UNITED STATES FISH AND WILDLIFE SERVICE
LAS VEGAS NATIONAL WILDLIFE REFUGE
VEGETATION MAP
LAS VEGAS, NEW MEXICO

Final Report

Submitted to:

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Introduction

A map of the current vegetation distribution of Las Vegas National Wildlife Refuge (LVNWR) was produced by Earth Data Analysis Center (EDAC) in association with the New Mexico Natural Heritage Program (NMNHP) at the University of New Mexico (UNM). The map was developed using computer analysis of high-resolution digital ortho-photography and Landsat Thematic Mapper (TM) satellite imagery.

Ground survey vegetation data were gathered in late summer and fall of 1999 and these data provided the basis for the development of map units appropriate for use at a 1:24,000 scale. The mapping methodology is described below along with brief descriptions of each map unit provided in Appendix A. The map is available in both digital and hard-copy formats. The vegetation map provides a baseline on the spatial distribution of native vegetation communities and areas of potential concern where weedy non-native and native plants are abundant or appear to be increasing. The mapped information can be used to assist in the long-term management goals of the refuge to maintain and restore native environments and provide staging habitats for migratory birds.

Study Area

Location & Landscape

Las Vegas National Wildlife Refuge is located approximately 10 km (6 mi.) southeast of Las Vegas, New Mexico in San Miguel County and encompasses approximately 3,556 ha. (8,787 acres)[1]. The refuge lies east of the Sangre de Cristo Mountains and within the Great Plains Province of eastern New Mexico (Hawley 1986). The refuge is mostly an open, broad plain with an average elevation of 1,980 m. (6,500 ft.), but it is bounded by steep, forested canyons on the east, south, and west. Vegosa Creek roughly bounds the eastern edge of the refuge and the Gallinas River bounds the western edge. They both meet to the south creating 150 m. (500 ft.) of relief to the south. This is the western edge of the Canadian Escarpment, which separates the more mesic grasslands of the New Mexico High Plains from the more xeric Llano Estacado to the south.

This region receives 350 mm. (14 in.) of rain, most of it from convective thundershowers during the summer. Snow can occur from November to May with usually not more than 100 mm. (4 in.) of accumulation at any time. Temperatures can range from as low as -23°C (-9°F) in the winter to as high as 33°C (92°F) in the summer.

[1] Throughout this report, area is derived from the Geographic Information System (GIS).

The refuge was established in 1965 as a wintering and staging area for migratory birds and is managed by the U.S. Fish and Wildlife Service. Since 1966, 271 bird species have been recorded, including shorebirds, neotropical migrants and raptors which represent the range of wetland, grassland and montane habitats present within the refuge (USFWS, 1995). Because the refuge is on the central flyway, it is an important wintering site for large numbers of sandhill cranes, geese and eagles. The mix of montane and grassland habitats support other wildlife species such as antelope, mule deer, bobcats, badgers and coyotes.

The natural landscape of the refuge is a grassy, rolling plain with deep, loamy soil. This landscape has been heavily modified by past agricultural practices, which have introduced noxious weeds and changed the soil composition. Playa lakes that dot this plain have deep, impermeable clay basins. Towards the cliffs, the soils become shallow with numerous rock outcrops of Mesozoic sandstone and shale (Hilley et al. 1981). In these areas, conifer woodlands and forests are found.

Several playa lake depressions within the refuge have been altered to provide continuous supplies of water for wildlife. The playas are fed through irrigation canals with water from Storrie Lake to the northwest. The largest of these impoundments is McAllister Lake, containing approximately 71 ha. (191 acres), although this is managed by the New Mexico Department of Game & Fish. Active agriculture still occurs on the refuge through cooperation with local farmers where some of the crops are left for the wildlife. Grazing is also allowed and is managed by rotating the cattle through 5 pastures on a fifteen-month cycle.

Materials and Methods

Data Sources

Satellite Imagery

Landsat Thematic Mapper (TM) satellite imagery was one of the data sets used to map the natural vegetation for the study area. The TM scene used for the project was acquired over the area on 3 September, 1993, by the Landsat 5 platform. It was imported into ERDAS Imagine (Version 8.3) where all raster processing and analyses were accomplished. The TM scene was of good quality with no clouds, cirrus or scan line defects.

The satellite imagery, with its stable sensor platform, is relatively easy to geometrically correct to the known coordinate system of a base map. The height of the sensor above the earth (705 km. for Landsat) negates most parallax problems, commonly found in 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, 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 at specific wavelengths, which can then be statistically analyzed to develop a vegetation map of spectrally similar plant communities.

Landsat TM, with six spectral bands and one thermal band, has the highest spectral discrimination among commercially available space-based sensors. Each band represents a specific range of light wavelength (Table 1). 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 in developing mapping units of the vegetation communities in sparsely vegetated areas that occur on the refuge.

TM integrates the spectral characteristics of each band over the Instantaneous Field of View (IFOV) of an area 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.

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
1	0.45-0.52	Blue visible
2	0.52-0.60	Green visible
3	0.63-0.69	Red visible
4	0.76-0.90	Near-infrared
5	1.55-1.75	Mid-infrared
6	10.4-12.5	Thermal Infrared
7	2.08-2.35	Mid-infrared

Aerial Photography

Black and white aerial photographs were acquired over this area under the National Aerial Photography Program (NAPP) on 29 September, 1997. The photographs were ortho-rectified and used in an analysis of spatial variability in the landscape (explained below).

Ancillary Map Coverages

In addition to the above data sources, four vector files in ARC/INFO (7.2.1) format were created to aid map development. These include coverages for boundaries, roads, elevation contours, and landuse.

The boundary coverage was digitized using a combination of the U.S. Geological Survey (USGS) 1:24,000 Digital Raster Graphics (DRG) and map sheets provided by the Las Vegas NWR office. The roads were digitized principally using the aerial photography since the USGS Digital Line Graphs (DLG) did not sufficiently represent the current road network. Drainages and irrigation canals were also digitized from the air photo.

A USGS Digital Elevation Model (DEM) with a spatial resolution of 30m x 30m was processed and geometrically referenced to the coordinate system listed above. These data were used to ortho-rectify the aerial photography and processed to create elevation contours to identify geomorphic position and provide general terrain reference.

The refuge office also provided a map of the land ownership prior to acquisition by the U.S. Fish and Wildlife Service. Land ownership is useful in determining past land uses, such as grazing or agriculture, which can influence the composition and structure of present plant communities. Agricultural fields were digitized based on the aerial photograph. Agricultural fields, roads, and past landuse designations were used to fine-tune the vegetation classification since misclassification can result in areas that are not considered a ‘vegetation class’.

Image Processing

Geometric Correction

The TM scene 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 these images was 0.98 pixel error (or approximately 28 m). The images were projected into the New Mexico State Plane, Zone 4726, using the 1983 North American Datum and the Geodetic Reference Spheroid 1980.

Radiometric Correction

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 that 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 header. The effect of these deviations on the original data can be modeled as:

$$L = (DN * Gain) + Offset \quad (Eq. 1)$$

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

Table 2. Gains and offsets used to radiometrically calibrate 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

Normalized Difference Vegetation Index

The Normalized Difference Vegetation Index (NDVI) enhances vigorous vegetation over other major surface features. It is believed that this enhancement helps to emphasize vegetation response patterns in the classification over soil responses. The NDVI also allows quick assessment of class signatures: for example, riparian areas should have a higher NDVI response than senescent grasslands.

The Normalized Difference Vegetation Index (NDVI) was created using Equation 2 and added to the file.

$$NDVI = (TM4 - TM3) / (TM4 + TM3) \quad (Eq. 2)$$

Where **TM4** is the near infrared TM band and **TM3** is the visible red TM band.

Panchromatic Aerial Photo Processing

The two NAPP air photos were scanned at 1 meter (3 ft.) pixel resolution and ortho-rectified using the USGS DEM for elevation control and the USGS DRG for ground reference. Ortho-rectification is a process that uses a terrain model to take out parallax and other distortions to correct the photos to a planimetric grid[2]. Specifically, ortho-rectification takes the known geometry of the lens and camera system and compares these to the known geometry on the ground based on the DEM and DRG through a set of co-linear equations. Once a set of co-linear equations fall within a small enough RMS_{Error}, the resulting

[2] New Mexico State Plane projection, Zone 4726, using the 1983 North American Datum and the 1980 Geodetic Reference Spheroid.

equation is used to model the geometric distortion in the x, y, and z plane. This results in a photo that is planimetrically correct even across severe terrain changes.

Once ortho-rectified, the photos were mosaicked together. There was very little contrast difference between the photos; therefore, we were able to use the photos as another data set for the classification. The obvious advantage to using this data in the classification procedure is the one-meter spatial resolution. Additionally, the photography enhanced the differences between native vegetation and highly disturbed sites.

Variance Filter

It is expected that different vegetation types will have different spatial patterns. For example, a juniper/wavy-leaf oak community might have a lot of spatial variation due to changes in image response representing the mixed tree, shrub, and sparse grass components of this landscape, whereas a ponderosa pine/little bluestem community, with its nearly closed canopy forest will have less variation in response. Variance filters enhance different variance responses on different landscapes with little discernable evidence of the photograph frame boundaries.

A variance filter was applied to the aerial photographs using the below equation:

$$V = \sum(DN - \mu)^2 / 9 \quad \text{(Eq. 3)}$$

where **V** is the resulting variance, **DN** is the image value, and μ is the average value for the 3 x 3 filter kernel.

Software and Hardware Used

ERDAS Imagine, Version 8.3, was the principal software used throughout the mapping process. All digital imagery and GIS coverages were processed, manipulated, and used as overlays for analysis within the Imagine environment. The ERDAS Imagine software was loaded on a PC using an NT operating system. Arc/Info, Version 7.2.1, and ArcView 3.1 were used to create, import, and manipulate vector coverages. Microsoft Excel, Version 2.0 was used to store and manipulate all field data. Trimble's GeoExplorers were used to collect GPS data in the field.

Mapping Strategy

Ground Survey Data

The mapping process used here is dependent on ground vegetation survey data to develop the map. A set of eighty-eight (88) vegetation plots was collected from the study area on September 3-4, September 21-22, and November 17, 1999. To ensure a wide coverage of the study area for mapping purposes, potential field plot locations were initially determined using aerial photography interpretation and an unsupervised image classification (see Image Classification below) of the range of patch types. Sampling was directed towards large polygons of uniform spectral characteristics distributed throughout the study area.

Plot data included noting the major vegetation community, collection of unidentified plants, general comments that include qualitative condition of the plant community, regularly repeated forbs, geomorphic position, and aspect, where relevant. Plots were placed in the center of stands of more or less uniform vegetation representing the dominant vegetation type of the selected polygon. Stands were a minimum of 1 ha in size, with the exception of stands that are limited in size, such as disturbances along drainages.

A Global Positioning System (GPS) was used to record the plot locations necessary for use in the image analysis. GPS positions were collected using Trimble Geoexplorers. No attempt was made to differentially correct the data since a ± accuracy of 100 meters (300 feet) was considered acceptable for plant community typing.

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. A supervised classification strategy was adopted to create the vegetation map based on vegetation community types of Las Vegas NWR. This strategy develops spectral classes based on ground locations with known characteristics such as vegetation composition and landscape context.

In a supervised classification strategy, the field data is applied to the image data 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:

$$SD = \sqrt{\sum(\mu - X)^2}$$

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 image band, and X is the spectral value of the new pixel for each 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 that 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 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 values.

Supervised Classification

Statistics gathered in the seeding process were used to perform a supervised classification. Supervised classifications are based on a maximum likelihood decision rule that contains a Bayesian classifier that 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:

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

where **D** is the weighted distance, $\mathbf{cov_c}$ is the covariance matrix for a particular class, $\mathbf{X}$ is the measurement vector of the pixel, $\mathbf{M_c}$ is the mean vector of the class and ^{T} is the matrix transpose function (ERDAS 1997). 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 blue grama/buffalo grass community which might be fairly heterogeneous, to a water class, which is more homogeneous.

To locate problems, informal accuracy checking was used based on field data, air photos, personal knowledge of a site and other ancillary data. If a distribution problem with a seed was detected, the seed was rechecked to insure it was properly modeling the vegetation type and landscape. This preliminary map had as many map classes as seeds used to develop it.

RESULTS

Map Units

The seed map classes were aggregated into a limited number of Mapping Units (MU's) for the final map (Figure 1). Mapping Units are grouped together based on floristic composition, landscape position, spatial contiguity and spectral similarity; i.e., 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 that was continued until all seed classes were grouped into the most consistent and accurate mapping units

Twenty map units were defined (Table 3) that include four forest and woodlands, eight grasslands, and three wetlands, all which represent a general vegetation community type. For the most part, these community types correspond to the New Mexico Natural Heritage's (NMNHP) plant community classification database. The NMNHP classifies communities based on a combination of the dominant perennial vegetation, substrate and landscape position. There are also five miscellaneous cover classes which represent planted vegetation (Agricultural Fields and Roadside Tree classes) or non-vegetative land cover types (Barren and Surface Water classes). A 'Herbaceous

Disturbance' class was created to identify the distribution of disturbance-dependent plants such as sweetclover, sunflower, thistle, and bindweed and other weedy vegetation of interest to the refuge.

Detailed descriptions of each map unit are provided in Appendix A. The dominant plant communities included within the map unit are provided as well as communities that are considered *inclusions* within the mapping unit. The communities designated as *inclusions* were either too small to differentiate into separate mapping units or are considered to have enough similar elements of the dominant plant communities represented by the mapping unit.

There are seven grassland units. Grasslands dominate the refuge and cover large expanses on the mesas and lowlands surrounding the impoundments. The dominant grassland units are blue grama and bottlebrush squirreltail. The grasslands are native communities with the exception of introduced species that include beardless wheatgrass and smooth brome. Some of the native grasslands may have been planted for reclamation purposes and many have been replaced by agricultural fields that are principally located on the eastern side of the refuge. Agricultural fields currently in production are estimated to cover 265 ha (655 acres).

There are four wetland units, some of which include obligate wetland species such as cattails, rushes, and sedges. Inland saltgrass and alkali muhly are the dominant wetland and playa grasses. Wet areas along ditches and canals have a variety of non-native plants and are identified in the classification as Herbaceous Wetlands. Bottlebrush squirreltail appeared to be very adaptive to both the drier mesa grasslands and saturated lowlands of the Herbaceous Wetlands.

Forest and woodlands ring the refuge along the escarpment of the Gallinas River and Vegosa Creek. Four forest and woodland units were identified. An effort was made to include highly disturbed areas in the classification for the purposes of identifying disturbance-dependent plants such as sweetclover, sunflower, thistle, and bindweed; these are included in the unit Herbaceous Disturbance. The remaining units represent various land cover types such as barren, surface water, agricultural fields, and tree groves.

Final Vegetation Map

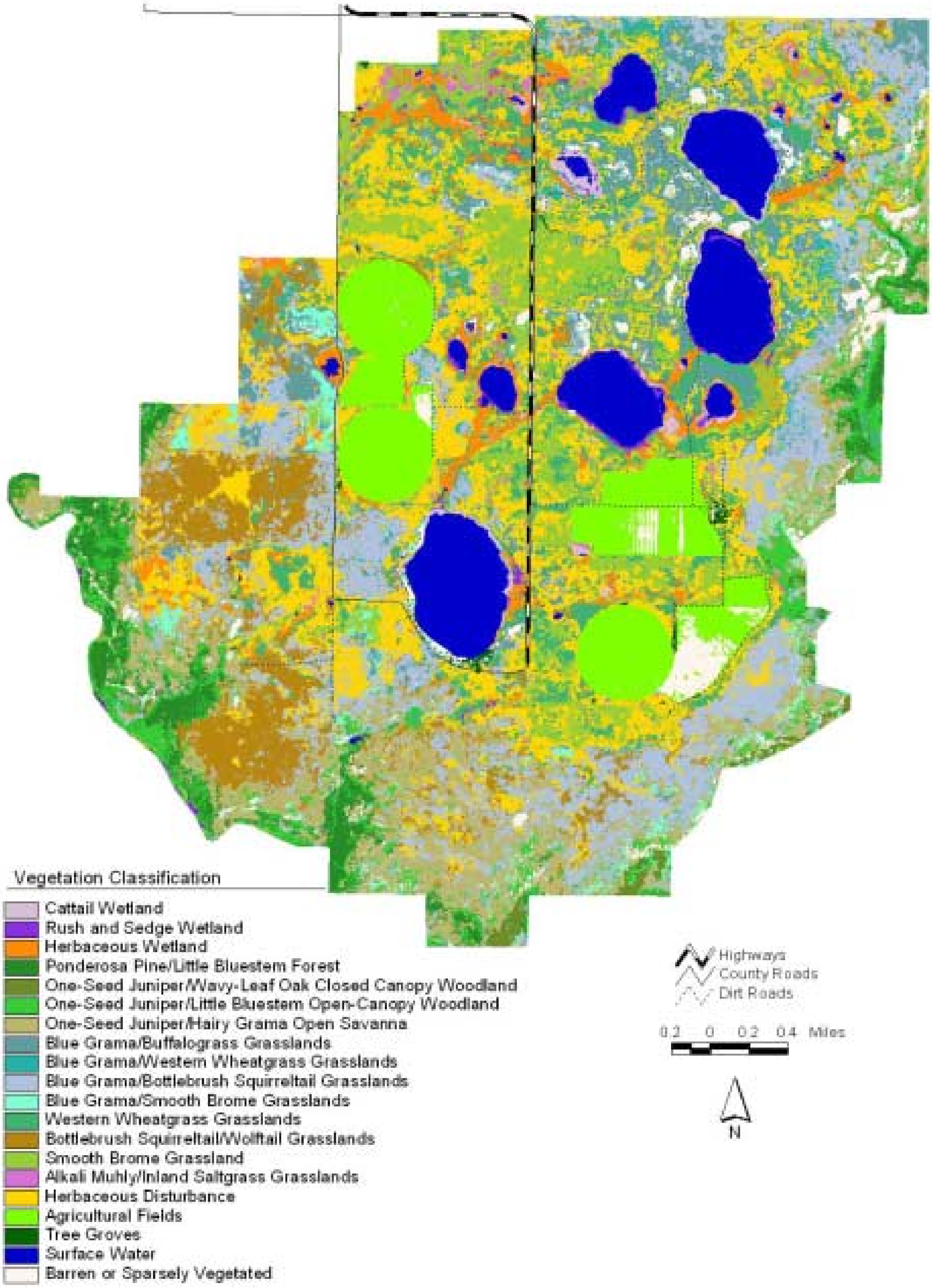
To create the final map, a filtering process was applied to create a minimum map unit polygon size of 40 square meters (0.004 ha.). The procedure eliminates the "speckle" created by spatially solitary mapping units that have less than six contiguous pixels. The eliminated areas are then filled in by the majority of surrounding pixels using a 5-pixel x 5- pixel majority filter (a majority filter replaces the middle pixel of a 5 x 5 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 40 square meters.

No attempt was made to classify buildings, pavement, concrete, or lawns due to the heterogeneity of reflecting surfaces. A few seeded classes did map features such as roadside trees very well and were used in the classification. Roads, water, and agricultural GIS coverages in vector format were placed directly onto the map to provide for their classification.

Table 3. Las Vegas NWR vegetation mapping units.[3]

MU#	MU Description	Ha.	Ac.
1	Cattail Wetland	29.4	72.7
2	Rush and Sedge Wetland	20.1	49.6
3	Herbaceous Wetland	139.9	345.7
4	Ponderosa Pine/Little Bluestem Forest	119.6	295.7
5	One-Seed Juniper/Wavy-Leaf Oak Closed-Canopy Woodlands	26.8	66.4
6	One-Seed Juniper/Little Bluestem Open-Canopy Woodland	150.1	370.9
7	One-Seed Juniper/Hairy Grama Open Savanna	317.6	784.8
8	Blue Grama/Buffalograss Grasslands	210.3	519.7
9	Blue Grama/Western Wheatgrass Grasslands	50.7	125.4
10	Blue Grama/Bottlebrush Squirreltail Grasslands	435.0	1075.0
11	Blue Grama/Smooth Brome Grasslands	51.4	127.2
12	Western Wheatgrass Grassland	276.6	683.5
13	Bottlebrush Squirreltail/Wolftail Grasslands	223.3	551.8
14	Smooth Brome Grassland	261.2	645.4
15	Alkali Muhly/Inland Saltgrass Grasslands	24.5	60.5
16	Herbaceous Disturbance	636.1	1571.9
17	Agricultural Fields	264.5	653.6
18	Tree Groves	7.9	19.6
19	Surface Water	190.5	470.9
20	Barren or Sparsely Vegetated	120.0	296.5

[3] Area was calculated using a Geographic Information System and does not include the McAllister Lake New Mexico Game and Fish Department Management Area.


Vegetation Classification
Cattail Wetland
Rush and Sedge Wetland
Herbaceous Wetland
Ponderosa Pine/Little Bluestem Forest
One-Seed Juniper/Wavy-Leaf Oak Closed Canopy Woodland
One-Seed Juniper/Little Bluestem Open-Canopy Woodland
One-Seed Juniper/Hairy Grama Open Savanna
Blue Grama/Buffalograss Grasslands
Blue Grama/Western Wheatgrass Grasslands
Blue Grama/Bottlebrush Squirreltail Grasslands
Blue Grama/Smooth Brome Grasslands
Western Wheatgrass Grasslands
Bottlebrush Squirreltail/Wolftail Grasslands
Smooth Brome Grassland
Alkali Muhly/Inland Saltgrass Grasslands
Herbaceous Disturbance
Agricultural Fields
Tree Groves
Surface Water
Barren or Sparsely Vegetated
Highways
County Roads
Dirt Roads
0.2 0 0.2 0.4 Miles
N

DISCUSSION

Las Vegas NWR is within the Plains-Mesa-Foothill Grassland complex of North America (New Mexico Natural Heritage Program Community classification database, Brown & Lowe 1982, Dick-Peddie 1993) that is composed almost entirely of grasses with shrubs and forbs constituting less than ten percent. These grasslands once spread nearly uninterrupted over the vast rolling plains of eastern New Mexico and adjacent Texas, Oklahoma, Kansas and Nebraska, but have been greatly reduced due to dryland and irrigated farming (Haukos and Smith 1992, Dick-Peddie 1993). Little is known of the extent, distribution and condition of Plains-Mesa Grassland in New Mexico, and for this reason, mapping the plant communities within the refuge will contribute to the knowledge base of this important group.

During field surveys, an attempt was made to identify patterns of affinities for some forbs and shrubs to consistently occur within plant communities. Our field surveys concur with previous work by Brown and Lowe (1982), Dick-Peddie (1993) and Parmenter et al. (1994) that specific forbs appear consistently that are indicative of the plains-mesa-foothill grassland type. Common forbs include globemallow (*Sphaeralcea spp*.), curly cup gumweed (*Grindelia squarrosa*), blackfoot daisy (*Melampodium leucanthum*) and coneflower (*Ratibida tagetes*). Common shrubs found scattered throughout the plains-mesa grasslands are fringed sage (*Artemisia frigida*) and soapweed yucca (*Yucca glauca*), particularly in the upland grasslands within the refuge. Broom snakeweed (*Gutierrezia microcephala*), a disturbance indicator shrub is also found in some of the more degraded grasslands on the refuge. The highest densities of forbs and shrubs occur in areas where there has obviously been soil disturbance.

An attempt was also made to identify areas that had a high occurrence of non-native plants, with particular attention to noxious weeds, as designated by the New Mexico Department of Agriculture (NMDA) in 1999. The NMDA has classified noxious weeds into three divisions. *Class A* are species not yet present in New Mexico or have a limited distribution and prevention of infestation is the highest priority. We found no Class A weeds on the refuge; however, it is possible they exist as vegetation surveys were done near and past the end of the growing season, making positive identification of some species difficult. *Class B* are species limited to portions of the state, and should be treated as Class A weeds in areas where they have not yet reached infestation level. Musk thistle (*Carduus nutans*), a Class B weed, was found within the refuge. The musk thistle is widespread along roadsides, particularly near Wallace Lake, and has also advanced into disturbed grasslands within the refuge. It is our opinion that musk thistle has not yet reached a level of severe infestation on the refuge, but because it has been known to spread rapidly over the course of a few years, particularly in moisture enhanced habitats (Pase and Stockert 1990), it is strongly recommended that action be taken to eradicate this weed from the refuge soon, before it becomes widespread. *Class C* weeds are those that are widespread in New Mexico, with management decisions for these species to be determined at the local level. Bindweed (*Convolvulus arvensis*) is a Class C weed that is ubiquitous throughout the western wheatgrass monotypic grasslands and common in the blue grama grasslands on the eastern side of the refuge. This may be due to the present or past grazing practices on these lands. Cattle will ignore bindweed in favor of the grasses, leaving these plants to increase. Another Class C noxious weed found on the refuge is the Siberian elm (*Ulmus pumila*). This tree appears to be limited to the roadsides or at old home sites and does not appear to be increasing its distribution rapidly.

Other weedy species are also present at high densities on the refuge. Many of the blue grama grasslands are thick with bottlebrush squirreltail (*Elymus elymoides*), sleepygrass (*Stipa robusta*) or poverty three-awn (*Aristida divaricata*). These species are disturbance increasers, and usually occur in rangelands subjected to heavy grazing. Once established, these grasses are difficult to eradicate. Because they are unpalatable to livestock, grazing only leads to further increase of these species since grazers avoid them, creating new seedbeds. Seed dispersal is enhanced by awns that cling to animals that disperse the seed widely.

In disturbed bottomlands with intermittent standing water, Canadian wildrye (*Elymus canadensis*) is found along with horseweed (*Conyza canadensis*), cocklebur (*Xanthium strumarium*), Mexican dock (*Rumex salicifolia* var. *mexicana*) and rabbitfoot grass (*Polypogon monspeliensis*). These areas are certainly used by birds, and some of the plants, particularly Mexican dock, are eaten and may be spread by birds. Weedy species, such as sunflower (*Helianthus annuus*), sweetclover (*Melilotus alba/M. officinalis*), pigweed (*Amaranthus hybridus*) and kochia (*Kochia scoparia*) are abundant along drainages and irrigation canals which are probably subject to regular mowing, clearing, and fluctuating water levels.

In areas that were formerly in cultivation, smooth brome (*Bromus inermis*) was planted as forage. Smooth brome was introduced from Europe for hay and pasture in the western U.S., but now is widely dispersed. It is excellent livestock forage, but easily outcompetes native species in many areas.

The map presented here is the most accurate and detailed map developed to date for the vegetation of Las Vegas National Wildlife Refuge. The map units were designed to both reflect the vegetation composition of the area, and also to be optimally useful for natural resources management at the 1:24,000 scale (7.5' USGS quadrangle size). Use of the map at finer scales is not recommended without additional ground truthing. Future refinement of map unit categories at a larger scale might be possible, but not necessarily appropriate for most natural resources management applications. The map has been made available both in hard copy form and in a digital format suitable for integration into a Geographic Information System.

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Appendix A. Map Unit Descriptions

(Area measurements do not include the McAllister Lake New Mexico Game and Fish Department Management Area)

LAS VEGAS NATIONAL WILDLIFE REFUGE
MAPPING UNIT DESCRIPTIONS

MU#	MU DESCRIPTION	AC	HA
1	Cattail Wetland	72.7	29.4

These wetlands are dominated by stands of monotypic cattail species (*Typha spp*.) with minor patches of three-square sedge (*Schoenoplectus americanus*), and American bulrush (*Scirpus pungens*). Cattail is an obligate wetland plant species that forms dense colonies in standing water along the near-shore margin of the lakes and ponds on the refuge. They are also found within the mud banks of some canals and drainages. Rushes, sedges, and inland saltgrass are locally dominant.

MU#	MU DESCRIPTION	AC	HA
2	Rush and Sedge Wetland	49.6	20.1

Rushes and sedges are principally found at the margins of the lakes and ponds on the refuge, where water levels are shallow or fluctuating. Although, at Wallace Lake, American bulrush (*Scirpus pungens*) can be found at higher water levels. American bulrush (*Scirpus pungens*), Baltic rush (*Juncus balticus*), common spikerush (*Eleocharis palustris*), three-square sedge (*Schoenoplectus americanus*), and Mexican dock (*Rumex salicifolius var. mexicanus*) are the most common species within this map unit.

MU#	MU DESCRIPTION	AC	HA
3	Herbaceous Wetland	345.7	139.9

These wetlands are found in low-lying areas and along waterways where the ground is saturated for significant periods of time. The vegetation in these wetlands are a mix of grasses, wetland and weedy species. Grass species are common and generally are dominant including bottlebrush squirreltail (*Elymus elymoides*), western wheatgrass (*Pascopyrum smithii*), alkali muhly (*Muhlenbergia asperifolia*), inland saltgrass (*Distichlis spicata*), rabbitfoot grass (*Polypogon monspeliensis*), and Canadian wildrye (*Elymus canadensis*). Wetland species such as the cattails, rushes, and sedges listed in the previous mapping units can be locally dominant. In addition there is a wide diversity of mesic-associated plants such as horseweed (*Conyza canadensis*), common cocklebur (*Xanthium strumarium*), milkweed species (Asclepias spp.), and Mexican dock (*Rumex salicifolius var. mexicanus*). Coyote willow (Salix *exigua*) can also be found lining irrigation canals.

MU#	MU DESCRIPTION	AC	HA
4	Ponderosa Pine/Little Bluestem Forest	295.7	119.6

This mapping unit represents a closed-canopy forest dominated by ponderosa pine (*Pinus ponderosa*), with a varied subcanopy of pinyon pine (*P. edulis*), junipers (*Juniperus monosperma* and *J. scopulorum*), and oaks (*Quercus undulata* and *Q. gambelii*). Little bluestem (*Schizachyrium scoparium*) dominates the under-story, but other flora are also found including soaptree and banana yucca (*Yucca glauca* and *Y. baccata*), big bluestem (*Andropogon gerardii*), plains lovegrass (*Eragrostis intermedia*), three-awn grasses (*Aristida spp*.), hairy grama (*Bouteloua hirsuta*), bulb panicgrass (*Panicum bulbosum*), and dropseed grasses (*Sporobolus spp*.). Moss, lichen and cryptogams cover the rock and soil. This community occurs on the steep canyon slopes of the Gallinas River and Vegosa Creek near the refuge boundaries.

MU#	MU DESCRIPTION	AC	HA
5	One-seed Juniper/Wavyleaf Oak Closed Canopy Woodlands	66.4	26.8

This unit is a closed canopy woodland dominated by one-seed juniper (*Juniperus monosperma*) and wavyleaf oak (*Quercus undulata*). The understory is variously dominated by little bluestem (*Schizachyrium scoparium*) and/or sideoats grama (*Bouteloua curtipendula*). This mapping unit is found both on cliff edges and alluvial slopes along the canyons of the Gallinas River and Vegosa Creek near the refuge boundaries.

MU#	MU DESCRIPTION	AC	HA
6	One-seed Juniper/Little Bluestem Open-Canopy Woodland	370.9	150.1

This mapping unit represents an open-canopy woodland dominated by one-seed juniper *(Juniperus monosperma*) with Rocky mountain juniper (*J. scopulorum*), wavyleaf oak (*Quercus undulata*), and sacahuista (*Nolina microcarpa*) scattered throughout. The understory is dominated by little bluestem (*Schizachyrium scoparium*), but there is a variety of other grasses including big bluestem (*Andropogon gerardii*), sideoats grama (*Bouteloua curtipendula*), plains lovegrass (*Eragrostis intermedia*), three-awn grasses (*Aristida spp*.), hairy grama (*B. hirsuta*), sleepy grass (*Stipa robusta*), and wolftail (*Lycurus phleoides*). Buckwheat (*Eriogonum spp*.) is typically found in this community. The substrate is a heavily rocky soil with substantial cryptogamic cover. This community is found along the escarpment edges of the Gallinas River and Vegosa Creek canyons where large outcrops of sandstone, covered with moss and lichen are found.

MU#	MU DESCRIPTION	AC	HA
7	One-seed Juniper/Hairy Grama Open Savanna	784.8	317.6

This mapping unit represents an open savanna of one-seed juniper (*Juniperus monosperma*) with hairy grama (*Bouteloua hirsuta*) dominant in the under-story. It occurs at the margins of the extensive mesa-plains grasslands and is a rich transitional zone between the grasslands and woodlands where a diverse array of shrubs, grasses and forbs meet within these juniper dotted grasslands. Wolftail (*Lycurus phleoides*), blue grama (*B. gracilis*) and sideoats grama (*B. curtipendula*) are well distributed among shrubs such as soaptree yucca (*Yucca glauca*), skunkbush sumac (*Rhus trilobata*), and wavyleaf *oak (Quercus undulata*). Occasional pinyon pines (*Pinus edulis*) are scattered throughout.

MU#	MU DESCRIPTION	AC	HA
8	Blue Grama/Buffalo Grass Grasslands	519.7	210.3

This grassland community is equally dominated by blue grama (*Bouteloua gracilis*) and buffalo grass (*Buchloe dactyloides*). Blue grama/buffalo grass grasslands are a major community of the Great Plains eco-region to the east, and is found predominately on the eastern plains of the refuge. This grassland can have a high number of weedy plants that include snakeweed (*Gutierrezia microcephala*), field bindweed (*Convolvulus arvensis*), and sweetclover (*Melilotus spp*). The more degraded communities may include high densities of three-awn grasses (*Aristida spp*.). Curlycup gumweed (*Grindelia squarrosa*), fringed sage (*Artemisia frigida*), and bottlebrush squirreltail (*Elymus elymoides*) are also often found in these grasslands.

Inclusions: blue grama monotypic
blue grama/sleepy grass

MU#	MU DESCRIPTION	AC	HA
9	Blue Grama/Western Wheatgrass Grasslands	125.4	50.7

This grassland is dominated by blue grama (*Bouteloua gracilis*) with western wheatgrass (*Pascopyrum smithii*) locally co-dominant. It occurs as a band of vegetation on intermediately mesic soils of lower slopes between basin or drainage vegetation and upland grasses.

Inclusions: blue grama/crested wheatgrass

MU#	MU DESCRIPTION	AC	HA
10	Blue Grama/Bottlebrush Squirreltail Grasslands	1075.0	435.0

This grassland community is dominated by blue grama (*Bouteloua gracilis*), although bottlebrush squirreltail (*Elymus elymoides*) is locally dominant. The understory is frequently composed of dense trailing fleabane (*Erigeron flagellaris*), sweetclover (*Melilotus* spp.) and snakeweed (*Gutierrezia microcephala*) are also found at varying densities within this grassland. This community is primarily found on the far-eastern and southern plains of the refuge.

MU#	MU DESCRIPTION	AC	HA
11	Blue Grama/Smooth Brome Grasslands	127.2	51.4

This grassland is co-dominated by blue grama (*Bouteloua gracilis*) with smooth brome (*Bromus inermis*). It occurs near the edge of existing and former agricultural fields and probably represents a spread of the planted smooth brome into the native blue grama grasslands.

MU#	MU DESCRIPTION	AC	HA
12	Western Wheatgrass Grassland	683.5	276.6

This is a mesic grassland community characterized by dense monotypic stands of western wheatgrass (*Pascopyrum smithii*), although in some areas there is a significant understory of bindweed. Other grasses are seldom found within this community; however, there may be inclusions of forbs such as sweetclover (*Melilotus* spp), velvetweed (*Gaura parviflora*), and common sunflower (*Helianthus annuus*). Patches of beardless wheatgrass (*Pseudoroegneria spicata ssp inermis*) are also included within this mapping unit.

Inclusions: beardless wheatgrass monotypic

MU#	MU DESCRIPTION	AC	HA
13	Bottlebrush Squirreltail/Wolftail Grasslands	551.8	223.3

This diverse grassland is dominated by bottlebrush squirreltail (*Elymus elymoides*), although wolftail (*Lycurus phleoides*) can be locally dominant. A variety of other grasses can co-dominate with bottlebrush squirreltail, such as blue grama (*Bouteloua gracilis*), sideoats grama (*B. curtipendula*), and hairy grama (*B. hirsuta*). Fringed sage (*Artemisia frigida*) and prickly pear are found scattered throughout this community, which is primarily found on the southern and western plains of the refuge.

Inclusions: blue grama/wolftail

MU#	MU DESCRIPTION	AC	HA
14	Smooth Brome Grassland	645.4	261.2

The smooth brome (*Bromus inermis*) mapping unit combines several associations together, all of which are dominated by smooth brome. Smooth brome is a non-native that was planted in the old agricultural fields that still contain a significant amount of alfalfa (*Medicago sativa*). Throughout these old fields there are small pockets of various grasses such as dropseed (*Sporobolus spp*.), vine mesquite (*Panicum obtusum*), and western wheatgrass (*Pascopyrum smithii*). Often these patches reflect the microtopography and soil moisture of the field with vine mesquite and western wheatgrass dominating in the swales.

Inclusions: smooth brome/crested wheatgrass
smooth brome/western wheatgrass

MU#	MU DESCRIPTION	AC	HA
15	Alkali Muhly/Inland Saltgrass Grasslands	60.5	24.5

Alkali muhly (*Muhlenbergia asperifolia*)/inland saltgrass (*Distichlis spicata*) is a wetland community found throughout the refuge in swales, playas, ditches, and at the margins of waterbodies. This community forms a thick mat of either alkali muhly or saltgrass with occasional forbs in saturated soils.

MU#	MU DESCRIPTION	AC	HA
16	Herbaceous Disturbance	1571.9	636.1

The herbaceous disturbance mapping unit covers areas that are dominated by early colonizers such as common sunflower (*Helianthus annuus*), sweetclover (*Melilotus* spp.), thistle (*Cirsium* spp.), velvetweed (*Gaura parviflora*), amaranth (*Amaranthus hybridus*), and kochia (*Kochia scoparia*). These plants are quick to establish in areas that have been cleared by surface disturbance, such as blading, fire, mowing, overgrazing or flooding. Many of these areas follow the canals and ditches or the margins of wetlands and sometimes spread into adjacent grasslands. Heavily disturbed sand dropseed (*Sporobolus cryptandrus*) monotypic grasslands are found within this mapping unit. Some of the playa depressions within the extensive plains grasslands are dominated by these herbaceous disturbance plants.

MU#	MU DESCRIPTION	AC	HA
17	Agricultural Fields	653.6	264.5

This mapping unit represents fields that were in production or fallow at the time of image acquisition.

MU#	MU DESCRIPTION	AC	HA
18	Trees Groves	19.6	7.9

Usually near old homesteads or along roads are areas dominated by groves of trees that can be combinations of any of the following: Siberian elm (*Ulmus pumila*), cottonwood (*Populus deltoides*), Russian olive (*Elaeagnus angustifolia*), or juniper (*Juniperus spp*.).

MU#	MU DESCRIPTION	AC	HA
19	Surface Water	470.9	190.5

This mapping unit represents the surface water extent as of 3 September, 1993, the acquisition date of the satellite image and the aerial photography from 29 September, 1997.

MU#	MU DESCRIPTION	AC	HA
20	Barren or Sparsely Vegetated	296.5	120.0

This mapping unit represents barren ground with little to no cover of vegetation. It can include rock outcrop.

Appendix B. Preliminary Species List

The species list is grouped into lifeforms and arranged within groups alphabetically first by family and second by genus. Species names follow Kartesz (1994). The “Origin” column indicates whether a species is a native (N) or introduced (I). This list is not intended to be a complete list of all species found within the refuge, but a preliminary account of species identified under this contract.

Common Name	Scientific Name	Family	Origin
TREES			
One-seed juniper	*Juniperus monosperma* (Engelm.) Sarg.	Cupressaceae	N
Rocky Mountain juniper	*Juniperus scopulorum* Sarg.	Cupressaceae	N
Russian olive	*Elaeagnus angustifolia* L.	Elaeaganaceae	I
New Mexico locust	*Robinia neomexicana* Gray	Fabaceae	N
Pinyon pine	*Pinus edulis* Engelm.	Pinaceae	N
Ponderosa pine	*Pinus ponderos*a P. & C. Lawson	Pinaceae	N
Cottonwood	*Populus deltoides* Bartr. ex Marsh.	Salicaceae	N
Siberian elm	*Ulmus pumila* L.	Ulmaceae	I
SHRUBS			
Soaptree yucca	*Yucca glauca* Nutt.	Agavaceae	N
Skunkbush sumac	*Rhus trilobata* Nutt.	Anacardiaceae	N
Snakeweed	*Gutierrezia microcephala* (DC.) Gray	Asteraceae	N
Prickly pear	*Opuntia phaeacantha* Engelm.	Cactaceae	N
Winterfat	*Krascheninnikovia lanata* (Pursh) Guldenstaedt	Chenopodiaceae	N
Gambel's oak	*Quercus gambelii* Nutt.	Fagaceae	N
Wavyleaf oak	*Quercus undulata* Torr.	Fagaceae	N
Apache plume	*Fallugia paradoxa* (G. Don) Endl. ex Torr.	Rosaceae	N
Thimbleberry	*Rubus parviflorus* Nutt.	Rosaceae	N
Coyote willow	*Salix exigua* Nutt.	Salicaceae	N
FORBS			
Broadleaf milkweed	*Asclepias latifolia* (Torr.)Raf.	Asclepiadaceae	N
Western whorled milkweed	*Asclepias subverticillata* (Gray) Vail	Asclepiadaceae	N
Russian knapweed	*Acroptilon repens* (L.) DC.	Asteraceae	I
Common ragweed	*Ambrosia artemisiifolia* L.	Asteraceae	N
Fringed sage	*Artemisia frigida* Willd.	Asteraceae	N
Cluster aster	*Aster falcatus* var. *commutatus* (Torr. & Gray) A.G. Jones	Asteraceae	N
	Berlandiera lyrata Benth.	Asteraceae	N
Beggar tick	*Bidens* spp. L.	Asteraceae	N
Musk thistle	*Carduus nutans* L.	Asteraceae	I
Wavyleaf thistle	*Cirsium undulatum* (Nutt.) Spreng.	Asteraceae	N
Thistle	*Cirsium* spp. P. Mill.	Asteraceae	N
Canadian horseweed	*Conyza canadensis* (L.) Cronq.	Asteraceae	N
Fetid marigold	*Dyssodia papposa* (Vent.) Hitchc.	Asteraceae	N
Trailing fleabane	*Erigeron flagellaris* Gray	Asteraceae	N
Curlycup gumweed	*Grindelia squarrosa* (Pursh) Dunal	Asteraceae	N
Common sunflower	*Helianthus annuus* L.	Asteraceae	N

Common Name	Scientific Name	Family	Origin
FORBS CONT.			
Hairy golden aster	*Heterotheca villosa* (Pursh) Shinners	Asteraceae	N
Marsh elder	*Iva xanthifolia* Nutt.	Asteraceae	N
Prickly lettuce	*Lactuca serriola* L.	Asteraceae	I
Dotted gayfeather	*Liatris punctata* Hook.	Asteraceae	N
Plains blackfoot	*Melampodium leucanthum* Torr. & Gray	Asteraceae	N
Short ray coneflower	*Ratibida tagetes* (James) Barnh.	Asteraceae	N
Broom groundsel	*Senecio spartioides* Torr. & Gray	Asteraceae	N
Yellow salisfy	*Tragopogon dubius* Scpo.	Asteraceae	I
Common cocklebur	*Xanthium strumarium* L.	Asteraceae	N
Hiddenflower	*Cryptantha* spp. Lehm. ex G. Don	Boraginaceae	N
Pigweed	*Amaranthus hybridus* L.	Amaranthaceae	N
Common Kochia	*Kochia scoparia* L. Schrad	Chenopodiaceae	I
Russian thistle	*Salsola kali* L.	Chenopodiaceae	I
Wright's spiderwort	*Tradescantia wrightii* Rose & Bush	Commelinaceae	N
Field bindweed	*Convolvulus arvensis* L.	Convolvulaceae	I
Alfalfa	*Medicago sativa* L.	Fabaceae	I
White sweetclover	*Melilotus albus* Medik.	Fabaceae	I
Yellow sweetclover	*Melilotus officinalis* (L.) Lam	Fabaceae	I
Locoweed	*Astragalus* spp. L.	Fabaceae	N
Red stemmed filaree	*Erodium cicutarium* (L.) L'Her. ex Ait.	Geraniaceae	I
Lanceleaf sage	*Salvia reflexa* Hornem.	Lamiaceae	N
Nodding onion	*Allium cernuum* Roth	Liliaceae	N
Venice mallow	*Hibiscus trionum* L.	Malvaceae	I
Common mallow	*Malva neglecta* Wallr.	Malvaceae	N
Globemallow	*Sphaeralcea* spp. St.-Hil.	Malvaceae	N
Velvety gaura	*Gaura parviflora* Dougl. ex Lehm.	Onagraceae	N
Tree-seed phlox	*Phlox triovulata* Thurb. ex Torr.	Polemoniaceae	N
Buckwheat spp.	*Eriogonum* spp. Michx.	Polygonaceae	N
Pink smartweed	*Polygonum pensylvanicum* L.	Polygonaceae	N
Mexican dock	*Rumex salicifolius* var. *mexicanus* (Meisn.) C.L. Hitchc.	Polygonaceae	N
Common mullein	*Verbascum thapsus* L.	Scrophulariaceae	I
Penstemon	*Penstemon* spp. Schmidel	Scrophulariaceae	N
Groundcherry	*Physalis* spp. L.	Solanaceae	N
Silverleaf nightshade	*Solanum elaeagnifolium* Cav.	Solanaceae	N
Common cattail	*Typha latifolia* L.	Typhaceae	N
Verbena	*Verbena bracteata* Lag. & Rodr.	Verbeneaceae	N

Common Name	Scientific Name	Family	Origin
GRASSES AND GRASS-LIKE PLANTS			
Spikerush	*Eleocharis palustris* (L.) Roemer & Shultes	Cyperaceae	N
Three-square sedge	*Schoenoplectus americanus* (Pers.) Volk. Ex Schinz & R. Keller	Cyperaceae	N
American bulrush	*Scirpus pungens* Vahl.	Cyperaceae	N
Baltic rush	*Juncus balticus* Willd.	Juncaceae	N
Torrey's rush	*Juncus torreyi* Coville	Juncaceae	N
Crested wheatgrass	*Agropyron cristatum* (L.) Gaertn.	Poaceae	I
Big bluestem	*Andropogon gerardii* Vitman	Poaceae	N
Poverty threeawn	*Aristida divaricata* Humb. & Bonpl. ex Willd.	Poaceae	N
Sideoats grama	*Bouteloua curtipendula* (Michx.) Torr.	Poaceae	N
Blue grama	*Bouteloua gracilis* (Willd. ex Kunth) Lag. ex Griffiths	Poaceae	N
Hairy grama	*Bouteloua hirsuta* Lag.	Poaceae	N
Smooth brome	*Bromus inermis* Leyss.	Poaceae	I
Buffalograss	*Buchloe dactyloides* (Nutt.) Engelm.	Poaceae	N
Inland saltgrass	*Distichlis spicata* (L.) Greene	Poaceae	N
Bottlebrush squirreltail	*Elymus elymoides* (Raf.) Swezey	Poaceae	N
Plains lovegrass	*Eragrostis intermedia* Hitchc.	Poaceae	N
Galleta	*Hilaria jamesii* (Torr.) Benth.	Poaceae	N
Common wolftail	*Lycurus phleoides* Kunth	Poaceae	N
Alkali muhly	*Muhlenbergia asperifolia* (Nees & Meyen ex Trin.) Parodi	Poaceae	N
Mountain muhly	*Muhlenbergia montana* (Nutt.) Hitchc.	Poaceae	N
Mat muhly	*Muhlenbergia richardsonis* (Trin.) Rydb.	Poaceae	N
Ring muhly	*Muhlenbergia torreyi* (Kunth) Hitch. ex Bush	Poaceae	N
Indian ricegrass	*Oryzopsis hymenoides* (Roemer & Schultes) Ricker ex Piper	Poaceae	N
Bulb panicgrass	*Panicum bulbosum* Kunth	Poaceae	N
Vine mesquite	*Panicum obtusum* Kunth	Poaceae	N
Western wheatgrass	*Pascopyrum smithii* (Rydb.) Love	Poaceae	N
Rabbitfoot grass	*Polypogon monspeliensis* (L.) Desf.	Poaceae	I
Beardless wheatgrass	*Pseudoroegneria spicata* ssp *inermis* (Scribn. & J.G. Sm.) A. Love	Poaceae	I
Little bluestem	*Schizachyrium scoparium* (Michx.) Nash	Poaceae	N
Sand dropseed	*Sporobolus cryptandrus* (Torr.) Gray	Poaceae	N
Sleepygrass	*Stipa robusta* (Vasey) Scribn.	Poaceae	N