0.00	12	0.96	0.48
Common nighthawk	0	0.00	1	0.08	0.04
REPTILES					
Six-lined racerunner	0	0.00	1	5.00	2.50
Lesser earless lizard	0	0.00	1	5.00	2.50
Great Plains skink	1	5.00	0	0.00	2.50

Table 13. Wildlife species, numbers observed, estimated site densities (numbers per hectare), and mean habitat densities within the Barren or Sparsely Vegetated Ground habitat type, Melrose Air Force Range, Clovis, NM.

Species Name	Site 1 No. Observed	Site 1 Density (No./Ha)	Site 2 No. Observed	Site 2 Density (No./Ha)	Mean Density
MAMMALS					
Silky pocket mouse	2	0.28	4	0.57	0.42
Spotted ground squirrel	3	0.42	2	0.28	0.35
BIRDS					
Eastern meadowlark	1	0.08	1	0.08	0.08
Lark sparrow	1	0.08	0	0.00	0.04
Lark bunting	6	0.48	0	0.00	0.24
Western flycatcher	1	0.08	0	0.00	0.04
Swainson's hawk	1	0.08	0	0.00	0.04
REPTILES					
Texas horned lizard	2	10.00	0	0.00	5.00

Table 14. Wildlife species, numbers observed, estimated site densities (numbers per hectare), and mean habitat densities within the Grazed Blue Grama–Buffalo Grass Grassland habitat type, Melrose Air Force Range, Clovis, NM.

Species Name	Site 1 No. Observed	Site 1 Density (No./Ha)	Site 2 No. Observed	Site 2 Density (No./Ha)	Mean Density
MAMMALS					
Silky pocket mouse	2	0.28	2	0.28	0.28
Thirteen-lined ground squirrel	1	0.14	4	0.56	0.35
BIRDS					
Horned lark	6	0.48	0	0.00	0.24
REPTILES					
Texas horned lizard	1	5.00	0	0.00	2.50

Table 15. Wildlife species, numbers observed, estimated site densities (numbers per hectare), and mean habitat densities within the Ungrazed Blue Grama–Buffalo Grass Grassland habitat type, Melrose Air Force Range, Clovis, NM.

Species Name	Site 1 No. Observed	Site 1 Density (No./Ha)	Site 2 No. Observed	Site 2 Density (No./Ha)	Mean Density
MAMMALS					
Northern grasshopper mouse	1	0.14	0	0.00	0.07
Thirteen-lined ground squirrel	2	0.28	2	0.28	0.28
BIRDS					
Eastern meadowlark	1	0.08	1	0.08	0.08
Cactus wren	1	0.08	0	0.00	0.04
Horned lark	0	0.00	1	0.08	0.04
Lark bunting	0	0.00	8	0.64	0.32
Scaled quail	0	0.00	12	0.96	0.48
REPTILES					
Western box turtle	1	5.00	1	5.00	5.00

IV. Literature Cited

Anderson, D. R., K. P. Burnham, G. C. White, and D. L. Otis. 1983. Density estimation of small-mammal populations using a trapping web and distance sampling methods. Ecology, 64:674-680.

Buckland, S. T., D. R. Anderson, K. P. Burnham, and J. L. Laake. 1993. Distance sampling. Estimating abundance of biological populations. Chapman and Hall, New York, 446 pp.

Burnham, K. P., and D. R. Anderson. 1992. Data-based selection of an appropriate biological model: the key to modern data analysis. Pp. 16-30, *in* Wildlife 2001: Populations (D. R. McCullough and R. H. Barrett, eds.). Elsevier Science Publishers, London.

Degenhardt, W.G., C. W. Painter, and A. H. Price. 1996. Amphibians and reptiles of New Mexico. University of New Mexico Press, Albuquerque. 431 pp.

Findley, J. S., A. H. Harris, D. E. Wilson, and C. Jones. 1975. Mammals of New Mexico. University of New Mexico Press, Albuquerque. 360 pp.

Hubbard, J.P. 1978. Revised check-list of the birds of New Mexico. New Mexico Ornithological Society Publication No. 6., Albuquerque. 110 pp.

Laake, J. L., S. T. Buckland, D. R. Anderson, and K. P. Burnham. 1993. DISTANCE User's Guide V2.0. Colorado Cooperative Fish & Wildlife Research Unit, Colorado State University, Fort Collins, 72 pp.

Lillesand, T. M. and R. W. Kiefer. 1987. Remote Sensing and Image Interpretation, 2nd Ed. 721 pp.

Mueller-Dombois, D., and H. Ellenberg. 1974. Aims and methods of vegetation ecology. J. Wiley and Sons, New York, NY.

Parmenter, R. R., J. A. MacMahon, and D. R. Anderson. 1989. Animal density estimation using a trapping web design: Field validation experiments. Ecology, 70:169-179.

Parmenter, R. R., E. Muldavin, T. L. Yates, J. N. Stuart, G. H. Farley, and T. Maddux. 1994. A Biological Survey of Melrose Air Force Range, Melrose, New Mexico. Final Report, Contract No. M6700491D0010, Biological Studies/Surveys of Department of Defense Lands. 205 pp. plus map.

Robbins, C.S., D. Bystrak and P.H. Geissler. 1986. The breeding bird survey: its first fifteen years, 1965-1979. U.S. Department of the Interior, Fish and Wildlife Service, Resource Publication 157, Washington D.C. 196 pp.

Wickland, D. E. 1991. Mission to Planet Earth: The ecological perspective. Ecology, 72:1923-1933.

Wilson, K. R., and D. R. Anderson. 1985. Evaluation of a density estimator on a trapping web and distance sampling theory. Ecology, 66:1185-1194.

Appendix 1. Plant Species list for Melrose Air Force Range Vegetation Map. Names follow Soil Conservation Service 1994 Plants species names database for New Mexico. Acronyms are seven letter codes of the first three letters of the genus and speciesnames plus a tie breaker as they occur in the NMNHP databse.

Common Name	Scientific Name	Family	Acronym
SHRUBS			
Broom stakeweed	Gutierrezia sarothrae (Pursh) Britt.& Rusby	Asteraceae	GUTSAR
featherplume	Dalea formosa Torr.	Fabaceae	DALFOR
gilia beardtongue	Penstemon ambiguus Torr.	Scrophulariaceae	PENAMB
honey mesquite	Prosopis glandulosa Torr.	Fabaceae	PROGLA
pricklypear spp.	Opuntia spp.P. Mill.	Cactaceae	OPUNTI
rabbitbrush spp.	Chrysothamnus sp. Nutt.	Asteraceae	CHRYSO
sand sagebrush	Artemisia filifolia Torr.	Asteraceae	ARTFIL
seepwillow	Baccharis salicifolia (Ruiz & Pavon) Pers.	Asteraceae	BACSAL
soaptree yucca	Yucca glauca Nutt.	Agavaceae	YUCGLA
southwestern rabbitbrush	Chrysothamnus pulchellus(Gray) Greene	Asteraceae	CHRPUL
Torrey's jointfir	Ephedra torreyana S. Wats.	Ephedraceae	EPHTOR
tree cholla	Opuntia imbricata (Haw.) DC.	Cactaceae	OPUIMB
tulip pricklypear	Opuntia phaeacantha Engelm.	Cactaceae	OPUPHA
GRASSES			
alkali sacaton	Sporobolus airoides (Torr.) Torr.	Poaceae	SPOAIR
Australian beardgrass	Bothriochloa bladhii (Retz.) S.T. Blake	Poaceae	BOTBLA
big bluestem	Andropogon gerardiiVitman	Poaceae	ANDGER
black grama	Bouteloua eriopoda (Torr.) Torr.	Poaceae	BOUERI
blue grama	Bouteloua gracilis (Willd. ex Kunth) Lag. ex Griffiths	Poaceae	BOUGRA
bristlegrass spp.	Setaria spp.Beauv.	Poaceae	SETARI
buffalograss	Buchloe dactyloides (Nutt.) Engelm.	Poaceae	BUCDAC
common rush	Juncus effususL.	Juncaceae	JUNEFF
common wolfstail	Lycurus setosa (Nutt.)C.Reeder	Poaceae	LYCSET
ear muhly	Muhlenbergia arenacea (Buckl.) Hitchc.	Poaceae	MUHARE1
false buffalograss	Munroa squarrosa (Nutt.) Torr.	Poaceae	MUNSQU
flatsedge spp.	Cyperus spp. L.	Cyperaceae	CYPERU
gummy lovegrass	Eragrostis curtipedicellata Buckl.	Poaceae	ERACUR
hairy grama	Bouteloua hirsuta Lag.	Poaceae	BOUHIR
hairy woollygrass	Erioneuron pilosum(Buckl.) Nash	Poaceae	ERIPIL
Havard's threeawn	Aristida havardii Vasey	Poaceae	ARIHAV
little bluestem	Schizachyrium scoparium(Michx.) Nash	Poaceae	SCHSCO
lovegrass spp.	Eragrostis spp. von Wolf	Poaceae	ERAGRO
mesa dropseed	Sporobolus flexuosus (Thurb.) Rydb.	Poaceae	SPOFLE
muhly spp.	Muhlenbergia spp. Schreb.	Poaceae	MUHLEN
needlegrass spp.	Stipa spp. L.	Poaceae	STIPA
New Mexico needlegrass	Stipa neomexicana (Thurb.) Scribn.	Poaceae	STINEO
panicgrass spp.	Panicum spp. (depauperate)L.	Poaceae	PANICU
purple threeawn	Aristida purpurea Nutt.	Poaceae	ARIPUR
red lovegrass	Eragrostis secundiflora J. Presl	Poaceae	ERASEC

Appendix 1. Plant Species list for Melrose Air Force Range Vegetation Map (continued).

Common Name	Scientific Name	Family	Acronym
ring muhly	Muhlenbergia torreyi (Kunth) Hitch. ex Bush	Poaceae	MUHTOR
sand dropseed	Sporobolus cryptandrus (Torr.) Gray	Poaceae	SPOCRY
sand muhly	Muhlenbergia arenicola Buckl.	Poaceae	MUHARE2
sedge spp.	Carex spp. L.	Cyperaceae	CAREX
sideoats grama	Bouteloua curtipendula (Michx.) Torr.	Poaceae	BOUCUR
silver beardgrass	Bothriochloa laguroides (DC.) Herter	Poaceae	BOTLAG
slim tridens	Tridens muticus (Torr.) Nash	Poaceae	TRIMUT
threeawn spp.	Aristida spp. L.	Poaceae	ARISTI
tobosagrass	Hilaria mutica (Buckl.) Benth.	Poaceae	HILMUT
tumble lovegrass	Eragrostis sessilispica Buckl.	Poaceae	ERASES
tumble windmill grass	Chloris verticillata Nutt.	Poaceae	CHLVER
tumblegrass	Schedonnardus paniculatus (Nutt.) Trel.	Poaceae	SCHPAN
vine mesquite	Panicum obtusum Kunth	Poaceae	PANOBT
windmill grass spp.	Chloris spp. Sw.	Poaceae	CHLORI
witchgrass	Panicum capillare L.	Poaceae	PANCAP
FORBS			
beeblossom spp.	Gaura spp. L.	Onagraceae	GAURA
beehive cactus spp.	Escobaria spp. Britt. & Rose	Cactaceae	ESCOBA
bladderpod spp.	Lesquerella spp. S. Wats.	Brassicaceae	LESQUE
broadleaf milkweed	Asclepias latifolia (Torr.)Raf.	Asclepiadaceae	ASCLAT
buckwheat spp.	Eriogonum spp. Michx.	Polygonaceae	ERIOGO
bush morningglory	Ipomoea leptophylla Torr.	Convolvulaceae	IPOLEP
catseye	Cryptantha spp. Lehm. ex G. Don	Boraginaceae	CRYPTA
common purslane	Portulaca oleracea L.	Portulacaceae	POROLE
dayflower spp.	Commelina spp. L.	Commelinaceae	COMMEL
Fendler's bladderpod	Lesquerella fendleri(Gray) S. Wats.	Brassicaceae	LESFEN
feverplant spp.	Tribulus spp. L.	Zygophyllaceae	TRIBUL
flax spp.	Linum spp. L.	Linaceae	LINUM
fleabane spp.	Erigeron spp. L.	Asteraceae	ERIGER
gaillardia spp.	Gaillardia spp. Foug.	Asteraceae	GAILLA
globemallow spp.	Sphaeralcea spp. St.-Hil.	Malvaceae	SPHAER
groundsel spp.	Senecio spp. L.	Asteraceae	SENECI
hedgehog cactus spp.	Echinocereus spp. Engelm.	Cactaceae	ECHINO2
hogweed spp.	Portulaca spp. L.	Portulacaceae	PORTUL1
Jame's holdback	Caesalpinia jamesii (Torr. & Gray) Fisher	Fabaceae	CAEJAM
mentzelia spp.	Mentzelia spp. L.	Loasaceae	MENTZE
milkvetch spp.	Astragalus spp. L.	Fabaceae	ASTRAG
milkweed	Asclepias spp. (depauperate)L.	Asclepiadaceae	ASCLEP
Missouri gourd	Cucurbita foetidissima Kunth	Cucurbitaceae	CUCFOE
morningglory spp.	Ipomoea spp. L.	Convolvulaceae	IPOMOE
nightshade spp.	Solanum spp.L.	Solanaceae	SOLANU
plains blackfoot	Melampodium leucanthum Torr. & Gray	Asteraceae	MELLEU
plains ironweed	Vernonia marginata (Torr.) Raf.	Scrophulariaceae	VERMAR

Appendix 1. Plant Species list for Melrose Air Force Range Vegetation Map (continued).

Common Name	Scientific Name	Family	Acronym
prairie spiderwort	Tradescantia occidentalis (Britt.) Symth	Commelinaceae	TRAOCC
prickly Russian thistle	Salsola kali L.	Chenopodiaceae	SALKAL
ragweed spp.	Ambrosia spp. L.	Asteraceae	AMBROS
Rocky Mountain zinnia	Zinnia grandiflora Nutt.	Asteraceae	ZINGRA
rushpea spp.	Hoffmannseggia spp. Cav.	Fabaceae	HOFFMA
spectacle pod	Dimorphocarpa wislizeni (Engelm.) Rollins	Brassicaceae	DIMWIS
spinystar	Escobaria vivipara (Nutt.) Buxbaum	Cactaceae	ESCVIV
spurge spp.	Chamaesyce spp. (depauperate) S.F. Gray	Euphorbiaceae	CHASPP
spurge spp.	Euphorbia spp. L.	Euphorbiaceae	EUPHOR1
stemmy hymenoxys	Tetraneuris scaposa (DC.) Greene	Asteraceae	TETSCA
sundrops spp.	Calylophus spp. Spach	Onagraceae	CALYLO
thistle spp.	Cirsium spp. (depauperate) P. Mill.	Asteraceae	CIRSIU
vervain spp.	Verbena spp. L.	Verbenaceae	VERBEN
whitemouth dayflower	Commelina erecta L.	Commelinaceae	COMERE
woolly paperflower	Psilostrophe tagetina (Nutt.) Greene	Asteraceae	PSITAG
yellowspine thistle	Cirsium ochrocentrum Gray	Asteraceae	CIROCH
zinnia spp.	Zinnia spp. L.	Asteraceae	ZINNIA

Appendix 2. Melrose Air Force Range Vegetation Communities Summary Table. Constancy and average relative cover per community type for all species.

No. Plots	Table Acronym	Community Type Common Name
1	AFBG	sand sagebrush/blue grama
10	AFBH	sand sagebrush/hairy grama
3	AFSN	sand sagebrush/New Mexico needlegrass
8	BLBC	silver beardgrass-sideoats grama
4	BLBG	silver beardgrass-blue grama
2	BLBH	silver beardgrass-hairy grama
2	BGBE	blue grama-black grama
1	BGAP	blue grama-purple threeawn
1	BGBC	blue grama-sideoats grama
88	BGBD	blue grama-buffalograss
3	BGBDDT	blue grama-buffalograss/dogtown
1	BGPO	blue grama-vine mesquite
3	BGYG	blue grama/soaptree yucca
3	BHBC	hairy grama-sideoats grama
2	BHBGYG	hairy grama-blue grama/soaptree yucca
8	BHDF	hairy grama/featherplume
13	BHYG	hairy grama/soaptree yucca
2	BDMT	buffalograss-monotypic stand
2	BDYG	buffalograss/soaptree yucca
1	DTWL	Well
6	ESYG	tumble lovegrass/soaptree yucca
3	HMBG	tobosagrass-blue grama
2	JESA	common rush-alkali sacaton
7	PGBG	honey mesquite/blue grama
4	PGBGBD	honey mesquite/blue grama-buffalograss
1	PGSF	honey mesquite/mesa dropseed
1	PGTM	honey mesquite/treatment
2	SSYG	little bluestem/soaptree yucca
2	SAEG	alkali sacaton-lovegrass spp.
2	SCBC	sand dropseed-sideoats grama
11	SCYG	sand dropseed-soaptree yucca
6	SNYG	New Mexico needlegrass/soaptree yucca

Melrose Vegetation Community Summary Table

Plant Association Acronym:	AFBG		AFBH		AFSN		BDMT		BDYG	
Cover(COV)/Constancy(CON):	COV	CON	COV	CON	COV	CON	COV	CON	COV	CON
Artemisia filifolia	18	100	8	82	18	100				
Baccharis salicifolia										
Chrysothamnus pulchellus										
Chrysothamnus sp.			8	9	<1	33				
Dalea formosa										
Ephedra torreyana										
Gutierrezia sarothrae	<1	100	3	27						
Opuntia imbricata									<1	50
Opuntia spp.										
Opuntia phaeacantha			<1	9	<1	33			<1	100
Penstemon ambiguus										
Prosopis glandulosa			<1	27						
Yucca glauca			5	82	3	33			2	100
Andropogon gerardii			<1	9	<1	33				
Aristida havardii									<1	50
Aristida purpurea			8	9	8	67				
Aristida spp.	<1	100	3	73	8	33			3	50
Bothriochloa bladhii										
Bothriochloa laguroides									<1	50
Bouteloua curtipendula			4	18					<1	50
Bouteloua eriopoda										
Bouteloua gracilis	8	100							<1	50
Bouteloua hirsuta	<1	100	13	82	3	33				
Buchloe dactyloides			<1	9			42	100	18	100
Carex spp.										
Chloris spp.	<1	100	3	9						
Chloris verticillata									<1	50
Cyperus spp.										
Eragrostis curtipedicellata										
Eragrostis spp.			<1	18						
Eragrostis secundiflora			3	9						
Eragrostis sessilispica			3	18						
Erioneuron pilosum										
Hilaria mutica									<1	50
Juncus effusus										
Lycurus setosa			<1	9					8	50
Muhlenbergia arenacea			<1	9	4	67				
Muhlenbergia arenicola										
Muhlenbergia spp.			2	18					3	50
Muhlenbergia torreyi										
Munroa squarrosa										
Panicum capillare										
Panicum spp. (depauperate)										
Panicum obtusum										
Schedonnardus paniculatus										
Schizachyrium scoparium			13	55	<1	100				
Setaria spp.										
Sporobolus airoides										
Sporobolus cryptandrus	8	100	5	45	3	33			<1	50
Sporobolus flexuosus										
Stipa neomexicana					4	100				
Stipa spp.										

Melrose Vegetation Community Summary Table

Plant Association Acronym:	AFBG		AFBH		AFSN		BDMT		BDYG	
Cover(COV)/Constancy(CON):	COV	CON	COV	CON	COV	CON	COV	CON	COV	CON
Tridens muticus										
Ambrosia spp.			3	9	3	33				
Asclepias latifolia					<1	67				
Asclepias spp. (depauperate)										
Asteraceae										
Astragalus spp.					<1	33				
Boraginaceae										
Caesalpinia jamesii										
Calylophus spp.					3	33				
Chamaesyce spp. (depauperate)										
Cirsium ochrocentrum									<1	50
Cirsium spp. (depauperate)										
Commelina erecta			3	9						
Commelina spp.										
Cryptantha spp.					3	33				
Cucurbita foetidissima										
Dimorphocarpa wislizeni					<1	33				
Echinocereus spp.										
Erigeron spp.										
Eriogonum spp.					3	33				
Escobaria spp.										
Escobaria vivipara										
Euphorbia spp.					<1	33				
Gaillardia spp.					<1	33				
Gaura spp.			2	45	2	100				
Hoffmannseggia spp.					<1	33				
Ipomoea leptophylla			3	18	3	33				
Ipomoea spp.										
Lesquerella fendleri										
Lesquerella spp.										
Linum spp.					<1	33				
Melampodium leucanthum										
Mentzelia spp.			<1	9	1	100			<1	50
Nyctaginaceae										
Onagraceae										
Portulaca oleracea										
Portulaca spp.										
Psilostrophe tagetina			<1	9	<1	33				
Salsola kali					<1	33				
Senecio spp.										
Solanum spp.									<1	50
Sphaeralcea spp.										
Tetraneuris scaposa										
Tradescantia occidentalis					3	33				
Tribulus sp.										
Verbena spp.										
Vernonia marginata										
Zinnia grandiflora										
Zinnia spp.										

Melrose Vegetation Community Summary Table

Plant Association Acronym:	BGAP		BGBC		BGBD		BGBDDT		BGBE	
Cover(COV)/Constancy(CON):	COV	CON	COV	CON	COV	CON	COV	CON	COV	CON
Artemisia filifolia					4	2				
Baccharis salicifolia										
Chrysothamnus pulchellus					2	2				
Chrysothamnus sp.										
Dalea formosa										
Ephedra torreyana										
Gutierrezia sarothrae					<1	6				
Opuntia imbricata					<1	48	<1	50		
Opuntia spp.										
Opuntia phaeacantha	<1	50			<1	20	<1	25		
Penstemon ambiguus										
Prosopis glandulosa			<1	100	3	23				
Yucca glauca	<1	50			<1	60		50	<1	100
Andropogon gerardii										
Aristida havardii										
Aristida purpurea					<1	9	18	25		
Aristida spp.	18	50	5	100	2	31	3	25	3	100
Bothriochloa bladhii										
Bothriochloa laguroides					<1	8				
Bouteloua curtipendula			18	100	6	6				
Bouteloua eriopoda					2	15			18	100
Bouteloua gracilis	18	50	10	100	18	76	2	50	18	100
Bouteloua hirsuta					2	3				
Buchloe dactyloides					11	76	10	50	<1	100
Carex spp.										
Chloris spp.										
Chloris verticillata					<1	3				
Cyperus spp.										
Eragrostis curtipedicellata										
Eragrostis spp.										
Eragrostis secundiflora										
Eragrostis sessilispica										
Erioneuron pilosum					<1	<1				
Hilaria mutica					5	31				
Juncus effusus										
Lycurus setosa					<1	<1				
Muhlenbergia arenacea										
Muhlenbergia arenicola	18	50			3	<1				
Muhlenbergia spp.					<1	12	<1	25		
Muhlenbergia torreyi					<1	<1				
Munroa squarrosa					1	5	<1	50		
Panicum capillare					<1	<1				
Panicum spp. (depauperate)					<1	<1				
Panicum obtusum					1	5				
Schedonnardus paniculatus					<1	<1	<1	25		
Schizachyrium scoparium										
Setaria spp.										
Sporobolus airoides	<1	50								
Sporobolus cryptandrus					1	23				
Sporobolus flexuosus										
Stipa neomexicana	<1	50								
Stipa spp.					<1	<1				

Melrose Vegetation Community Summary Table

Plant Association Acronym:	BGAP		BGBC		BGBD		BGBDDT		BGBE	
Cover(COV)/Constancy(CON):	COV	CON	COV	CON	COV	CON	COV	CON	COV	CON
Tridens muticus			3	50	3	<1				
Ambrosia spp.										
Asclepias latifolia					<1	2				
Asclepias spp. (depauperate)										
Asteraceae										
Astragalus spp.										
Boraginaceae										
Caesalpinia jamesii										
Calylophus spp.										
Chamaesyce spp. (depauperate)					<1	4				
Cirsium ochrocentrum	3	50			<1	26	<1	25	<1	100
Cirsium spp. (depauperate)			<1	50	<1	3				
Commelina erecta										
Commelina spp.										
Cryptantha spp.										
Cucurbita foetidissima										
Dimorphocarpa wislizeni										
Echinocereus spp.					<1	3				
Erigeron spp.					<1	<1				
Eriogonum spp.					<1	<1				
Escobaria spp.					<1	<1				
Escobaria vivipara					<1	<1				
Euphorbia spp.										
Gaillardia spp.										
Gaura spp.					<1	10				
Hoffmannseggia spp.										
Ipomoea leptophylla										
Ipomoea spp.										
Lesquerella fendleri										
Lesquerella spp.										
Linum spp.										
Melampodium leucanthum					<1	<1				
Mentzelia spp.					3	<1				
Nyctaginaceae					<1	<1				
Onagraceae										
Portulaca oleracea										
Portulaca spp.					<1	2				
Psilostrophe tagetina					<1	6				
Salsola kali										
Senecio spp.					<1	3				
Solanum spp.					<1	46			<1	100
Sphaeralcea spp.					<1	16				
Tetraneuris scaposa					<1	<1				
Tradescantia occidentalis										
Tribulus sp.					<1	3				
Verbena spp.					<1	2				
Vernonia marginata					<1	2				
Zinnia grandiflora					<1	<1				
Zinnia spp.										

Melrose Vegetation Community Summary Table

Plant Association Acronym:	BGPO		BGYG		BHBC		BHBGYG		BHDF	
Cover(COV)/Constancy(CON):	COV	CON	COV	CON	COV	CON	COV	CON	COV	CON
Artemisia filifolia			3	25	3	17	<1	50		
Baccharis salicifolia										
Chrysothamnus pulchellus									<1	10
Chrysothamnus sp.										
Dalea formosa					<1	17			3	80
Ephedra torreyana									<1	30
Gutierrezia sarothrae			<1	25	<1	50	10	100		
Opuntia imbricata										
Opuntia spp.										
Opuntia phaeacantha					<1	17				
Penstemon ambiguus										
Prosopis glandulosa			<1	25	8	17	1	100		
Yucca glauca	<1	100	<1	25	<1	67	3	100	2	30
Andropogon gerardii										
Aristida havardii										
Aristida purpurea					5	33			8	20
Aristida spp.	3	100	3	25	4	50	3	50	3	60
Bothriochloa bladhii										
Bothriochloa laguroides					<1	17				
Bouteloua curtipendula			3	25	11	83			6	80
Bouteloua eriopoda					18	17	3	100		
Bouteloua gracilis	18	100	3	25	3	33	18	100		
Bouteloua hirsuta			<1	25	13	83	18	100	14	80
Buchloe dactyloides							3	50		
Carex spp.										
Chloris spp.			<1	25			<1	50		
Chloris verticillata										
Cyperus spp.										
Eragrostis curtipedicellata			<1	25	3	17				
Eragrostis spp.							3	50		
Eragrostis secundiflora										
Eragrostis sessilispica										
Erioneuron pilosum					<1	17				
Hilaria mutica	<1	100								
Juncus effusus										
Lycurus setosa										
Muhlenbergia arenacea										
Muhlenbergia arenicola										
Muhlenbergia spp.	<1	100								
Muhlenbergia torreyi										
Munroa squarrosa										
Panicum capillare										
Panicum spp. (depauperate)										
Panicum obtusum	8	100	<1	25						
Schedonnardus paniculatus										
Schizachyrium scoparium									<1	10
Setaria spp.										
Sporobolus airoides										
Sporobolus cryptandrus			<1	25					<1	10
Sporobolus flexuosus										
Stipa neomexicana					<1	17			6	40
Stipa spp.										

Melrose Vegetation Community Summary Table

Plant Association Acronym:	BGPO		BGYG		BHBC		BHBGYG		BHDF	
Cover(COV)/Constancy(CON):	COV	CON	COV	CON	COV	CON	COV	CON	COV	CON
Tridens muticus	3	100							<1	10
Ambrosia spp.										
Asclepias latifolia										
Asclepias spp. (depauperate)										
Asteraceae			3	25					<1	20
Astragalus spp.										
Boraginaceae										
Caesalpinia jamesii										
Calylophus spp.										
Chamaesyce spp. (depauperate)										
Cirsium ochrocentrum					<1	33	<1	50	<1	30
Cirsium spp. (depauperate)										
Commelina erecta										
Commelina spp.										
Cryptantha spp.										
Cucurbita foetidissima										
Dimorphocarpa wislizeni										
Echinocereus spp.										
Erigeron spp.										
Eriogonum spp.										
Escobaria spp.										
Escobaria vivipara										
Euphorbia spp.										
Gaillardia spp.			<1	25						
Gaura spp.			<1	25	<1	33			<1	20
Hoffmannseggia spp.										
Ipomoea leptophylla										
Ipomoea spp.										
Lesquerella fendleri										
Lesquerella spp.	<1	100								
Linum spp.										
Melampodium leucanthum					<1	17				
Mentzelia spp.										
Nyctaginaceae										
Onagraceae									<1	10
Portulaca oleracea										
Portulaca spp.										
Psilostrophe tagetina										
Salsola kali										
Senecio spp.										
Solanum spp.							<1	50		
Sphaeralcea spp.			<1	25	<1	17				
Tetraneuris scaposa					1	33			2	50
Tradescantia occidentalis										
Tribulus sp.										
Verbena spp.	<1	100								
Vernonia marginata										
Zinnia grandiflora	<1	100								
Zinnia spp.			3	25						

Melrose Vegetation Community Summary Table

Plant Association Acronym:	BHYG		BLBC		BLBG		BLBH		DTWL	
Cover(COV)/Constancy(CON):	COV	CON	COV	CON	COV	CON	COV	CON	COV	CON
Artemisia filifolia	2	56					3	33		
Baccharis salicifolia										
Chrysothamnus pulchellus	3	6								
Chrysothamnus sp.										
Dalea formosa										
Ephedra torreyana										
Gutierrezia sarothrae	3	28	<1	29						
Opuntia imbricata			<1	14	<1	25				
Opuntia spp.										
Opuntia phaeacantha	<1	6	<1	14	<1	50				
Penstemon ambiguus	<1	6								
Prosopis glandulosa	<1	6		29					<1	100
Yucca glauca	5	56	<1	71	<1	75	2	100	<1	100
Andropogon gerardii										
Aristida havardii	<1	6								
Aristida purpurea	6	33	2	29	3	25				
Aristida spp.	5	22	<1	29	3	25	<1	67		
Bothriochloa bladhii			8	14						
Bothriochloa laguroides	<1	6	4	100	21	75	18	67		
Bouteloua curtipendula	<1	28	27	100			<1	33		
Bouteloua eriopoda	3	6								
Bouteloua gracilis	3	6	3	14	8	100			<1	100
Bouteloua hirsuta	14	56	3	14			11	100		
Buchloe dactyloides	2	17	<1	43	9	75				
Carex spp.										
Chloris spp.	<1	6								
Chloris verticillata	<1	6			<1	25				
Cyperus spp.	<1	6								
Eragrostis curtipedicellata	3	6			<1	25				
Eragrostis spp.	<1	6								
Eragrostis secundiflora	5	33								
Eragrostis sessilispica	8	22								
Erioneuron pilosum										
Hilaria mutica					<1	25				
Juncus effusus										
Lycurus setosa	3	6								
Muhlenbergia arenacea	3	22								
Muhlenbergia arenicola										
Muhlenbergia spp.	<1	6			<1	25				
Muhlenbergia torreyi							5	67		
Munroa squarrosa										
Panicum capillare										
Panicum spp. (depauperate)	<1	6								
Panicum obtusum					<1	25				
Schedonnardus paniculatus										
Schizachyrium scoparium	<1	17	<1	14						
Setaria spp.										
Sporobolus airoides										
Sporobolus cryptandrus	2	39					8	33		
Sporobolus flexuosus										
Stipa neomexicana	<1	6								
Stipa spp.										

Melrose Vegetation Community Summary Table

Plant Association Acronym:	BHYG		BLBC		BLBG		BLBH		DTWL	
Cover(COV)/Constancy(CON):	COV	CON	COV	CON	COV	CON	COV	CON	COV	CON
Tridens muticus										
Ambrosia spp.										
Asclepias latifolia			<1	14						
Asclepias spp. (depauperate)										
Asteraceae										
Astragalus spp.										
Boraginaceae										
Caesalpinia jamesii	<1	6								
Calylophus spp.	<1	6								
Chamaesyce spp. (depauperate)			<1	29	<1	25				
Cirsium ochrocentrum	<1	17	<1	71	<1	50	<1	67		
Cirsium spp. (depauperate)			<1	14						
Commelina erecta										
Commelina spp.	<1	17								
Cryptantha spp.										
Cucurbita foetidissima			<1	14						
Dimorphocarpa wislizeni	<1	6								
Echinocereus spp.										
Erigeron spp.										
Eriogonum spp.										
Escobaria spp.										
Escobaria vivipara										
Euphorbia spp.										
Gaillardia spp.										
Gaura spp.	3	39	<1	57	<1	25				
Hoffmannseggia spp.										
Ipomoea leptophylla										
Ipomoea spp.	3	17								
Lesquerella fendleri										
Lesquerella spp.										
Linum spp.										
Melampodium leucanthum	<1	17	<1	14	<1	25				
Mentzelia spp.			<1	14						
Nyctaginaceae										
Onagraceae										
Portulaca oleracea										
Portulaca spp.										
Psilostrophe tagetina	<1	17								
Salsola kali										
Senecio spp.			<1	29						
Solanum spp.			<1	14			<1	33	<1	100
Sphaeralcea spp.			<1	14						
Tetraneuris scaposa										
Tradescantia occidentalis										
Tribulus sp.			8	14						
Verbena spp.										
Vernonia marginata										
Zinnia grandiflora										
Zinnia spp.										

Melrose Vegetation Community Summary Table

Plant Association Acronym:	ESYG		HMBG		JESA		PGBG		PGBGBD	
Cover(COV)/Constancy(CON):	COV	CON	COV	CON	COV	CON	COV	CON	COV	CON
Artemisia filifolia	2	83								
Baccharis salicifolia										
Chrysothamnus pulchellus										
Chrysothamnus sp.										
Dalea formosa										
Ephedra torreyana										
Gutierrezia sarothrae										
Opuntia imbricata			<1	75			<1	11		
Opuntia spp.			<1	25						
Opuntia phaeacantha	<1	17			<1	50				
Penstemon ambiguus	<1	17								
Prosopis glandulosa							8	56	15	100
Yucca glauca	3	100	<1	25					5	50
Andropogon gerardii										
Aristida havardii										
Aristida purpurea	<1	17								
Aristida spp.	3	83					<1	11	<1	25
Bothriochloa bladhii										
Bothriochloa laguroides					18	50				
Bouteloua curtipendula	2	83					<1	11		
Bouteloua eriopoda							1	44	9	75
Bouteloua gracilis			14	75			16	56	15	100
Bouteloua hirsuta	<1	33								
Buchloe dactyloides			3	25					8	100
Carex spp.	<1	17								
Chloris spp.										
Chloris verticillata	<1	17								
Cyperus spp.										
Eragrostis curtipedicellata	1	33								
Eragrostis spp.										
Eragrostis secundiflora	<1	33								
Eragrostis sessilispica	5	100								
Erioneuron pilosum										
Hilaria mutica			34	75						
Juncus effusus					29	100				
Lycurus setosa	<1	17								
Muhlenbergia arenacea	3	83								
Muhlenbergia arenicola									<1	25
Muhlenbergia spp.										
Muhlenbergia torreyi										
Munroa squarrosa							<1	22		
Panicum capillare					18	50				
Panicum spp. (depauperate)										
Panicum obtusum			<1	25	18	100				
Schedonnardus paniculatus										
Schizachyrium scoparium										
Setaria spp.										
Sporobolus airoides					35	100				
Sporobolus cryptandrus	2	83					3	22		
Sporobolus flexuosus			3	25						
Stipa neomexicana										
Stipa spp.										

Melrose Vegetation Community Summary Table

Plant Association Acronym:	ESYG		HMBG		JESA		PGBG		PGBGBD	
Cover(COV)/Constancy(CON):	COV	CON	COV	CON	COV	CON	COV	CON	COV	CON
Tridens muticus										
Ambrosia spp.										
Asclepias latifolia										
Asclepias spp. (depauperate)										
Asteraceae										
Astragalus spp.										
Boraginaceae	<1	17								
Caesalpinia jamesii										
Calylophus spp.										
Chamaesyce spp. (depauperate)										
Cirsium ochrocentrum			<1	25	<1	100				
Cirsium spp. (depauperate)										
Commelina erecta										
Commelina spp.										
Cryptantha spp.										
Cucurbita foetidissima										
Dimorphocarpa wislizeni	<1	50								
Echinocereus spp.										
Erigeron spp.										
Eriogonum spp.										
Escobaria spp.										
Escobaria vivipara										
Euphorbia spp.										
Gaillardia spp.										
Gaura spp.	1	33								
Hoffmannseggia spp.										
Ipomoea leptophylla	<1	17								
Ipomoea spp.										
Lesquerella fendleri										
Lesquerella spp.										
Linum spp.										
Melampodium leucanthum	<1	17								
Mentzelia spp.										
Nyctaginaceae										
Onagraceae	<1	17								
Portulaca oleracea	8	17								
Portulaca spp.										
Psilostrophe tagetina					<1	50				
Salsola kali										
Senecio spp.										
Solanum spp.			<1	50	<1	50			<1	25
Sphaeralcea spp.			<1	25						
Tetraneuris scaposa										
Tradescantia occidentalis										
Tribulus sp.										
Verbena spp.										
Vernonia marginata										
Zinnia grandiflora	<1	33								
Zinnia spp.										

Melrose Vegetation Community Summary Table

Plant Association Acronym:	PGSF		SAEG		SCBC		SCYG		SNYG	
Cover(COV)/Constancy(CON):	COV	CON	COV	CON	COV	CON	COV	CON	COV	CON
Artemisia filifolia	3	100					4	36	<1	17
Baccharis salicifolia									<1	17
Chrysothamnus pulchellus										
Chrysothamnus sp.							<1	7		
Dalea formosa									1	33
Ephedra torreyana										
Gutierrezia sarothrae	<1	100					1	14		
Opuntia imbricata			<1	100						
Opuntia spp.										
Opuntia phaeacantha			<1	100					<1	33
Penstemon ambiguus							<1	14		
Prosopis glandulosa	8	100								
Yucca glauca					<1	25	5	50	4	50
Andropogon gerardii										
Aristida havardii										
Aristida purpurea							18	7	2	33
Aristida spp.	3	100			<1	25	3	43	3	17
Bothriochloa bladhii										
Bothriochloa laguroides										
Bouteloua curtipendula					5	50	<1	21	<1	17
Bouteloua eriopoda										
Bouteloua gracilis									5	33
Bouteloua hirsuta							<1	21		
Buchloe dactyloides										
Carex spp.										
Chloris spp.										
Chloris verticillata										
Cyperus spp.										
Eragrostis curtipedicellata										
Eragrostis spp.										
Eragrostis secundiflora										
Eragrostis sessilispica	<1	100					<1	21		
Erioneuron pilosum										
Hilaria mutica										
Juncus effusus										
Lycurus setosa										
Muhlenbergia arenacea	<1	100					6	21		
Muhlenbergia arenicola										
Muhlenbergia spp.										
Muhlenbergia torreyi										
Munroa squarrosa										
Panicum capillare			<1	50	<1	50				
Panicum spp. (depauperate)										
Panicum obtusum										
Schedonnardus paniculatus										
Schizachyrium scoparium					<1	25	<1	21	<1	17
Setaria spp.	<1	100								
Sporobolus airoides			30	100						
Sporobolus cryptandrus					10	50	5	43	<1	17
Sporobolus flexuosus	3	100					5	14		
Stipa neomexicana									33	50
Stipa spp.										

Melrose Vegetation Community Summary Table

Plant Association Acronym:	PGSF		SAEG		SCBC		SCYG		SNYG	
Cover(COV)/Constancy(CON):	COV	CON	COV	CON	COV	CON	COV	CON	COV	CON
Tridens muticus										
Ambrosia spp.									3	17
Asclepias latifolia										
Asclepias spp. (depauperate)									<1	17
Asteraceae										
Astragalus spp.										
Boraginaceae							<1	7		
Caesalpinia jamesii										
Calylophus spp.										
Chamaesyce spp. (depauperate)										
Cirsium ochrocentrum			<1	100	<1	25	<1	7	<1	33
Cirsium spp. (depauperate)							<1	7		
Commelina erecta									<1	17
Commelina spp.							<1	36		
Cryptantha spp.										
Cucurbita foetidissima										
Dimorphocarpa wislizeni			<1	50			<1	29	<1	17
Echinocereus spp.										
Erigeron spp.										
Eriogonum spp.										
Escobaria spp.										
Escobaria vivipara										
Euphorbia spp.										
Gaillardia spp.										
Gaura spp.							<1	29	<1	17
Hoffmannseggia spp.										
Ipomoea leptophylla							<1	7		
Ipomoea spp.										
Lesquerella fendleri			<1	100						
Lesquerella spp.									<1	17
Linum spp.										
Melampodium leucanthum									<1	17
Mentzelia spp.							<1	14	<1	50
Nyctaginaceae										
Onagraceae							<1	7		
Portulaca oleracea										
Portulaca spp.										
Psilostrophe tagetina			<1	50			<1	7	<1	33
Salsola kali			<1	100					<1	17
Senecio spp.										
Solanum spp.			<1	100	<1	25	<1	7	<1	17
Sphaeralcea spp.										
Tetraneuris scaposa										
Tradescantia occidentalis										
Tribulus sp.										
Verbena spp.										
Vernonia marginata										
Zinnia grandiflora	<1	100					3	21		
Zinnia spp.										

Melrose Vegetation Community Summary Table

Plant Association Acronym: SSYG Cover(COV)/Constancy(CON):	COV	CON	COV	CON
Artemisia filifolia	8	50		
Baccharis salicifolia				
Chrysothamnus pulchellus				
Chrysothamnus sp.				
Dalea formosa				
Ephedra torreyana				
Gutierrezia sarothrae	<1	50		
Opuntia imbricata				
Opuntia spp.				
Opuntia phaeacantha				
Penstemon ambiguus	<1	50		
Prosopis glandulosa				
Yucca glauca	3	100		
Andropogon gerardii	<1	50		
Aristida havardii				
Aristida purpurea				
Aristida spp.	3	100		
Bothriochloa bladhii				
Bothriochloa laguroides				
Bouteloua curtipendula	3	50		
Bouteloua eriopoda				
Bouteloua gracilis				
Bouteloua hirsuta				
Buchloe dactyloides				
Carex spp.				
Chloris spp.				
Chloris verticillata				
Cyperus spp.				
Eragrostis curtipedicellata				
Eragrostis spp.				
Eragrostis secundiflora				
Eragrostis sessilispica	1	100		
Erioneuron pilosum				
Hilaria mutica				
Juncus effusus				
Lycurus setosa				
Muhlenbergia arenacea	<1	50		
Muhlenbergia arenicola				
Muhlenbergia spp.				
Muhlenbergia torreyi				
Munroa squarrosa				
Panicum capillare				
Panicum spp. (depauperate)				
Panicum obtusum	<1	50		
Schedonnardus paniculatus				
Schizachyrium scoparium	5	100		
Setaria spp.				
Sporobolus airoides				
Sporobolus cryptandrus				
Sporobolus flexuosus	<1	100		
Stipa neomexicana				
Stipa spp.				

Melrose Vegetation Community Summary Table

Plant Association Acronym: SSYG				
Cover(COV)/Constancy(CON):	COV	CON	COV	CON
Tridens muticus				
Ambrosia spp.				
Asclepias latifolia				
Asclepias spp. (depauperate)				
Asteraceae	<1	50		
Astragalus spp.				
Boraginaceae	<1	50		
Caesalpinia jamesii				
Calylophus spp.				
Chamaesyce spp. (depauperate)				
Cirsium ochrocentrum				
Cirsium spp. (depauperate)				
Commelina erecta				
Commelina spp.	<1	100		
Cryptantha spp.				
Cucurbita foetidissima				
Dimorphocarpa wislizeni	<1	50		
Echinocereus spp.				
Erigeron spp.				
Eriogonum spp.				
Escobaria spp.				
Escobaria vivipara				
Euphorbia spp.				
Gaillardia spp.				
Gaura spp.	<1	100		
Hoffmannseggia spp.				
Ipomoea leptophylla	<1	50		
Ipomoea spp.				
Lesquerella fendleri				
Lesquerella spp.				
Linum spp.				
Melampodium leucanthum				
Mentzelia spp.				
Nyctaginaceae				
Onagraceae				
Portulaca oleracea				
Portulaca spp.				
Psilostrophe tagetina				
Salsola kali				
Senecio spp.				
Solanum spp.				
Sphaeralcea spp.				
Tetraneuris scaposa				
Tradescantia occidentalis				
Tribulus sp.				
Verbena spp.				
Vernonia marginata				
Zinnia grandiflora				
Zinnia spp.				

APPENDIX 3. LIST OF MAMMALS OF THE MELROSE AIR FORCE RANGE AND VICINITY, ROOSEVELT AND CURRY COUNTIES, NEW MEXICO.

(P) = Present [specimen(s) collected/observed on MAFR].
(V) = Vicinity of MAFR [specimen(s) collected/observed in vicinity of MAFR].
(NO) = Not observed, but likely to be on, or in vicinity of, MAFR.

MARSUPIALS

Didelphis virginiana, Virginia opossum (NO)

SHREWS
Cryptotis parva, Least shrew (NO)
Notiosorex crawfordii, Desert shrew (NO)

BATS

Myotis velifer, Cave myotis (NO)
Lasionycteris noctivagans, Silver-haired bat (NO)
Pipistrellus hesperus, Western pipistrelle (NO)
Antrozous pallidus, Pallid bat (NO)
Tadarida brasiliensis, Brazilian free-tailed bat (NO)

HARES AND RABBITS

Sylvilagus audubonii, Desert cottontail (P)
Lepus californicus, Black-tailed jackrabbit (P)

RODENTS

Spermophilus spilosoma, Spotted ground squirrel (P)
Spermophilus tridecemlineatus, Thirteen-lined ground squirrel (P)
Cynomys ludovicianus, Black-tailed prairie dog (P)
Geomys bursarius, Plains pocket gopher (P)
Pappogeomys castanops, Yellow-faced pocket gopher (P)
Perognathus flavescens, Plains pocket mouse (V)
Perognathus flavus, Silky pocket mouse (P)
Chaetodipus hispidus, Hispid pocket mouse (P)
Dipodomys ordii, Ord's kangaroo rat (P)
Dipodomys spectabilis, Banner-tailed kangaroo rat (P)
Reithrodontomys megalotis, Western harvest mouse (NO)
Reithrodontomys montanus, Plains harvest mouse (P)
Peromyscus leucopus, White-footed mouse (P)
Peromyscus maniculatus, Deer mouse (P)
Peromyscus nasutus (NO)
Onychomys leucogaster, Northern grasshopper mouse (P)

APPENDIX 3 (Continued). LIST OF MAMMALS OF THE MELROSE AIR FORCE RANGE AND VICINITY, ROOSEVELT AND CURRY COUNTIES, NEW MEXICO.

(P) = Present [specimen(s) collected/observed on MAFR].
(V) = Vicinity of MAFR [specimen(s) collected/observed in vicinity of MAFR].
(NO) = Not observed, but likely to be on, or in vicinity of, MAFR.

RODENTS (Continued)

Sigmodon hispidus, Hispid cotton rat (P)
Neotoma micropus, Southern plains woodrat (P)
Mus musculus, House mouse (NO)
Erethizon dorsatum, Porcupine (P)

CARNIVORES

Canis latrans, Coyote (P)
Vulpes velox, Swift fox (V)
Vulpes vulpes, Red fox (NO)
Bassariscus astutus, Ringtail (NO)
Mustela frenata, Long-tailed weasel (V)
Taxidea taxus, Badger (P)
Mephitis mephitis, Striped skunk (P)
Felix rufus, Bobcat (NO)

UNGULATES

Odocoileus hemionus, Mule deer (P)
Odocoileus virginianus, White-tailed deer (V)
Antilocapra americana, Pronghorn (P)

APPENDIX 4. SPECIES LIST OF BIRDS OF THE MELROSE AIR FORCE RANGE AND VICINITY, ROOSEVELT AND CURRY COUNTIES, NEW MEXICO.

R = Resident – species lives on site year-round.
B = Breeder – breeds on site, but migrates off site during non-breeding season.
M = Migrant – passes through site during Spring and/or Fall migration.
W = Winter-resident – present on site only during winter and non-breeding season.
(* = species of special interest, i.e., uncertain population trends)

IBIS

White-faced ibis *Plegadis chihi* (M) *

HAWKS, FALCONS etc.

Turkey vulture, *Cathartes aura* (M)
Northern harrier, *Circus cyaneus* (R, W)
Swainson's hawk, *Buteo swainsoni* (B)
Red-tailed hawk, *Buteo jamaicensis* (W)
Ferruginous hawk, *Buteo regalis* (R) *
Golden eagle, *Aquila chrysaetos* (R)
American kestrel, *Falco sparverius* (R, W)
Prairie falcon, *Falco mexicanus* (R)

QUAIL

Scaled quail, *Callipepla squamata* (R)

PLOVERS and SANDPIPERS

Killdeer, *Charadrius vociferus* (R, B)
Greater yellowlegs, *Tringa melanoleuca* (M)
Solitary sandpiper, *Tringa solitaria* (M)
Spotted sandpiper, *Actitis macularia* (M)
Long-billed curlew, *Numenius americanus* (B) *
Baird's sandpiper, *Calidris bairdii* (M)

DOVES

Mourning dove, *Zenaida macroura* (R)

CUCKOOS

Greater roadrunner, *Geococcyx californianus* (R)

APPENDIX 4 (Continued). LIST OF BIRDS OF THE MELROSE AIR FORCE RANGE AND VICINITY, ROOSEVELT AND CURRY COUNTIES, NEW MEXICO.

R = Resident – species lives on site year-round.
B = Breeder – breeds on site, but migrates off site during non-breeding season.
M = Migrant – passes through site during Spring and/or Fall migration.
W = Winter-resident – present on site only during winter and non-breeding season.
(* = species of special interest, i.e., uncertain population trends)

OWLS

Barn owl, *Tyto alba* (R, B)
Great-horned owl, *Bufo virginianus* (R, W)
Burrowing owl, *Athene cunicularia* (B)

NIGHTJARS

Common nighthawk, *Chordeiles acutipennis* (B)

HUMMINGBIRDS

Black-chinned hummingbird, *Archilochus alexandri* (M)

WOODPECKERS

Ladder-backed woodpecker, *Picoides scalaris* (R)
Northern flicker, *Colaptes auratus* (R)

FLYCATCHERS

Western wood-pewee, *Contopus sordidulus* (M)
Willow flycatcher, *Empidonax traillii* (M) *
Say's phoebe, *Sayornis saya* (B)
Western kingbird, *Tyrannus verticalis* (B)

LARKS

Horned lark, *Eremophila alpestris* (R, W)

SWALLOWS

Cliff swallow, *Hirundo pyrrhonota* (M)
Barn swallow, *Hirundo rustica* (B)

JAYS AND CROWS

White-necked raven, *Corvus cryptoleucus* (R)

APPENDIX 4 (Continued). LIST OF BIRDS OF THE MELROSE AIR FORCE RANGE AND VICINITY, ROOSEVELT AND CURRY COUNTIES, NEW MEXICO.

R = Resident – species lives on site year-round.
B = Breeder – breeds on site, but migrates off site during non-breeding season.
M = Migrant – passes through site during Spring and/or Fall migration.
W = Winter-resident – present on site only during winter and non-breeding season.
(* = species of special interest, i.e., uncertain population trends)

WRENS

Cactus wren, *Campylorhynchus brunneicapillus* (R)
Canyon wren, *Catherpes mexicanus* (R)
Rock wren, *Salpinctes obsoletus* (R)

THRASHERS

Northern mockingbird, *Mimus polyglottos* (B)
Curve-billed thrasher, *Toxostoma curvirostre* (R)

SHRIKES

Loggerhead shrike, *Lanius ludovicianus* (R, W) *

SPARROWS

Cassin's sparrow, *Aimophila cassinii* (B)
Brewer's sparrow, *Spizella breweri* (B)
Vesper sparrow, *Pooecetes gramineus* (B, W)
Lark sparrow, *Chondestes grammacus* (B)
Lark bunting, *Calamospiza melanocorys* (R, W)
White-crowned sparrow, *Zonotrichia leucophrys* (W)
Chestnut-collared longspur, *Calcarius ornatus* (W)
McCown's longspur, *Calcarius mccownii* (W) *

BLACKBIRDS

Eastern meadowlark, *Sturnella magna* (B)
Western meadowlark, *Sturnella neglecta* (R)
Brown-headed cowbird, *Molothrus ater* (B)
Northern oriole, *Icterus galbula* (B)

OLD WORLD SPARROWS

House sparrow, *Passer domesticus* (R)

APPENDIX 5. LIST OF REPTILES OF THE MELROSE AIR FORCE RANGE AND VICINITY, ROOSEVELT AND CURRY COUNTIES, N.M.

(P) = Present [specimen(s) collected/observed on MAFR].
(V) = Vicinity of MAFR [specimen(s) collected/observed in vicinity of MAFR].
(A) = Aquatic habitats near MAFR [but unlikely to occur on MAFR].
(NO) = Not observed, but likely to be on, or in vicinity of, MAFR.

TURTLES

Chelydra serpentina, Snapping turtle (A)
Kinosternon flavescens, Yellow mud turtle (P)
Chrysemys picta, Painted turtle (A)
Terrapene ornata, Ornate box turtle (P)

LIZARDS

Cnemidophorus sexlineatus, Six-lined racerunner (P)
Crotaphytus collaris, Collared lizard (P)
Eumeces multivirgatus, Many-lined skink (P)
Eumeces obsoletus, Great Plains skink (P)
Holbrookia maculata, Lesser earless lizard (P)
Phrynosoma cornutum, Texas horned lizard (P)
Phrynosoma douglassi, Short-horned lizard (P)
Phrynosoma modestum, Round-tailed horned lizard (NO)
Sceloporus undulatus, Prairie lizard (P)
Uta stansburiana, Side-blotched lizard (V)

SNAKES

Arizona elegans, Glossy snake (P)
Coluber constrictor, Racer (NO)
Crotalus atrox, Western diamondback rattlesnake (NO)
Crotalus viridis, Western rattlesnake (P)
Diadophis punctatus, Ringneck snake (P)
Elaphe guttata, Corn snake (NO)
Heterodon nasicus, Western hognose snake (P)
Hypsiglena torquata, Night snake (NO)
Lampropeltis getula, Common kingsnake (V)
Lampropeltis triangulum, Milk snake (NO)
Leptotyphlops dulcis, Texas blind snake (NO)
Masticophis flagellum, Coachwhip (P)
Pituophis melanoleucus, Bullsnake (V)
Rhinocheilus lecontei, Long-nosed snake (NO)
Sonora semiannulata, Ground snake (NO)
Sistrurus catenatus, Massassauga (NO)
Tantilla nigriceps, Plains blackhead snake (P)
Thamnophis marcianus, Checkered garter snake (V)