Vegetation of Grassy Remnants in the Las Vegas Valley, Southern Nevada

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Abstract
The approximately 1000-km^2 Las Vegas Valley contains a rich assemblage of unique plant communities in the eastern Mojave Desert. Yet, there is little published documentation of this vegetation as its destruction continues with proceeding urban development. Development has intensified after the 1998 Southern Nevada Public Land Management Act mandated the disposal of federal lands. We document plant communities at four unique grassy remnants, some of which have since been destroyed, in the southwestern Las Vegas Valley. Sample plots of 0.25 or 0.09 ha at each site contained washes (supporting catclaw [*Acacia greggii*] at three sites) and associated uplands. Native perennial grasses comprised 12% of plant species richness/100 m^2 and 5% of total relative cover on average. A total of 8 native perennial grasses were detected at the four sites, with predominant species including fluff grass (*Dasyochloa pulchella*), purple three-awn (*Aristida purpurea*), big galleta (*Pleuraphis rigida*), red grama (*Bouteloua trifida*), and slim tridens (*Tridens muticus*). These communities appeared as grass-shrublands, rather than the widespread shrublands commonly described for the Mojave Desert. Of large shrubs at the three sites containing catclaw, catclaw density ranged from 52-124/ha, Mojave yucca (*Yucca schidigera*) from 8-32/ha, and creosote bush (*Larrea tridentata*) from 168-456/ha. We also obtained permission to salvage native plants from one site prior to land development. Overall survival of salvaged plants of eight species exceeded 76% after one year of greenhouse/outdoor storage. We suggest that while many opportunities have already been lost, collecting and documenting information on the rich vegetation of the Las Vegas Valley and salvaging native plants or seed for use in desert landscaping, parks, and habitat improvement in protected areas would leave a future legacy of this ecologically unique region.

Introduction
Las Vegas means "the meadows" in Spanish, a name given by Spanish travelers in the early1800s to what is now the largest city in Nevada. The approximately 1000-km^2 Las Vegas Valley is a different place now than the landscape encountered by its namers. Between 1990 and 2000, Las Vegas experienced the largest population growth (83%) of any U.S. metropolitan area during that time period (Perry and Mackun 2001). Growth and development was further propelled by the 1998 Southern Nevada Public Land Management Act, where congress directed the Bureau of Land Management (BLM) to dispose of public BLM land for private development in the Las Vegas Valley. Through 2007, 13,944 hectares had been sold by BLM (BLM 2008). By 2006, Las Vegas already contained an estimated 1.8 million people (Southern Nevada Regional Planning Coalition 2006). A consequence of this explosive development is that rich ecological communities in the Las Vegas Valley have been quickly and irreversibly destroyed.

The Las Vegas Valley supports diverse vegetation, such as springs, wetlands, washes, mesquite (*Prosopis glandulosa*) and catclaw (*Acacia greggii*) woodlands, and creosote-bursage (*Larrea tridentata-Ambrosia dumosa*) shrub communities; along with communities on unique soil types such as gypsum (Stave 2001). Published documentation of current vegetation is virtually nonexistent, leaving no quantitative records of what this valley contained as development and vegetation destruction proceeds. In this study, we document plant communities at four unique grassy sites in the Las Vegas Valley. Some of the sites have been cleared since our study, so these data are a valuable vegetation record that can no longer be obtained. We also conducted a salvage project with eight native species and assessed greenhouse survival of transplants. Benefits of understanding plant communities in Las Vegas include using the information for habitat restoration or creation (establishing a community where it did not previously occur) in Las Vegas or on adjacent protected land, understanding how plant communities in Las Vegas relate to or might affect (through their loss) communities in the broader Mojave Desert (e.g., Hickerson and Wolf 1998), and for providing a cultural and educational reference.

Site Descriptions
We sampled four privately held sites in the southwestern Las Vegas Valley that contained unique assemblages of native grasses and that we were able to obtain permission to sample (Figure 1, 2). Land area of the study sites ranged from 0.2-15 ha. Three of the sites were within 1 km of each other, while the fourth site was 5 km to the east. All of the sites were surrounded by roads, housing developments typically constructed within the past five years, and businesses. Soils at the three western sites are derived from alluvium and limestone and are mapped as Goodsprings and Cave gravelly fine sandy loams (Typic Paleorthids; Speck and Mckay 1985). These sites included washes (approximately 10-20 m wide and 0.5-3 m deep) and adjacent uplands. The fourth site occupied a sandy wash less than 1 m deep, with soils derived from sandy alluvium. These soils are mapped as Jean gravelly loamy fine sand (Typic Torriorthents). Washes at all sites had been

severed by developments prior to reaching the site, so the washes may no longer receive periodic flows. Elevations of the sites ranged from 720-790 m.

Survey and Salvage Techniques

We established one sample plot in the center of each site to reduce edge effects on these small sites as much as possible. Plots were 50 m × 50 m (0.25 ha) at sites 1-3 and 30 m × 30 m (0.09 ha) at the smaller site 4 that would not accommodate a larger plot. We divided plots into 10 × 10 m (0.01 ha) cells, with 25 cells on each plot at sites 1-3 and 9 cells at site 4. We mapped individuals of three native shrub species (catclaw, creosote, and Mojave yucca) to the nearest meter using x, y coordinates within plots. We sampled sites 1-3 in December 2006 or January 2007, and site 4 in February 2008. Our sampling time period was not designed to detect live annuals, but we did record dead annuals and included them in vegetation measures such as species richness. In each cell, we recorded species rooted in the cell and categorized their cover using Peet et al.'s (1998) cover classes. One plant specimen did not have sufficient material for identification to genus, so we deleted this unknown from the data set. Five plants could only be identified to genera, they were included in richness and life form analyses. Plant nomenclature follows NRCS (2008). From the plot data, we calculated species richness (the number of species present on average per 0.01 ha and in whole plots) and relative cover of each species (the proportion of the total cover of all species that was contributed by each focal species). We also calculated frequency, the proportion of 0.01-ha cells a species occupied per site.

In a trial to test the feasibility of salvaging native plant material, we obtained permission to salvage plants in February 2007 from site 1. We used hand shovels to dig out as much root as possible and salvaged plants bare-root by wrapping them in moist paper towels and transporting them in plastic bags. We salvaged 10 individuals of each of eight species: purple three-awn (*Aristida purpurea*), fluff grass (*Dasyochloa pulchella*), red grama (*Bouteloua trifida*), deergrass (*Muhlenbergia rigens*), Virgin River brittlebush (*Encelia virginensis*), desert trumpet (*Eriogonum inflatum*), broom snakeweed (*Gutierrezia sarothrae*), and globemallow (*Sphaeralcea ambigua*). Within three hours of salvage, we planted individuals with potting soil in 1-gallon (4-liter) pots. We kept samples in a greenhouse at the Lake Mead National Recreation Area plant nursery, (approximately 30 km east of the Las Vegas Valley), for six months before placing the pots outdoors for another six months.

Plant Community Characteristics

Based on the results of our site surveys, density of the three mapped shrubs at sites 1-3 ranged from 52-124/ha (average = 85) for catclaw, 8-32/ha (average = 20) for Mojave yucca, and 168-456/ha (average = 291) for creosote. Catclaw probably has higher moisture requirements and tended to occupy the washes, but scattered individuals also occurred on adjacent uplands (Figure 3). The fourth site had 578 creosote/ha, but did not contain catclaw or Mojave yucca.

Richness of native species per 0.01 ha ranged from 5-22 species, with natives comprising 62-94% of the total richness per 0.01 ha (Figure 4). Richness tended to be higher in washes, but several sections of the uplands contained richness equal or greater to the washes (Figure 3). The total number of species occurring on 0.25-ha plots at sites 1-3 was 38, 39, and 42, and 28 species occurred on the 0.09-ha plot at site 4. We found a grand total of 73 species on all plots.

All four sites were dominated by native shrubs and perennial grasses, with smaller components of cacti and native and exotic forbs and annual grasses (Appendix 1). White bursage, Nevada jointfir (*Ephedra nevadensis*), creosote, and littleleaf ratany (*Krameria erecta*) overall were the most frequently occurring shrubs, with catclaw also occurring at ≥ 40% frequency at three sites. Two to four cactus species occurred per site, although these occurrences were scattered typically at < 10% frequency. Perennial forbs were not abundant overall, with desert trumpet being the most frequent species at all four sites followed by broom snakeweed exhibiting 60-80% frequency at two sites. Perennial grasses were sharply more abundant than is typically described for Mojave Desert shrub communities (Vasek and Barbour 1977).

Description of the Perennial Grasses

At least three native perennial grass species occurred at each site (Appendix 1). Purple three-awn was frequent at sites 1-3 and was principally concentrated in the washes. Red grama, listed as a rare species in California in different rarity classifications (California Native Plant Society 2008), occurred with purple three-awn at two sites and also inhabited washes. The short-statured fluff grass occurred at greater than 50% frequencies at all four sites, although at low relative cover (<1%). Scratchgrass (*Muhlenbergia asperifolia*), whose habitat Baldwin et al. (2002) list as moist, often alkaline meadows, seeps, or hot springs, occurred at 100% frequency in the sandy wash site 4. Blue grama (*Bouteloua gracilis*) was another major grass co-occurring with scratchgrass at site 4. Occurring only at site 3, bush muhly (*Muhlenbergia porteri*) occurred in two 0.01-ha cells only in the wash. There was one patch of approximately 3 m^2 of 100% ground cover of bush muhly directly below a mesquite tree. Big galleta grass (*Pleuraphis rigida*) was most abundant at site 3, where it formed grassland-like stands that had more than 10% relative cover in some cells. Although it occurred just to the west of the sample plot at site 1 and not on the plot, deergrass formed a nearly pure dense stand of several hectares in a shallow, flat part of the wash (Figure 2). This species is sometimes used for landscaping in Las Vegas, and it is unclear whether the species is native to this site or results from escaped landscape plants. Baldwin et al. (2002) indicate that deergrass is native to the Mojave

Desert and occupies sandy to gravelly soils, canyons, and stream bottoms. Grasses are unique components of desert ecosystems (Bock and Bock 1986), and factors affecting their past and present distribution and abundance warrant additional study (Abella 2008).

Salvage Project

After one year of storage, 76% of overall salvaged plants were alive. This is similar to a previous study at these sites that found 82% greenhouse survival for salvaged globemallow (Abella 2007). Salvaging plants can be particularly useful for species that have seeds difficult to germinate or are difficult to propagate. Given its potential for success suggested by this study, more controlled experiments could be undertaken to include additional species (those with different rooting habits and other characteristics) and to more rigorously test methods to improve efficiency and feasibility of salvage. Obtaining good survival of transplants in field plantings is difficult in the Mojave, as it is in other deserts, due to limited water, herbivory by animals, and other factors (Lovich and Bainbridge 1999). Nevertheless, there are many examples of successful desert plantings. For instance, Newton (2001) achieved 92% survival for creosote and 100% survival for beavertail pricklypear (*Opuntia basilaris*) after two years at Lake Mead National Recreation Area in the eastern Mojave Desert. Plantings for urban desert landscaping may have higher survival. The potential for salvaging seed from sites, as well as harvesting seed from salvaged plants themselves, also should not be overlooked.

Conclusion

The grass and catclaw-mesquite communities described in this study are rare and do not occupy extensive areas of the Mojave Desert. For example, Crampton et al. (2006) estimated that catclaw and mesquite occupy only approximately 14,000 ha (0.7%) within the total land area (20,950-km^2) encompassed by Clark County. Native perennial grasses and other species in these and other native Mojave Desert communities may be suitable for establishment in areas such as urban parks, golf courses, and those benefitting from desert landscaping. Attempts could be made to create elsewhere habitats that have been lost in Las Vegas Valley, although creation of communities where they did not exist before may raise ethical issues and may not be fully ecologically feasible. Nevertheless, it should be recognized that much of the diverse vegetation of the Las Vegas Valley has been destroyed (Hickerson and Wolf 1998), so protecting or restoring similar habitat outside the valley and conducting habitat creation may be appropriate conservation goals. Salvaging plant material and possibly other material (e.g., soil crusts) from sites to be developed requires labor, facilities to store the material, and mechanisms for using the material. Although not as ecologically beneficial as protecting the habitat, salvage may offer the only opportunity for preserving local genetics and populations of many species of the Las Vegas Valley. In our view, great opportunities exist for at least partly maintaining the legacy of rich Las Vegas vegetation through strategic protection of remnants or incorporating remnants into developments, salvaging material, and conducting documented studies of past and present vegetation to record this unique resource.

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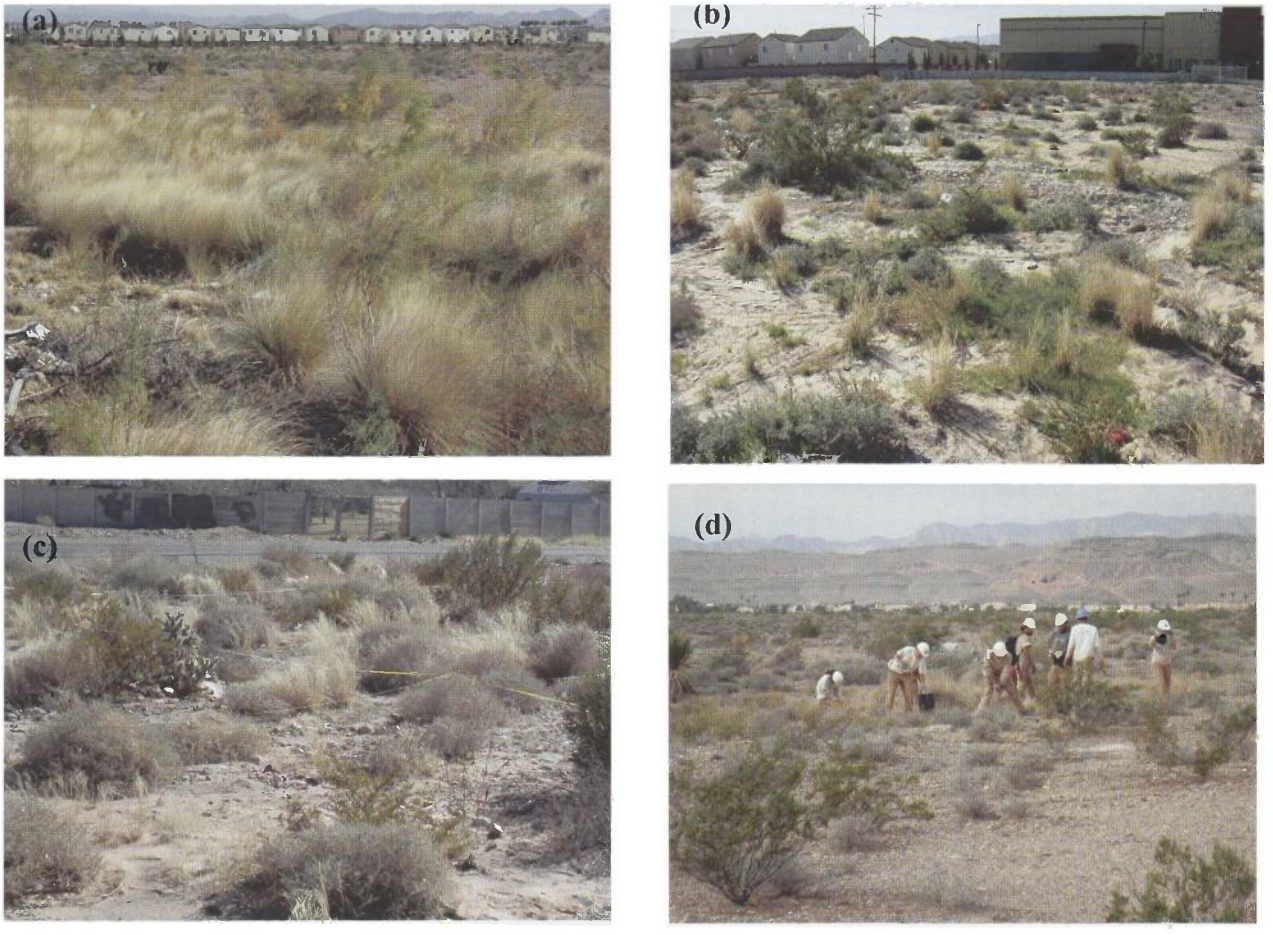

Figure 1. Views of (a) dense mat of deergrass that occurred just west of site 1, (b) the proximity of sites to development, disconnecting washes from natural drainage ways, (c) the strong presence of grasses at site 4, (d) the Nevada Conservation Corps assisting with plant salvage on site 1.

Figure 2. Location of surveyed sites in the southwestern Las Vegas Valley, Clark County, southern Nevada. Sites 1-3 were near the intersection of Warm Springs and Buffalo Roads, and site 4 was south of the intersection of Warm Springs and Decatur Roads.

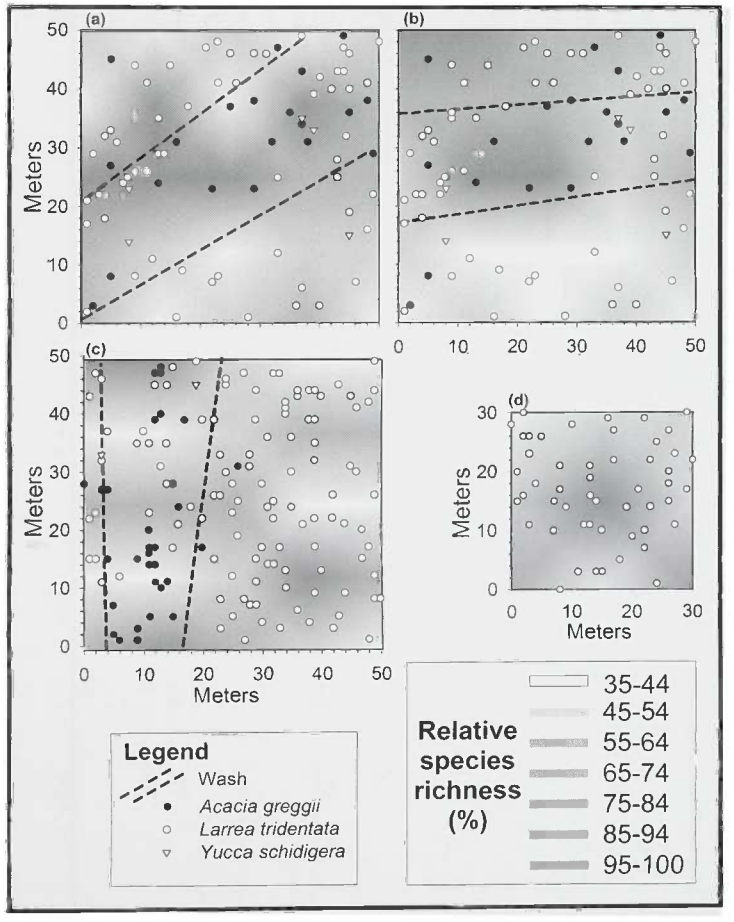

Figure 3. Distributions of three mapped shrub species and plant richness (smoothed based on 0.01 - ha sample cells) expressed as a percent of the maximum richness value on that plot for four sites in the Las Vegas Valley, southern Nevada; (a) site 1, (b) site 2, (c) site 3, (d) site 4.

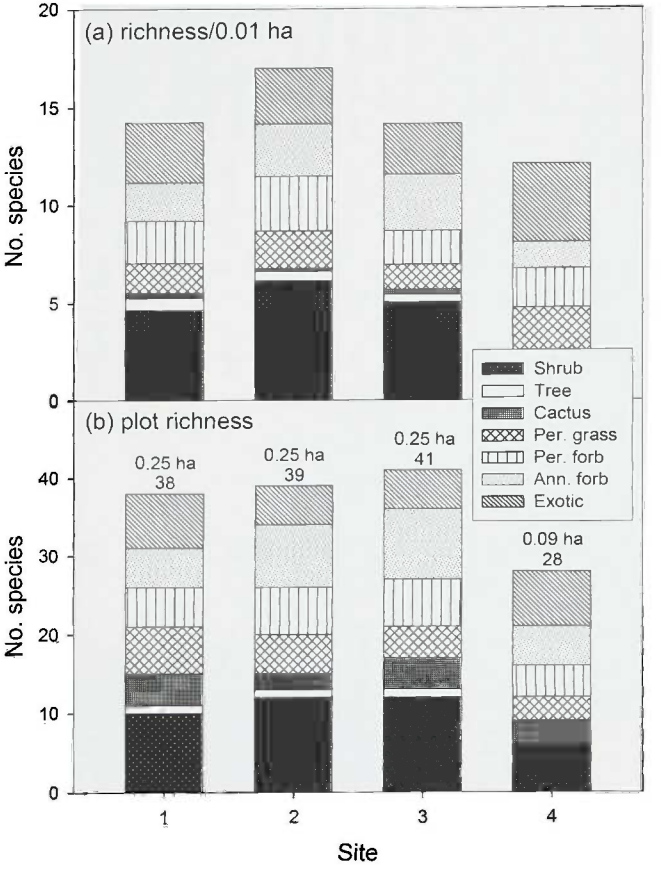

Figure 4. Plant species richness of exotic species and by growth form for native species for four sites in the Las Vegas Valley, southern Nevada.

Appendix 1. Species percent frequency in 25, 0.01-ha cells at sites 1-3 and in 9, 0.01-ha cells at site 4, Las Vegas Valley, southern Nevada. Lifeform and exotic/native classifications follow NRCS (2008).

SPECIES	Site 1	Site 2	Site 3	Site 4
EXOTIC				
Brassica tournefortii	20	56	56	100
Bromus madritensis	100	96	84	100
Eragrostis cilianensis				11
Erodium cicutarium	68	64	36	33
Salsola paulsenii				66
Salsola tragus	20	4		
Schismus spp.	48	64	76	77
Sisymbrium irio				11
Sisymbrium orientale	32		8	
Tamarix ramosissima	20			
NATIVE				
Annual forb				
Abronia villosa				11
Camissonia boothii			8	
Chamaesyce spp.				33
Chorizanthe rigida	32	48	68	
Cordylanthus ramosus	8			
Cryptantha spp.		24		
Datura wrightii				11
Eriogonum deflexum				11
Eriogonum spp.			20	4
Guillenia lasiophylla	24	4	12	
Lepidium lasiocarpum	48	72	52	
Mentzelia albicaulis			4	
Pectocarya spp.		4		
Phacelia crenulata		4		
Plantago ovata	88	92	92	67
Perennial forb				
Amsonia tomentosa			24	
Cuscuta californica				44
Eriogonum inflatum	88	80	76	89
Gutierrezia sarothrae	80	60	16	
Porophyllum gracile	12	48		
Sphaeralcea ambigua	32	52	32	
Stephanomeria pauciflora	4	4	4	56
Thymophylla pentachaeta		36	20	
Tidestromia oblongifolia				11
Perennial grass				
Aristida purpurea	60	48	20	
Bouteloua gracilis				89
Bouteloua trifida	12	44		
Dasyochloa pulchella	56	60	56	67
Muhlenbergia asperifolia				100
Muhlenbergia porteri			8	
Pleuraphis rigida	4	24	44	
Tridens muticus	20	16		
Cactus				
Cylindropuntia acanthocarpa				11
Cylindropuntia echinocarpa	4	8	8	
Cylindropuntia ramosissima	8		4	33
Echinocactus polycephalus			4	

Echinocereus engelmannii	4			
Ferocactus cylindraceus		4		
Opuntia basilaris			8	11
Shrub				
Ambrosia dumosa	100	92	100	89
Chrysothamnus spp.	8			
Encelia virginensis	32	84	40	
Ephedra nevadensis	80	100	60	100
Eriodictyon trichocalyx			44	
Eriogonum fasciculatum	48	72	44	
Krameria erecta	64	92	60	89
Krascheninnikovia lanata				44
Larrea tridentata	88	72	92	89
Lepidium fremontii		8	12	
Lycium spp.	16	32		
Menodora spinescens		4	16	44
Psorothamnus fremontii	12	20	52	
Salazaria mexicana		8	4	
Thamnosma montana			16	
Yucca schidigera	16	28	8	
Tree				
Acacia greggii	64	52	40	

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