

Two Decades of Vegetation Change in Saguaro National Park, 1990-2010



Final Report

August 2011

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Abstract

This report details the results from the third iteration of vegetation surveys on 45 plots in Saguaro National Park, as part of the park's 2010 Saguaro Census. These 100 m² plots were first surveyed when established in 1990, and surveyed again in 2000 and 2010. We followed previous survey protocols, and recorded cover and location of all individual perennial plants observed on each plot. We analyzed changes at the species, family, lifeform, and plot levels over the past two decades in the context of what is known about long-term vegetation change in Saguaro National Park.

In general, we observed that plant cover declined, but plant density increased, during the past decade in both districts. In the Rincon Mountain District, we observed increases in cover and density among most life forms (forbs, shrubs, subshrubs, succulents, and vines) except trees; however, in the TMD, we observed decreases in all life forms except succulents. For all lifeforms except trees, which have declined during the past two decades in both districts, the gains observed in 1990-2000 exceed the losses observed during 2000-2010.

Researchers in 2000 observed significant increases in the density or cover of a large number of the 75 species now observed on the plots, and decreases in a much smaller number. For example, during 1990-2000 17 species increased in cover at RMD and none decreased, and 14 species at TMD increased and only one decreased. In contrast, during 2000-2010 only a few species increased in cover or density in the two districts, and others decreased. The exotic grass buffelgrass, which was observed on only one plot in 1990 and 2000, was observed on three plots in 2010.

While it is not possible to attribute changes in vegetation in Saguaro National Park to environmental changes using these monitoring data, it is noteworthy that the 2010 survey coincides with the close of Tucson's hottest and driest decade on record from 2000 to 2009, a period considerably drier than the previous decade of the 1990s. Nonetheless, long-term trends of increasing subshrubs, shrubs, vines are continuing at the park. Data from this study, which we hope will be repeated in 2020, have the potential to be a rich source for monitoring long-term vegetation changes in Saguaro National Park.

Acknowledgements

This project was made possible by funding from the Western National Parks Association. Additional support was provided by the George Melendez Wright Climate Change Fellowship Program, the Desert Southwest Cooperative Ecosystem Studies Unit, the Tucson Cactus and Succulent Society, and the Friends of Saguaro National Park. Thanks to all Saguaro National Park employees for their assistance with this project: Tiffany Alvarez, Kim Diamond, Emma Fajardo, Kelly Flickinger, Mike Jones, Justin Kolb, Cheryl McIntire, Mike Montalvo, Kara O'Brien, Johnny Ortiz, Chris Pruden, Kris Ratzlaff, Rafael Rojas, Alexis Sanchez, and Mike Ward. Also, special thanks to the many volunteers who assisted with field surveys: Albi von Dach, Martha Tullis, Susan Paul, Fred Roberts, Matt Christenson, Katie Gray and Carianne Funicelli. We are grateful for the support of Saguaro National Park, particularly Meg Weesner, Chief of Resource Management, Becky MacEwen, GIS specialist, and Dana Backer, restoration ecologist. We are particularly grateful to Andy Hubbard, Jeff Balmat, and other staff of the Sonoran Desert Inventory and Monitoring program for their assistance in design, analysis, and use of their total station.

Most of all, we are grateful to the researchers who came before us in 1990 and 2000, and who provided an excellent dataset and detailed protocols. We thank Dan Duriscoe and Sandra Graban, who set up the project in 1990, and Carianne Funicelli, Pam Anning, and Dale Turner, who improved the protocols and did an enormous amount of work digitizing the data and maps in 2000. We hope that the next generation of researchers in 2020 will find our work a useful addition to our predecessors.

Finally, this project is largely inspired by the vision and dedication to long-term monitoring of Sonoran Desert vegetation by Ray Turner, Tom Orum and Nancy Ferguson.

Introduction

This report details the third iteration of perennial vegetation mapping on plots associated with the Saguaro Census. The Saguaro Census is a large-scale monitoring effort at Saguaro National Park that focuses on the saguaro cactus and takes place every ten years (O'Brien et al. 2010). Forty-five permanent plots, each 100 square meters in size and associated with a 4 hectare Census plot, were first established and mapped in 1990 by Dan Duriscoe and Sandy Graban (Duriscoe and Graban 1991). The plots were again surveyed in 2000 by Dale Turner, Pam Anning, and Carianne Funicelli (Funicelli et al. 2001). We initiated field surveys for the 2010 survey in October of 2009 and concluded in October of 2010.

With each survey iteration we are able to gain more information about the composition of vegetation communities in Saguaro National Park. Concerns are growing over the impacts of climate change on the species in the park. The decade from 2000 to 2009 was the hottest and driest in Tucson, Arizona's recorded history (NOAA 2010). While it is uncertain whether this drought represents the beginning of a local shift into a drier climate as predicted, the impacts of climate change are starting to be felt globally (IPCC 2007). Climatologists warn that the southwestern U.S. may be moving towards the conditions of the Dust Bowl (Seager et al. 2007). These changing climatic conditions and the implications for invasion by exotic species are why Saguaro National Park has been named as one of America's most imperiled national parks (Saunders et al. 2009). This status is largely due to the establishment of exotic buffelgrass (*Pennisetum ciliare*), which is already underway and at least partially caused by recent changes in climatic conditions (Stevens and Falk 2009).

Funicelli et al. (2001) noted that the Saguaro Census vegetation project would benefit from the collection of weather data at additional locations in the park. Weather data is currently being collected at four locations in the park, the TMD visitor center, the RMD visitor center, Rincon Creek, and Manning Camp at 8000 feet elevation in the Rincon Mountains. These data from the past ten years have recently been summarized (Rojas et al. 2011) and are referenced in this report. Although park-specific climate data are not available for previous decades, it is clear from Tucson records that precipitation has varied considerably across the three survey periods. As opposed to the previous two surveys, which were preceded by relatively abundant summer precipitation, 2009 ranked as the eleventh driest monsoon on record due to El Niño conditions (NOAA 2010).

Our objective for this report is to highlight changes in vegetation at Saguaro National Park by individual plant species, families, lifeforms and plots between 1990 to 2000, 2000 to 2010, and 1990 to 2010. Furthermore, we place these changes in the context of historic management practices (e.g. grazing and wood-cutting) and climate change.

Study Area

Saguaro National Park (Figure 1) is comprised of two districts: the Rincon Mountain District (RMD) and the Tucson Mountain District (TMD). These two districts are separated by Tucson,

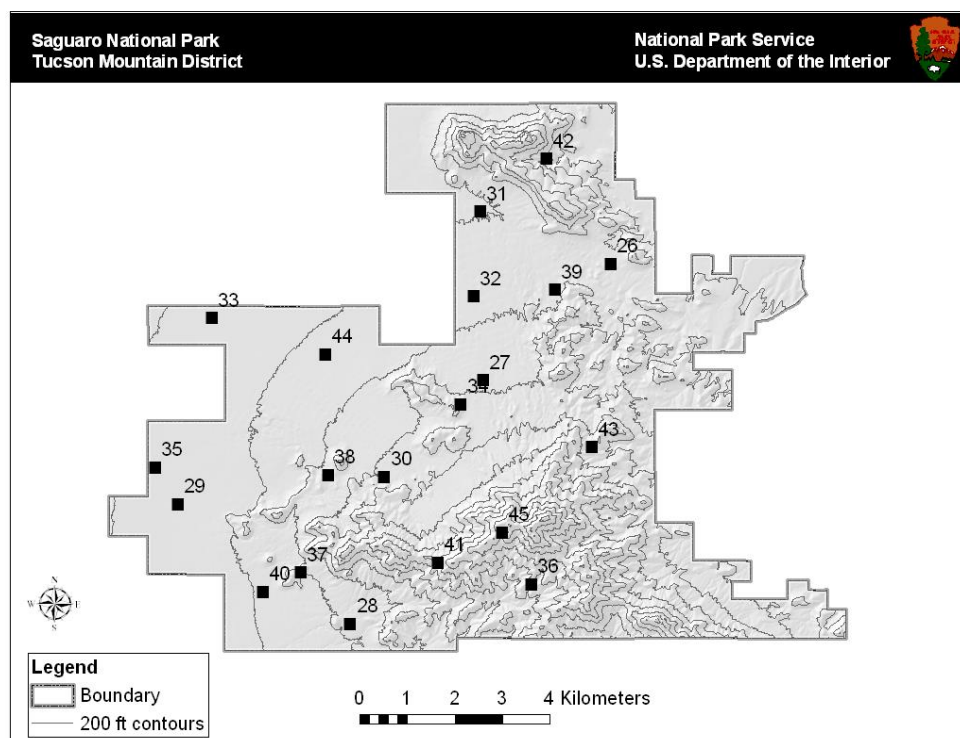
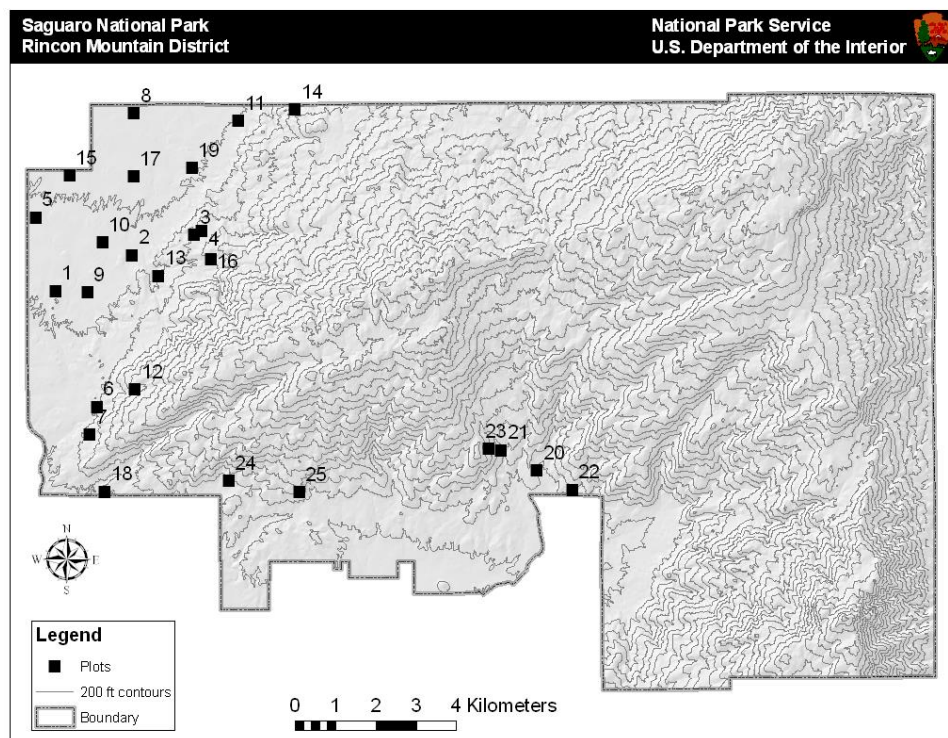


Figure 1. Plot locations at the Rincon Mountain District (top) and the Tucson Mountain District (bottom) of Saguaro National Park.

Arizona, with RMD located on the eastern side of Tucson and TMD situated on the western side of Tucson.

The two districts have substantial elevation gradients, with RMD ranging between 820 to 2,640 meters and TMD ranging between 670 to 1,428 meters. Forty-five plots were randomly located in 1990 on the Arizona Upland subdivision of the Sonoran Desert (Figure 1). At TMD, 20 plots are located randomly throughout the entire district, and range in elevation from 683 to 1,262 meters. At RMD, 25 plots are located within saguaro habitat as defined by an early vegetation map of the park (McDougall 1937, Roseberry and Dole 1939), and range in elevation from 823 to 1,213 meters.

The region is characterized by a bimodal precipitation pattern, with up to fifty percent of precipitation falling between July and September due to the North American monsoon (Sheppard et al. 2002). Winter rains, occurring between November and March, contribute less volume than monsoon rains, but produce more soil moisture because of the decreased evaporation rates in winter (Figure 2). In general, the climate in Saguaro National Park during 2000-2010 was characterized by a severe drought during the first part of the decade, and higher rainfall in the second part of the decade (Figure 3). However, a summer storm on July 31, 2006 brought one of the highest amounts of precipitation ever recorded in the Tucson area (Perger 2008).

Historical disturbances to the ecology of the two districts most notably came from cattle grazing and the harvesting of mature trees such as palo verde and mesquite (Clemensen 1987). Both activities are believed to have been much more intense at RMD, which was closer to settlement areas and had more reliable water sources. Grazing was eliminated from the TMD in the 1930s and gradually eliminated from the RMD between the 1940s and 1970s.

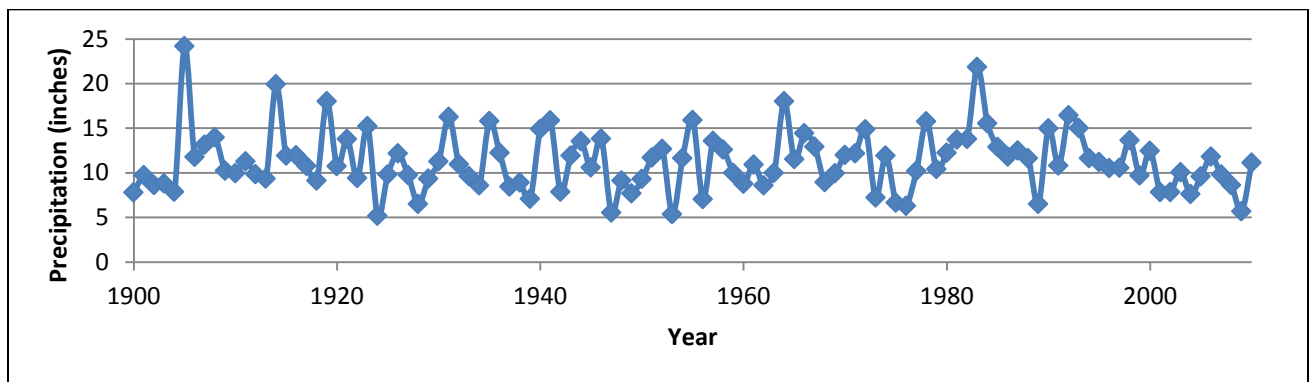


Figure 2. Annual precipitation record from the Tucson International Airport (1900-2010).

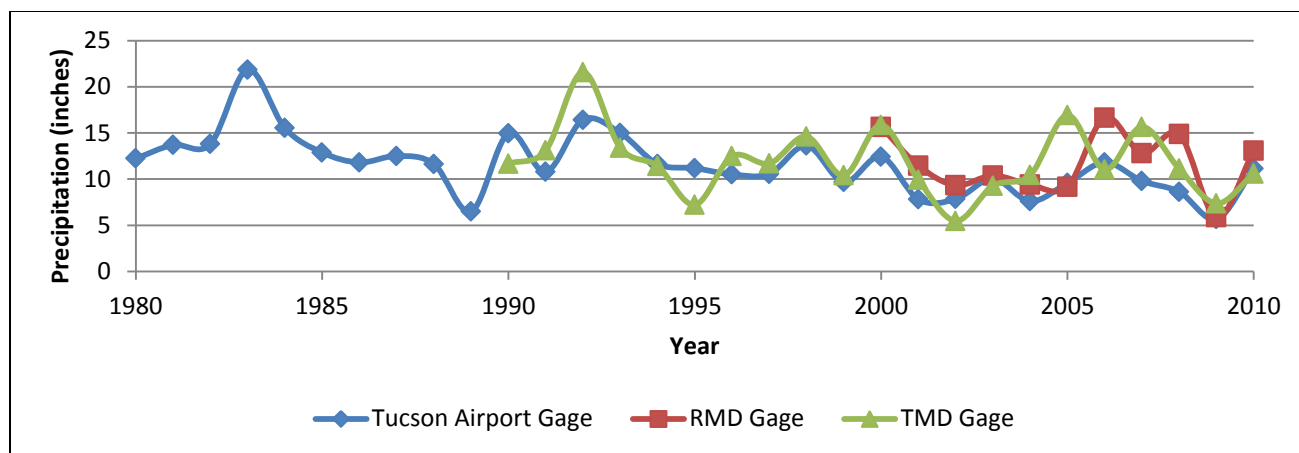


Figure 3. Annual precipitation record from the Tucson International Airport and the Rincon Mountain District (RMD) and Tucson Mountain District (TMD) of Saguaro National Park (1980-2010).

Methods

Survey methodology

Plots were initially established in 1990 (Duriscoe and Graban 1991), and centered on a saguaro (one individual >2 m on the 4 ha plot, randomly selected) as one component of the broader Saguaro Census project. Duriscoe and Graban (2001) created their field maps of these plots as a square 10 m x 10 m plot. During the 2000 survey, rebar stakes were placed at the four corners of the plots (Funicelli et al. 2001) to increase the accuracy of future surveys. During this process, it was discovered that the plots were not perfectly square. Plot size ranges from 96.93 m² to 106.54 m² due to the confounding influence of slope. The 2000 and 2010 surveys were conducted to the rebar stakes at plot corners. Funicelli et al. (2001) made adjustments to the 1990 survey data to enable comparative data analysis.

The 1990 and 2000 surveys were conducted using a plane table and alidade. Funicelli et al. (2001) report the accuracy of the plane table and alidade method as being +/- 10 cm.

After a careful evaluation that included input from the previous researchers, we chose to change the survey methodology to use a Nikon DTM-330 Total Station Transit. We selected this method because of the advantages of increased accuracy (less than 1 cm) and speed in data collection. Data collected in the field were stored in SurveyPro software on a Recon computer. We then downloaded these data using the Foresight DXM software program, and converted files to the shapefile format for use in the ArcGIS software suite.



Figure 4. Operation of the Nikon DTM-330 Total Station Transit and prism pole by Saguaro National Park employees Chris Hannum (l) and Kris Ratzlaff (r).

Other than equipment differences, survey methods across the three surveys were fundamentally the same. In 2010, as in previous surveys, we collected points at the stem of every plant within the plots. We measured the diameter of all plants that had a circular canopy and were roughly one meter or less in diameter, taking the mean of two perpendicular planes across the plant. If the canopy was irregularly shaped, we collected multiple points around the perimeter of the plant. In 1990 and 2000, surveyors connected these points by hand-sketches field maps to delineate the canopy of the plant. In 2010, we collected canopy points with the Total Station Transit and later connected these vertices using ArcGIS software in the office. In 2010, we recalculated canopy area in the GIS to confirm values for the 1990 and 2000 surveys and combined these values with data from the 2010 survey.

As Funicelli et al. (2001) noted, in cases of overlapping canopies of the same species such as fairy duster (*Calliandra eriophylla*) it was often more efficient to collect points for each of the stems and then map the collective canopy for all plants in the cluster. We followed this same protocol. Additionally, there were cases in which the canopy of a plant rooted outside the plot extended into the plot. Even though the stem of the plant is outside the plot, we followed the methods of Funicelli et al. (2001) by including these plants in the stem count for the plot.

As in previous surveys, we did not record any data for annual species. The survey protocol has also established that stem data is not collected for ferns or fern allies, but a percent cover for the entire plot is estimated. Perennial grass species are treated in the same way by not taking data for individual plants, but a percent cover is collected for each individual species at the plot level. One of our few exceptions to the established protocol was for buffelgrass (*Pennisetum ciliare*).

incremental and measurable. The few changes that have been made in methodology are superficial and have been made to increase the accuracy and repeatability of future surveys.

Inconsistencies between surveys

Our most substantial deviation from the methods of previous surveys was in capturing the post-2000 proliferation of three species: brittlebush (*Encelia farinosa*), desert zinnia (*Zinnia acerosa*) and hairyseed bahia (*Bahia absinthifolia*). We found as many as 665 *E. farinosa* individuals on a single plot with over 5,023 individuals of this species found across all plots. The large number of individuals of these species required us to adapt methods for efficiency in mapping the plots. Because mapping each individual was unfeasible, we only mapped individuals over 30 cm in diameter. We selected 30 cm as the threshold because individuals of that size were well-established and likely to have longer-term survival rates. We placed individuals less than 30 cm into two size classes (0-15 cm and 16-30cm), counted the number of individuals in each size class, and calculated an average diameter by selecting a random sample of plants in each size class. While less accurate than mapping individual plants, this method allowed us to capture some data for individual species that would have otherwise been neglected.

The taxonomic names of fourteen plants have changed since this project began. We have adopted the current accepted names (USDA, NRCS 2010) in this report. Funicelli et al (2001) identified several species that were inconsistently mapped between 1990 and 2000. Appendix 6 details all of the plant-specific changes that have been made in the two decades since the project began.

Funicelli et al. (2001) reported the inclusion of seven new species that had not been previously encountered or mapped: *Ayenia filiformis*, *Ayenia microphylla*, *Bahia absinthifolia*, *Baileya multiradiata*, *Carlowrightia arizonica*, *Commicarpus scandens*, and *Matelea* species. Some of these plants may have been inadvertently left out of the 1990 survey, although present, and changes related to these species should be interpreted with caution. Funicelli et al. (2001) reported finding misidentified plants from the 1990 survey. We also found plants that had been either mislabeled or misidentified. With thousands of plants mapped in each survey (Figure 6), it can be expected that some errors will occur. In all cases, the previous data has been corrected to enable the most accurate cross-decade analysis possible.

Analysis

We evaluated changes during 1990-2010 in number of plants and cover area by species, family, and lifeform. We used six lifeforms: forbs, shrubs, subshrubs, succulents, trees and vines. We separated data by district because of the fundamental differences observed in vegetation communities at RMD and TMD. To assess the significance of change observed by species, family, and lifeform at the plot level we used the Wilcoxin Signed-Rank Test, a non-parametric version of the paired t-test. We extended alpha levels to 0.10, following Funicelli et al. (2001). We used STATA 11 software for all statistical analysis.

GIS Data Archiving

Each iteration of the survey relied on three different mapping software systems. The 1990 survey utilized AutoCad software; the 2000 survey utilized ArcGIS 8.0; and the 2010 survey utilized ArcGIS 9.3. We migrated all data to the ArcGIS 9.3 format and archived it on the Saguaro

National Park server at “N:\GIS_Library\Vegetation\saguaro_census\subplots” and also at the NPS data center.

Results

Cover and density changes

The mean cover per plot of all perennial plants, which increased in both districts during 1990-2000, decreased in both districts during 2000-2010 (Figure 6, Table 1). In the RMD, mean cover per plot was 42 m² in 1990, 60 m² in 2000, and 44 m² in 2010. In the TMD, mean cover per plot was 42 m² in 1990, 53 m² in 2000, and 39 m² in 2010.

On all plots combined, the total number of individual plants observed (density) was higher during 2010 than in 1990 and 2000 (Figure 6, Table 1). At RMD, mean density (plants per 100 m²) was 114 in 1990, 140 in 2000, and 332 in 2010. In the TMD, mean density was 145 in 1990, 174 in 2000, and 185 in 2010.

Lifeform-level changes

Across the two decades, forbs, shrubs, subshrubs, succulents, and vines all generally increased in both districts. Gains experienced from 1990 to 2000 exceed the losses observed from 2000 to 2010, even at TMD. However, trees have declined in cover at both districts, and in density at RMD. A small decline of 8.29 m² was observed between 1990 and 2000, with an additional 140.61 m² decline in tree cover observed between 2000 and 2010. In total, tree cover declined 30% at RMD between 1990 and 2010.

Family-level changes

During 1990-2000, both density and cover of most plant families in both districts increased significantly (Figures 15-18). During 2000-2010 at RMD, both density and cover increased for most families; however, Polygonaceae lost 84% of all individuals from 1990 to 2010. *Eriogonum wrightii* is the only species representing this family on the 45 plots. During 2000-2010 at TMD, most families decreased in density, and greatly decreased in cover.

Species-Level Changes

The total number of species observed on the 45 plots in 2010 was 75, an increase in 2 species from 2000 (Table 1). *Jacquemontia pringlei* was mapped for the first time in 2010. Figures 11-14 show trends in individual species during the 1990-2010 period.

Of the 75 species represented on the 45 plots, 32 species have exhibited a significant change in density or cover across the two decades. During 1990-2000, general increases were seen at both districts. At RMD, 17 species increased in cover and 9 species increased in density. At TMD, 14 species increased in cover, and 8 species increased in density. During the same decade, no species decreased in cover at RMD and 3 species decreased in density, and at TMD only 1 species decreased in cover, and 1 species decreased in density.

During 2000-2010, 9 species gained density but only 4 gained cover at RMD while 2 species lost density and 4 species lost cover. At TMD, 1 species (*Jatropha cardiophylla*) increased in

density, and 1 species (*Fouquieria splendens*) increased in cover, while 2 species lost density and 4 species lost cover.

Individual species that deserve special attention are buffelgrass (*Pennisetum ciliare*), desert zinnia (*Zinnia acerosa*), hairyseed bahia (*Bahia absinthifolia*), and brittlebush (*Encelia farinosa*). The non-native grass *P. ciliare*, was observed on plot 35 in 1990 and 2000. In 2010, we observed *P. cilare* on plots 35, 12 and 18. *Z. acerosa*, *B. absinthifolia*, and *E. farinosa* are all native species, but should be noted for the extreme increases in density and cover that they exhibited between the 2000 and 2010 surveys. *E. farinosa* showed the most changes, with as many as 665 individuals on a single plot and over 5,023 individuals found across all plots.

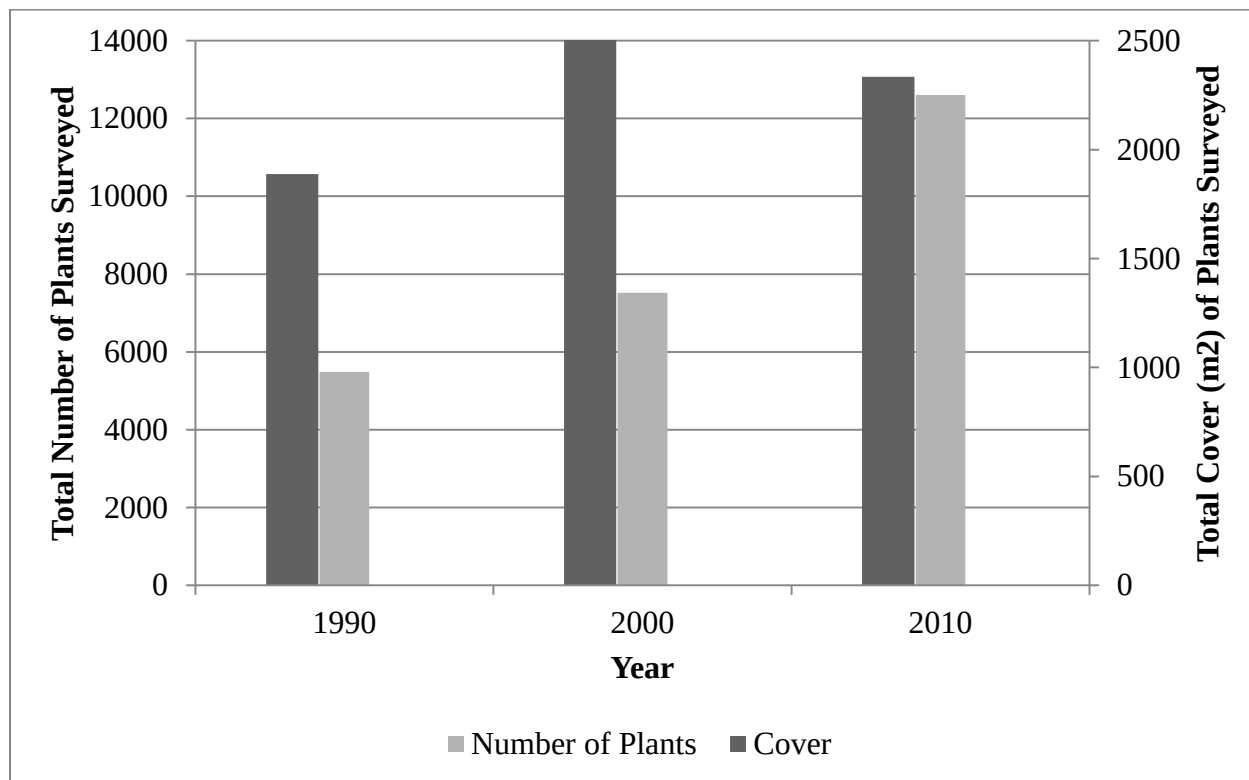


Figure 6. Total number of plants and total cover from the 1990, 2000 and 2010 surveys.

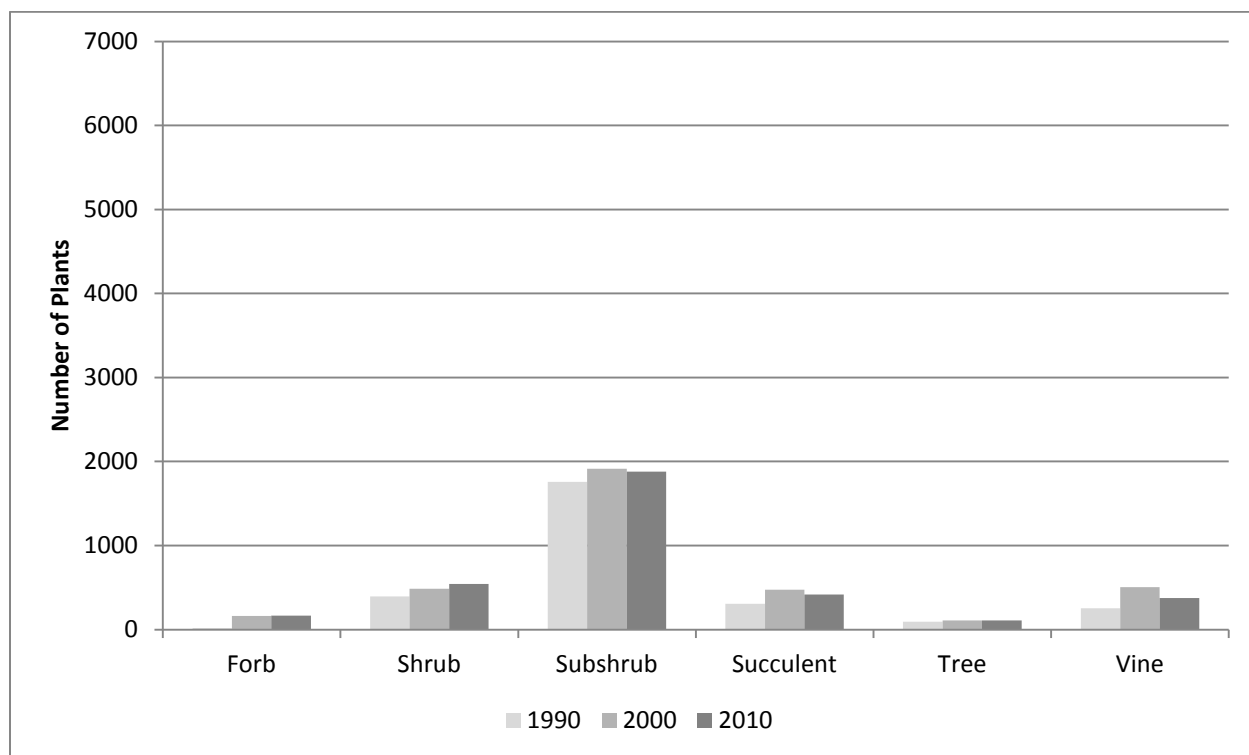


Figure 7. Total number of plants by lifeform at TMD (1990-2010).

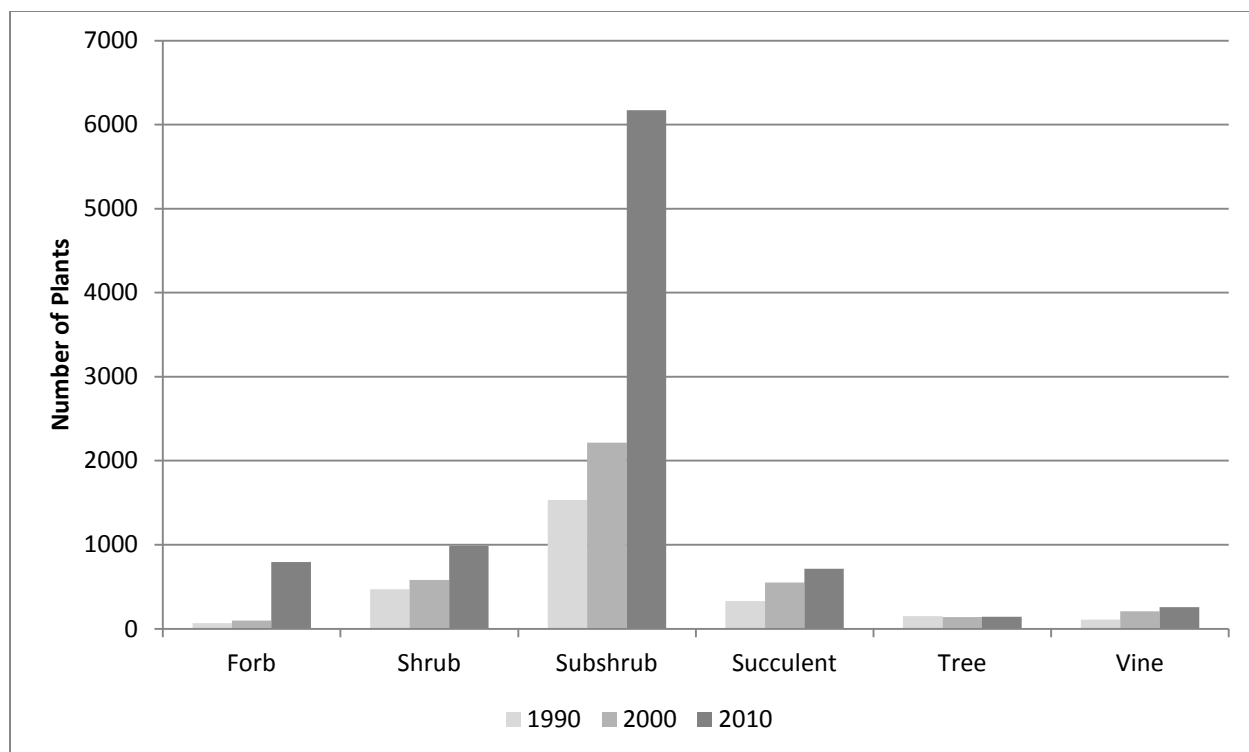


Figure 8. Total number of plants by lifeform at RMD (1990-2010).

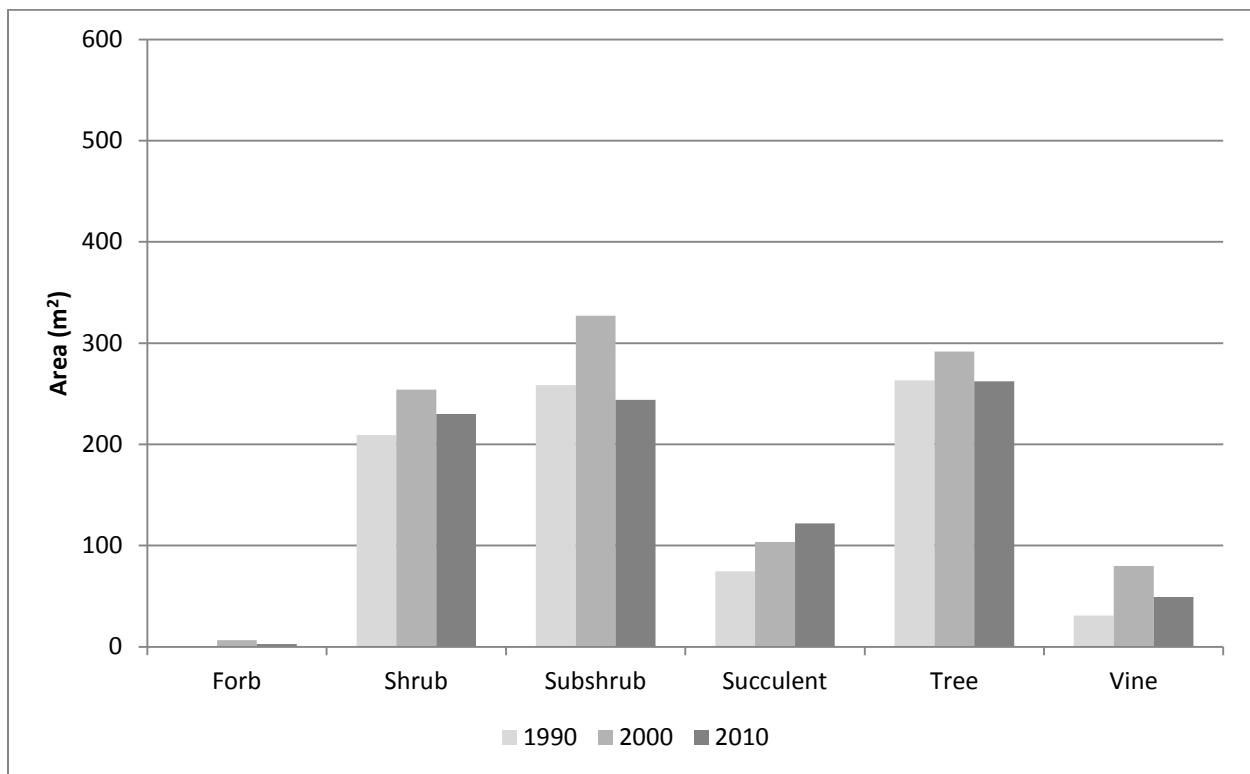


Figure 9. Total cover (m²) by plant lifeform at TMD (1990-2010).

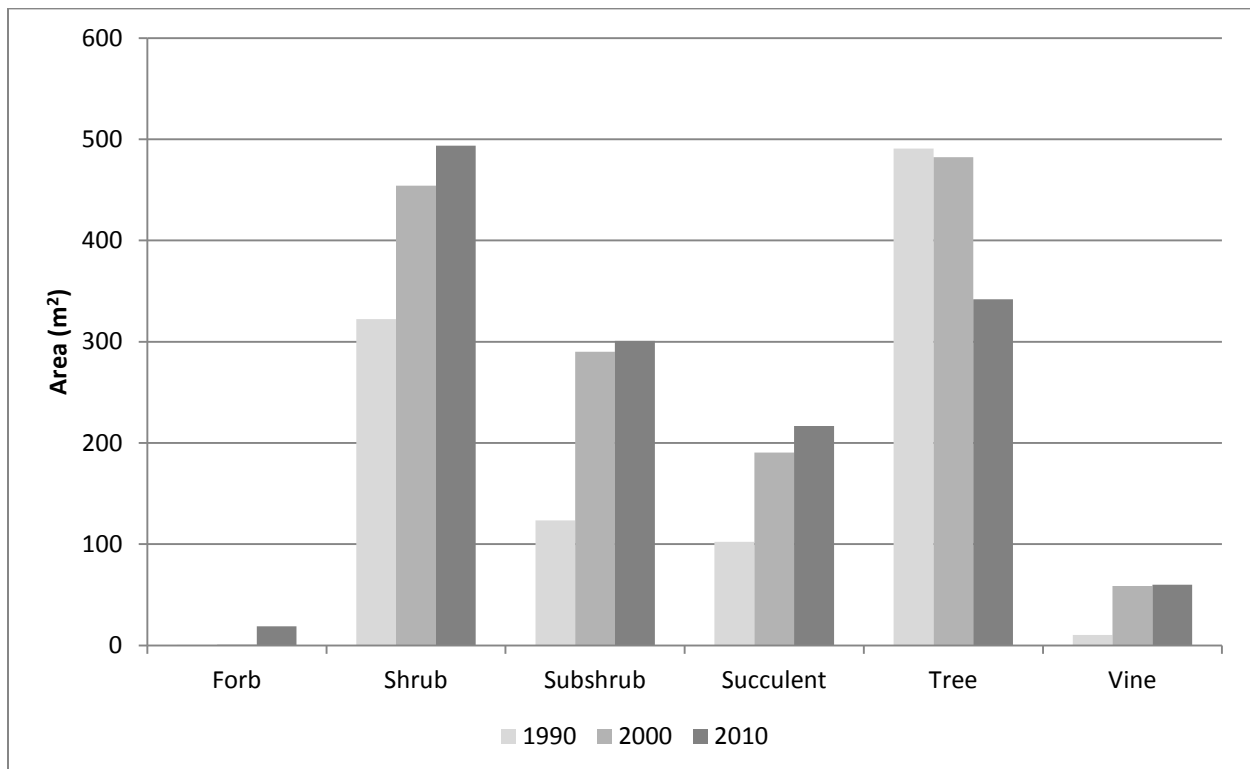


Figure 10. Total cover (m²) by plant lifeform at RMD (1990-2010).

Table 1. Summary of diversity, cover, and frequency by district for 1990, 2000, and 2010. Values for grasses, ferns and fern allies are not included. Values in parentheses exclude species that may have been inconsistently mapped in 1990. These species are *Ayenia filiformis*, *Ayenia microphylla*, *Bahia absinthifolia*, *Baileya multiradiata*, *Carlowrightia arizonica*, *Commicarpus scandens*, and *Matelea* species.

Location	Number of species	Number of species only found in one district	Number of families	Mean cover per plot (m ²)	Mean density (plants per 100m ²) per plot
RMD 1990	54	16	20	42.04	113.64
TMD 1990	53	12	19	41.88	145.00
Total 1990	68		22		
RMD 2000	57 (54)	11 (10)	21 (20)	59.56 (58.83)	153.64 (139.40)
TMD 2000	59 (53)	16 (13)	23	53.27 (52.93)	183.90 (174.45)
Total 2000	73 (66)		25		
RMD 2010	62 (58)	17 (16)	26 (23)	44.03 (43.86)	348 (331.68)
TMD 2010	58 (52)	13 (10)	20 (18)	38.56 (38.53)	195 (185.30)
Total 2010	75 (68)		26 (23)		

Table 2. District-wide changes in cover and density by plant lifeform. Density data is provided for the change in the total number of plants as well as changes in cover (m²). Numbers in parentheses indicate the percentage of change observed. Statistical significance is indicated from the Wilcoxin Signed-Rank Test.

		Density Change: # plants (% increase or decrease)		Cover Change m ² (%)	
		RMD	TMD	RMD	TMD
1990- 2000	Forb	33(50)	144(847)**	0.39(84)*	6.02(1067)**
	Shrub	110(23)**	91(23)**	131.83(41)***	44.96(21)***
	Subshrub	679(44)**	155(9)**	166.47(135)***	68.73(27)***
	Succulent	223(68)***	168(55)***	88.20(86)***	28.99(39)***
	Tree	-12(-8)	15(16)**	-8.29(-2)**	28.73(11)*
	Vine	102(95)***	253(100)***	48.36(475)***	49.12(160)***
2000- 2010	Forb	696(703)*	5(3)	17.86(2089)	-3.99(-61)
	Shrub	406(70)***	57(12)	39.54(9)*	-24.11(-9)
	Subshrub	3957(179)*	-32(-2)†	10.70(4)	-82.99(-25)*
	Succulent	163(30)†	-58(-12)	26.24(14)	18.41(18)*
	Tree	2(1)	-1(-1)	-140.61(-29)***	-29.48(-10)
	Vine	50(24)†	-130(-26)*	1.35(2)	-30.66(-38)*
1990- 2010	Forb	729(1105)	149(876)**	18.25(3924)	2.02(358)**
	Shrub	516(109)***	148(38)**	171.38(53)***	20.83(10)
	Subshrub	4636(302)***	123(7)	177.17(143)***	-14.25(-6)
	Succulent	386(118)***	110(36)**	114.44(112)***	47.40(64)***
	Tree	-10(-7)	14(15)	-148.91(-30)†	-0.76(-0.3)
	Vine	152(142)**	123(49)†	49.72(488)**	18.46(60)†

p<0.001 ***; p<0.01 **; p<0.05, *; p<0.10†

Discussion

How has the plant community at Saguaro National Park changed over time, how is it continuing to change, and what are the major environmental factors driving these changes? These questions have interested managers and biologists at the park for decades (McAuliffe 1993) and were the motivation for establishing the monitoring program described in this report.

Although there is a large amount of data on changes in the saguaro population in the Cactus Forest area over the past 70 years, little data exist on changes in the distribution and abundance of other plants, especially outside of the Cactus Forest. Nonetheless it is clear, based on historic photos (Turner et al. 2003) that trees and shrubs have dramatically increased in the Cactus Forest since the 1930s. A more recent dataset is from the detailed vegetation study in lower and upper

bajada areas at RMD by Warren Steenbergh (unpublished data) that was repeated by park staff in 2006. Preliminary analysis of these data (Andy Hubbard, personal communication) show an increase in subshrubs and perennial grasses during 1976-2006, but a decrease in shrubs and trees.

In general, data from our study suggests that the dramatic ecological changes that have occurred in the RMD since the 1930s, which include gains in most lifeforms (particularly shrubs, subshrubs, succulents, and vines), are continuing to occur. These changes are consistent with an overall increase in saguaros at the park, as documented in long-term monitoring (e.g., Turner 1992., Orum et al. in review, O'Brien et al. 2011). At the same time, increases in vegetation have probably contributed to an increase in wildland fires at lower elevations, a decrease in trees, and changes in distribution and abundance of a range of wildlife species (Swann 2011). Less is known about vegetation changes at TMD, although the small amount of information available suggests that vegetation has been more stable over time.

Lifeform-Level Changes

During the decade prior to our study, from 1990-2000, all lifeforms except trees at RMD experienced significant increases in either density, cover or both in both RMD and TMD. In general, we found that at RMD these increases continued during 2000-2010 with the exception (again) of trees, which declined in cover by 29%. At TMD, we found the opposite pattern: most lifeforms experienced decreases in cover and density, although not all decreases were statistically significant. The exception to this trend at TMD was succulents, which increased in both number and cover in the last decade.

Nevertheless, the declines even at TMD were not enough to offset the increases of the 1990-2000 period. Overall, during the 20 years from 1990 to 2010, all lifeforms except trees generally increased in both districts. The decrease in trees at RMD was substantial – more than 30%. Although Funicelli et al. (2001) noted that changes in trees should be interpreted with caution due to the small size of the plots and the potential influence of the loss of a single individual, the decrease seems noteworthy. We speculate that fire played a role in the loss of trees, based on observations that foothill palo verdes appear to have been reduced by both the 1994 Mother's Day Fire and the 1999 Box Canyon Fire.

Family- and Species-Level Changes

At the family level, the decade between 1990 and 2000 can be characterized as producing significant general increases in both density and cover across most plant families in both districts. In contrast, similar to changes observed for lifeforms, the period from 2000 to 2010 brought some increases to most plant families at RMD, but losses at TMD. The one family that stands out as suffering the most sustained losses over the two decades is Polygonaceae (represented on the 45 plots by a single species, *Eriogonum wrightii*), which lost 84% of all individuals from 1990 to 2010.

Differences between changes in cover and density are also observable at the family level in the decade between 2000 and 2010. While the changes in both density and cover are not significant in all cases, four families exhibit asynchronous behavior in which density and cover trend in different directions.

Only a few species increased in cover or density from 2000 to 2010, but between 1990 and 2010 most of the 32 species that exhibited a significant change increased in either density or cover. The most dramatic increase within species during the past decade have been *Encelia farinosa*, *Zinnia acerosa*, and *Bahia absinthifolia*. *E. farinosa*, in particular, proliferated in RMD after the heavy rains in 2006. Despite drier conditions in 2009, more than 5,000 individuals of this species were observed.

Implications for long-term vegetation change

The major goals of this report are to capture the results of the 2010 surveys for their future, long-term value, and to document general changes in the vegetation community at Saguaro National Park that have occurred during the past two decades. Although the effort expended in mapping individual plants on 45 randomly-located plots is significant in terms of time and effort, it is important to note that the 4500 m² of these plots represent only a small fraction of the more than 363 km² area of Saguaro National Park. More importantly, the random samples in the RMD only include areas considered to be “saguaro habitat” in 1990, based on a 1937 vegetation map. While this sample is hopefully representative of selected desert areas, our effort can only be part of a broader program of long-term vegetation monitoring. Similarly, understanding long-term vegetative change in any area requires time, particularly in the desert Southwest where so many individual plants are long-lived. Here, we can only speculate about their ultimate meaning in terms of long-term vegetative change and the causes for those changes. Nevertheless, the data we gathered in 2010 are interesting in the context of the earlier surveys of these plots in 1990 and 2000.

With a history of grazing and harvesting of mature trees, Saguaro National Park has been subjected to disturbances that altered its vegetative communities. As time passes, it could be expected that these communities will more closely resemble an undisturbed ecosystem. Funicelli et al. (2001) provide discussion regarding some of the species that are unpalatable or preferred by livestock. Further analysis of these species with comparison to undisturbed sites may reveal insights into ecosystem change following exclusion of cattle. Certainly, some vegetation changes in the Rincon Mountain District, where cattle grazing was quite heavy for nearly a century, are a result of cessation of grazing. Nevertheless, analysis of data from the repeat of the 1976 Steenbergh study, which included pairs of both grazed treatment and ungrazed control plots, found that changes in plant communities were much more strongly associated with the passage of time than with grazing.

Temperatures are expected to increase in the West one to two degrees Celsius by the middle of the twenty-first century (Barnett et al. 2004), while annual precipitation declines by about ten percent in the coming ten to 40 years (National Research Council 2007). These trends have led climatologist to predict a shift towards conditions of the 1930s Dust Bowl and the 1950s in the Southwest (Seager et al. 2007). This trend could possibly be underway locally, as the decade between 2000 and 2009 was noted as the hottest and driest decade in Tucson’s recorded history (NOAA 2010).

Studies indicate that climate is affecting Sonoran Desert species in complex and unexpected ways. While the extent and severity of cold weather may be decreasing in the Sonoran Desert (Weiss and Overpeck 2005), cold-adapted annuals are being favored due to a delay in winter

precipitation (Kimball et al. 2010). Studies also indicate that these changes are influenced by the interactions between climate and elevation gradient (Crimmins et al. 2009).

At Saguaro National Park, precipitation was generally average or above average from 1980 through 2000 (Figures 2 and 3). These favorable conditions may have promoted the broad increases in all lifeforms observed between the 1990 and 2000 surveys. The period between 2000 and 2010 was characterized as being notably dry, with conditions at TMD generally being drier than RMD. These conditions are perhaps responsible for the declines across lifeforms observed at TMD with the exception of succulents. Nevertheless, it is noteworthy that buffelgrass, first identified on a single plot by Duriscoe and Graban (1990), was observed on 3 vegetation subplots in 2010, and on a large number of the 45 4 ha plots (Saguaro National Park, unpublished data). The aggressive establishment of this invasive species is believed to be at least partly due to climate change (Stevens and Falk 2009).

Recommendations

This long-term monitoring program for vegetation in Saguaro National Park is a subset of a program called the Saguaro Census (O'Brien et al. 2010) that occurs every ten years in Saguaro National Park. The Census is a collection of a number of monitoring activities that includes demographic surveys on 45 plots; studies of individual, marked saguaros, especially related to the phenomenon of epidermal browning (Turner and Funicelli 2001); vegetation transects; buffelgrass mapping; saguaro belt transects (Duriscoe and Graban 1990), and saguaro distribution (Springer et al. 2011). Because there are so many different activities associated with the Saguaro Census, it is not always possible to accomplish all of them every ten years. In planning the 2010 Saguaro Census, Resource Management staff felt strongly that mapping vegetation on subplots should be included to ensure continuity of data on individual plants represented on the plots. For the same reason, we strongly recommend that sampling on subplots occur during the 2020 Census. We anticipate that new technologies may change the type of sampling that may occur and look forward to other improvements in field methodology and analysis.

While this report provides a basic, comparative analysis of two decades of vegetation change, the information collected in this study is interesting enough that we recommend that it be further analyzed in collaboration with climatologists, plant ecologists and park service researchers. The data summarized in this report can be used to build upon existing knowledge about the influence of climate change and other disturbances on vegetation in the park and the Sonoran Desert.

In February, 2011, the northern Sonoran Desert experienced an extreme cold event, with temperatures dropping below 6° Celcius for two nights in the Tucson area. Early observations following this freeze suggest mortality of many desert plants, although as of the writing of this report it is still too soon to know how widespread plants deaths will be in the park. Coupled with the results presented in this report, data following the freeze are likely to provide insight into the complex and sometimes unexpected climate-induced changes in vegetation communities over time. We anticipate that the utility and value of this project will continue to grow as additional information is learned about the impacts of climate change at Saguaro National Park and in the Sonoran Desert.

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Appendix A. District-wide changes in cover and density by species exhibiting significant change (1990-2000). Density data is provided for the change in the total number of plants as well as changes in cover (m²). Numbers in parentheses indicate the percentage of change observed. Statistical significance is indicated from the Wilcoxin Signed-Rank Test.

Species	Density Change		Cover Change	
	RMD	TMD	RMD	TMD
<i>Abutilon incanum</i>	37(247)**	37(116)	15.98(1622)**	13.41(673)*
<i>Acacia constricta</i>	4(15)	5(22)†	17.66(43)*	9.02(22)†
<i>Adenophyllum porophylloides</i>		15(300)		2.05(373)†
<i>Ayenia filiformis</i>	274(27400)***	-11(-16)*	17.46(1746)***	-0.25(-8)*
<i>Calliandra eriophylla</i>	94(50)*	66(53)*	23.94(100)**	11.25(66)*
<i>Cercidium microphyllum</i>	-5(-15)	5(11)†	-30.39(-29)	9.33(7)
<i>Cylindropuntia acanthocarpa</i>		17(15)		14.30(39)*
<i>Cylindropuntia fulgida</i>	15(115)*	23(82)†	2.93(131)*	1.40(92)*
<i>Encelia farinosa</i>	688(269)***	67(33)	91.56(536)***	16.33(75)*
<i>Ericameria laricifolia</i>	-135(-68)*	-1(-100)	-12.30(-34)	-0.23(-100)
<i>Eriogonum wrightii</i>	-58(-33)†		11.14(92)	
<i>Ferocactus wislizenii</i>	2(8)	0(0)	0.61(29)*	0.06(8)*
<i>Fouquieria splendens</i>	6(9)	3(13)†	31.61(40)**	9.78(25)
<i>Herissantia crispa</i>	10(71)†	33(206)	2.31(279)*	1.30(147)†
<i>Isocoma tenuisecta</i>	-296(-68)*		2.77(11)	
<i>Janusia gracilis</i>	94(89)**	253(100)***	43.09(454)**	49.12(160)***
<i>Jatropha cardiophylla</i>	17(22)	5(10)	28.95(131)**	7.55(74)
<i>Justicia longii</i>	26(1300)	4(400)	1.48(2149)*	0.02(18)
<i>Krameria grayii</i>		12(21)*		10.48(44)*
<i>Lycium berlandieri</i>	-1(-5)	5(8)	9.07(51)**	8.32(25)
<i>Mammillaria species</i>	144(1108)***	109(1363)***	0.76(1756)***	0.34(23)***
<i>Opuntia phaeacantha</i>	50(39)†	11(48)	84.04(159)***	11.55(77)*
<i>Porophyllum gracile</i>	80(235)	-10(-40)	16.13(1866)**	-0.23(-18)
<i>Trixis californica</i>		3(20)		3.22(231)*
<i>Zinnia acerosa</i>	60(30)	-2(-67)	12.28(130)†	-0.22(-76)

p<0.001 ***; p<0.01 **; p<0.05 *; p<0.10†

Table 3. District-wide changes in cover and density by species exhibiting significant change (2000-2010). Density data is provided for the change in the total number of plants as well as changes in cover (m²). Numbers in parentheses indicate the percentage of change observed. Statistical significance is indicated from the Wilcoxin Signed-Rank Test.

Species	Density Change		Cover Change	
	RMD	TMD	RMD	TMD
<i>Abutilon incanum</i>	211(406)*	21(30)	3.22(19)	-14.01(-91)*
<i>Acacia greggii</i>	-1(-3)	1(25)	-20.82(-35)**	-5.96(-49)
<i>Ambrosia deltoidea</i>		-470(-38)**		-67.33(-28)*
<i>Bahia absinthifolia</i>	135(167)†	76(127)	0.50(79)	-0.07(-17)
<i>Calliandra eriophylla</i>	258(91)*	11(6)	0.60(126)	-12.21(-43)†
<i>Cylindropuntia acanthocarpa</i>	-2(-100)	-22(-17)†	-0.02(-100)	0.19(38)
<i>Cylindropuntia bigelovii</i>	17(121)†	9(900)	0.20(19)	2.09(561)
<i>Encelia farinosa</i>	3669(389)**	396(147)	119.79(110)**	7.59(20)
<i>Eriogonum wrightii</i>	-92(-77)*	-1(-100)	-20.53(-89)*	-0.11(-100)
<i>Ferocactus wislizenii</i>	-7(-27)*	-1(-14)	-1.01(-37)†	-0.07(-8)
<i>Fouquieria splendens</i>	14(19)	15(56)	40.87(37)**	27.70(56)**
<i>Janusia gracilis</i>	53(27)†	-130(-26)*	7.05(13)	-30.66(-38)*
<i>Jatropha cardiophylla</i>	44(46)†	39(74)†	24.56(48)**	4.89(27)
<i>Krameria grayii</i>		-70(-100)*		-34.34(-100)**
<i>Larrea tridentata</i>	10(36)	19(86)	-4.97(-6)	-19.99(-50)*
<i>Lycium berlandieri</i>	11(58)*	2(3)	4.43(16)	4.47(11)
<i>Mammillaria species</i>	59(38)	-63(-54)*	-0.48(-60)	0.05(15)
<i>Opuntia phaeacantha</i>	64(36)†	9(26)	30.74(22)*	6.17(23)
<i>Prosopis velutina</i>	-3(-9)	0(0)	-100.74(-36)***	0.98(10)

p<0.001 ***; p<0.01 **; p<0.05 *; p<0.10†

Table 4. District-wide changes in cover and density by species exhibiting significant change (1990-2010). Density data is provided for the change in the total number of plants as well as changes in cover (m²). Numbers in parentheses indicate the percentage of change observed. Statistical significance is indicated from the Wilcoxin Signed-Rank Test.

Species	Density Change		Cover Change	
	RMD	TMD	RMD	TMD
<i>Abutilon incanum</i>	248(1653)*	58(181)†	19.19(1949)*	-0.60(-30)
<i>Acacia constricta</i>	8(31)	5(22)*	12.37(30)†	2.81(7)
<i>Ambrosia deltoidea</i>		-490(-39)*		-35.87(-17)
<i>Ayenia filiformis</i>	136(13600)**	-55(-79)	4.92(49243)**	-2.48(-82)
<i>Calliandra eriophylla</i>	352(187)**	77(62)*	24.54(103)**	-0.96(-6)
<i>Carnegiea giagntea</i>	3(5)	-6(-7)	2.61(21)**	-1.27(-10)
<i>Cylindropuntia acanthocarpa</i>		-5(-4)		14.49(40)*
<i>Cylindropuntia bigelovii</i>	4(15)†	9(900)	-0.79(-39)	2.10(587)
<i>Cylindropuntia fulgida</i>	39(300)†	-10(-36)	2.51(112)†	0.95(62)
<i>Encelia farinosa</i>	4357(1702)**	463(228)	211.35(1236)***	23.92(109)*
<i>Eriogonum wrightii</i>	-150(-84)*		-9.39(-78)	
<i>Fouquieria splendens</i>	20(29)	18(75)**	72.48(93)**	37.48(95)**
<i>Janusia gracilis</i>	147(139)**	123(49)†	50.14(528)**	18.46(60)†
<i>Jatropha cardiophylla</i>	61(77)†	44(92)†	53.51(242)**	12.44(121)†
<i>Larrea tridentata</i>	6(19)	19(86)	-1.69(-2)	-27.70(-58)†
<i>Lycium berlandieri</i>	10(50)**	7(12)	13.49(75)**	12.79(39)*
<i>Mammillaria species</i>	203(1562)***	46(575)*	0.28(640)**	0.39(2620)†
<i>Opuntia phaeacantha</i>	114(89)**	20(87)†	114.78(218)***	17.72(118)
<i>Porophyllum gracile</i>	49(144)	-10(-40)	6.72(777)*	-0.27(-21)
<i>Prosopis velutina</i>	-7(-19)*	0(0)	-99.53(-36)**	-1.79(-14)
<i>Trixis californica</i>		4(27)		1.21(87)†

p<0.001 ***; p<0.01 **; p<0.05 *; p<0.10†

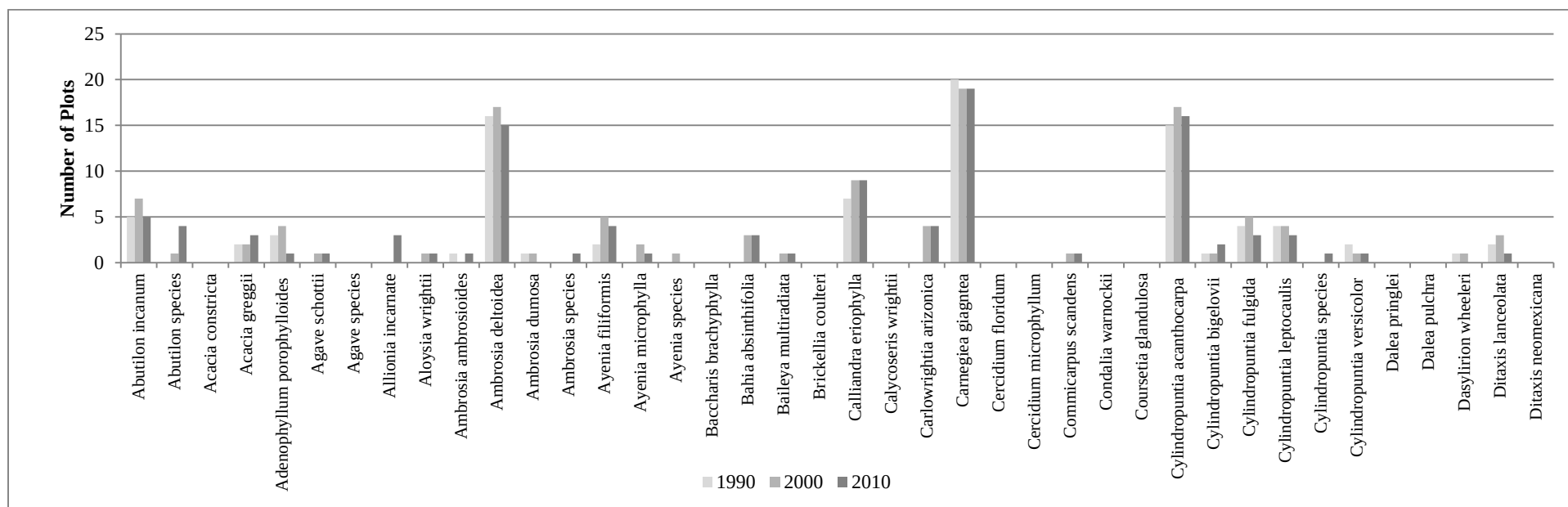


Figure 11. Number of plots with species (A-D) present at TMD (1990-2010).

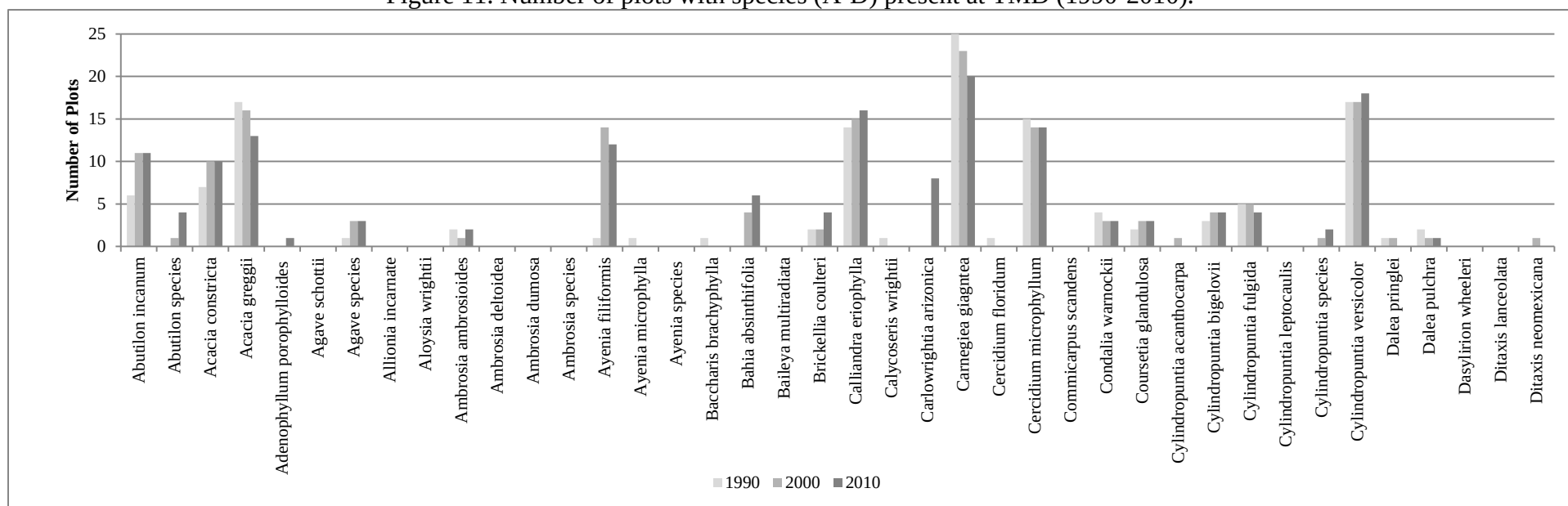


Figure 12. Number of plots with species (A-D) present at RMD (1990-2010).

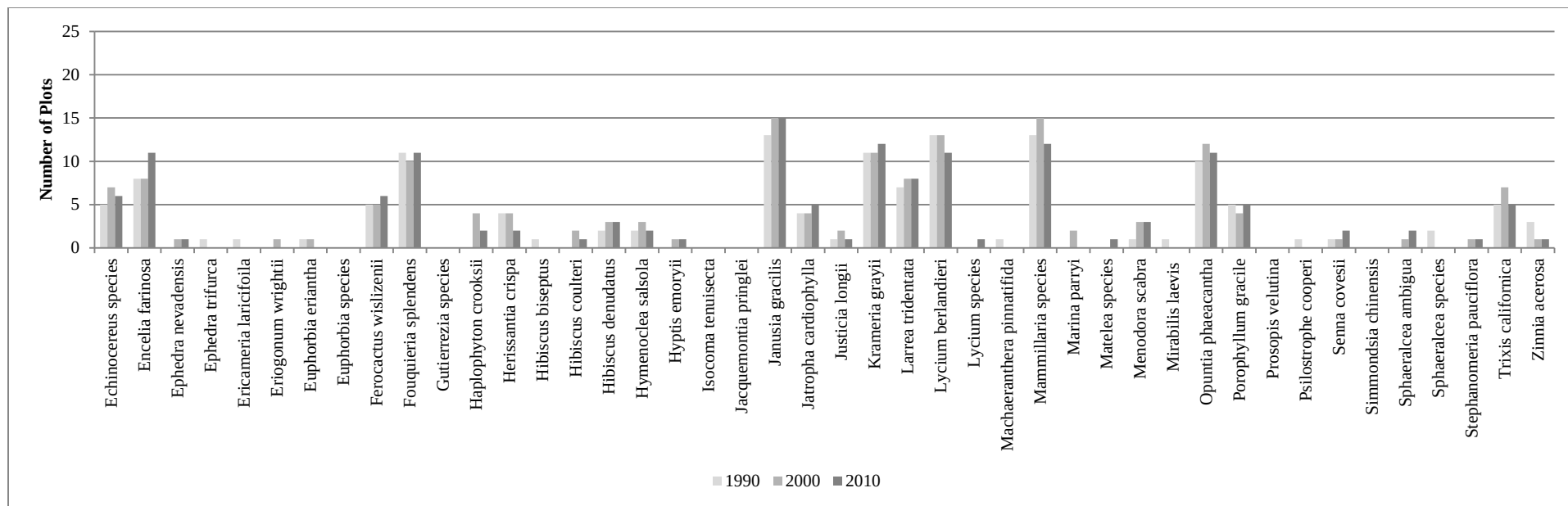


Figure 13. Number of plots with species (E-Z) present at TMD (1990-2010).

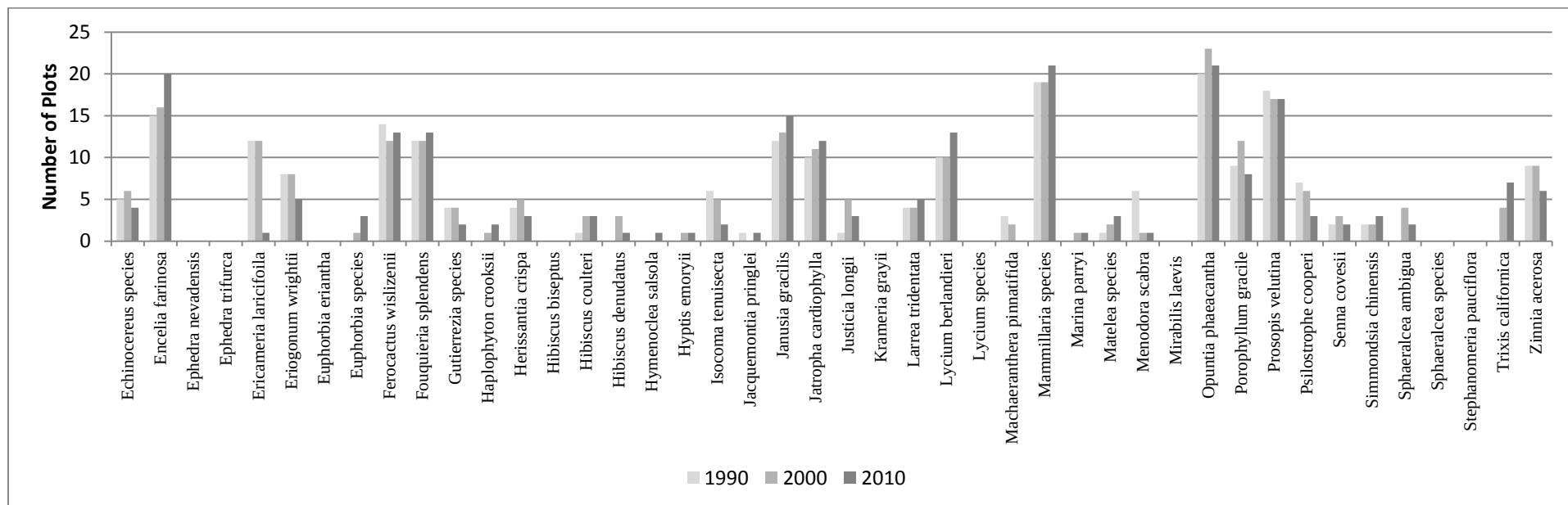


Figure 14. Number of plots with species (E-Z) present at RMD (1990-2010).

Appendix B. Family results at the TMD and RMD from 1990-2010.

Table 5. District-wide changes in cover and density by plant family exhibiting significant change. Density data is provided for the change in the total number of plants as well as changes in cover (m²). Numbers in parentheses indicate the percentage of change observed. Statistical significance is indicated from the Wilcoxin Signed-Rank Test.

	Density Change		Cover Change		
	Family	RMD	TMD	RMD	TMD
1990-2000	Acanthaceae	26(1300)*	21(2100)*	1.48(2149)*	0.86(662)†
	Asteraceae	370(27)	134(8)	111.52(102)***	54.64(22)***
	Cactaceae	219(68)***	166(54)***	87.49(89)***	28.59(40)***
	Euphorbiaceae	22(28)*	31(41)	28.99(131)**	9.22(81)*
	Fabaceae	116(30)*	100(47)***	29.21(5)***	36.34(14)**
	Fouquieriaceae	6(9)	3(12.5)†	31.61(40)**	9.78(25)
	Krameriaceae		12(21)*		10.48(44)*
	Malpighiaceae	94(89)**	253(100)***	43.09(454)**	49.12(160)***
	Malvaceae	62(207)***	71(100)*	19.76(1082)***	14.40(340)**
	Polygonaceae	-58(-33)†	1(0)	11.14(92)†	0.11(0)
	Solanaceae	-1(-5)	5(8)	9.07(51)**	8.32(25)
	Sterculiaceae	272(9067)**	-5(-7)**	17.33(11786)**	-0.23(-8)**
2000-2010	Asteraceae	4024(233)**	67(3)†	39.30(18)	-71.15(-23)†
	Cactaceae	162(29)†	-57(-13)	25.76(14)	21.23(21)*
	Euphorbiaceae	230(227)*	0(0)	24.95(49)**	2.57(12)
	Fabaceae	217(43)	-10(-4)	-171.39(-29)***	-41.27(-14)*
	Fouquieriaceae	14(18)	15(55)	40.87(37)**	27.70(56)**
	Krameriaceae		-70(-100)*		-34.34(-100)**
	Malpighiaceae	53(26)†	-130(-26)*	7.05(13)	-30.66(-38)*
	Malvaceae	288(313)*	14(9)	7.46(35)	-10.63(-57)
	Polygonaceae	-92(-77)*	-1(-100)	-20.53(-89)*	-0.11(-100)
	Solanaceae	11(57)*	3(4)	4.43(16)	4.63(11)
	Zygophyllaceae	10(35)	19(86)	-4.97(-6)	-19.99(-50)*
1990-2010	Asteraceae	4394(325)***	201(13)	150.81(139)***	-16.52(-7)
	Cactaceae	381(118)***	109(36)**	113.25(115)***	49.81(69)***
	Euphorbiaceae	252(319)*	31(41)*	53.93(244)**	11.80(103)†
	Fabaceae	333(86)*	90(43)*	-142.19(-25)	-4.93(-2)
	Fouquieriaceae	20(29)	18(75)**	72.48(93)**	37.48(95)**
	Malpighiaceae	147(139)**	123(49)†	50.14(528)**	18.46(60)†
	Malvaceae	350(1167)**	85(120)*	27.22(1491)**	3.76(89)
	Polygonaceae	-150(-84)*		-9.39(-78)	
	Solanaceae	10(50)**	8(14)	13.49(75)**	12.95(39)*
	Sterculiaceae	134(4467)**	-54(-77)	4.79(3257)**	-2.42(-80)
	Zygophyllaceae	6(19)	19(86)	-1.69(-2)	-27.70(-58)†

p<0.001 ***; p<0.01 **; p<0.05 *; p<0.10†

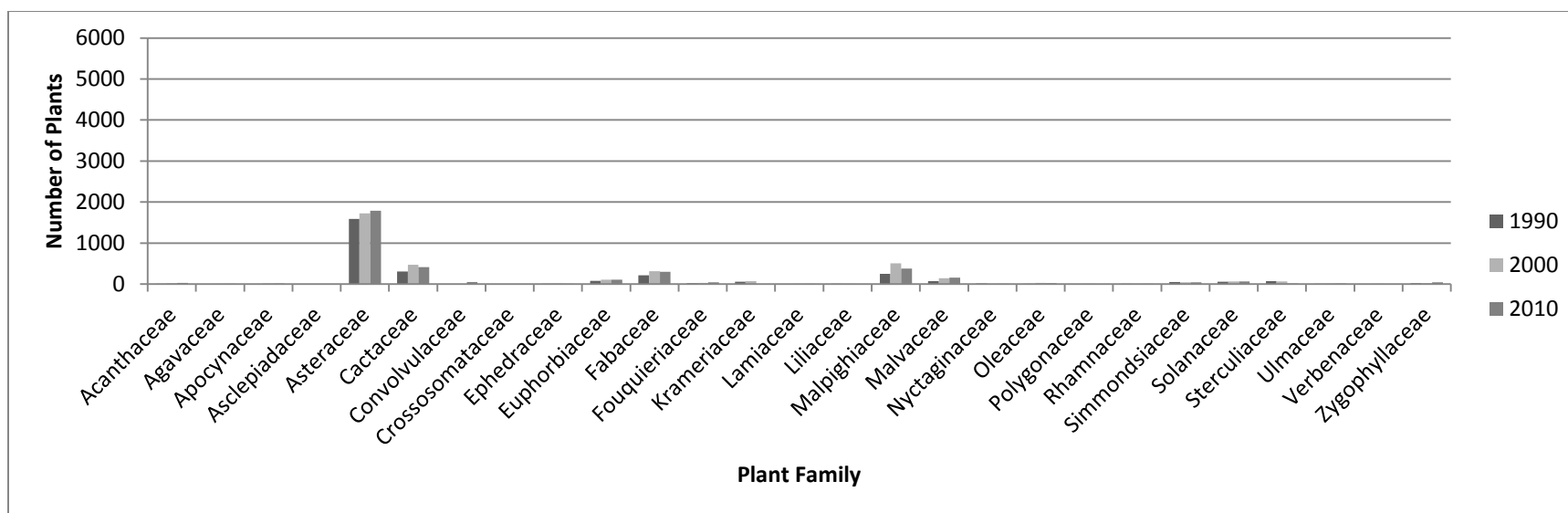


Figure 15. Total number of plants by family at TMD (1990-2010).

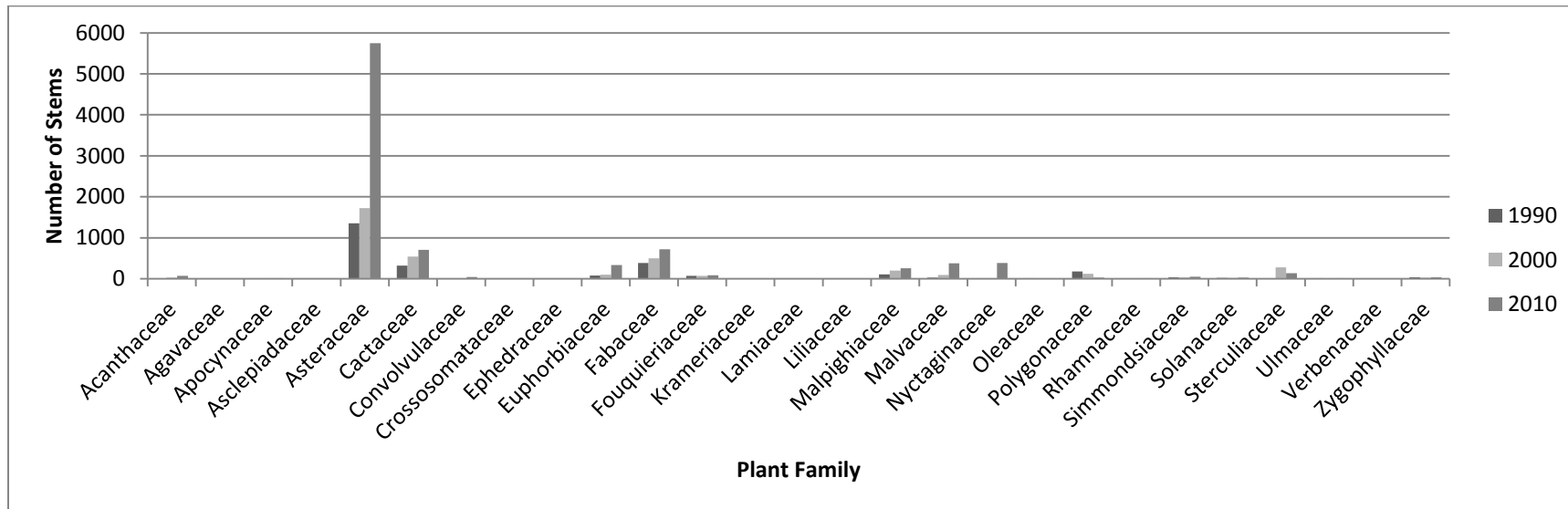


Figure 16. Total number of plants by family at RMD (1990-2010).

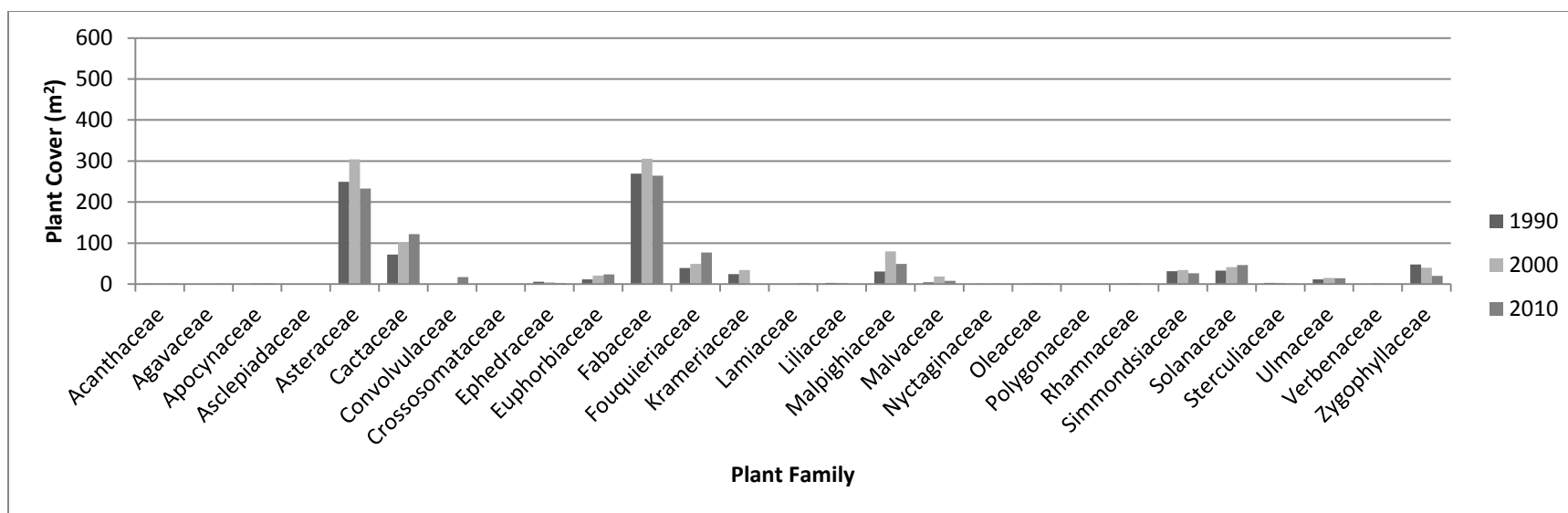


Figure 17. Total plant cover (m²) by family at TMD (1990-2010).

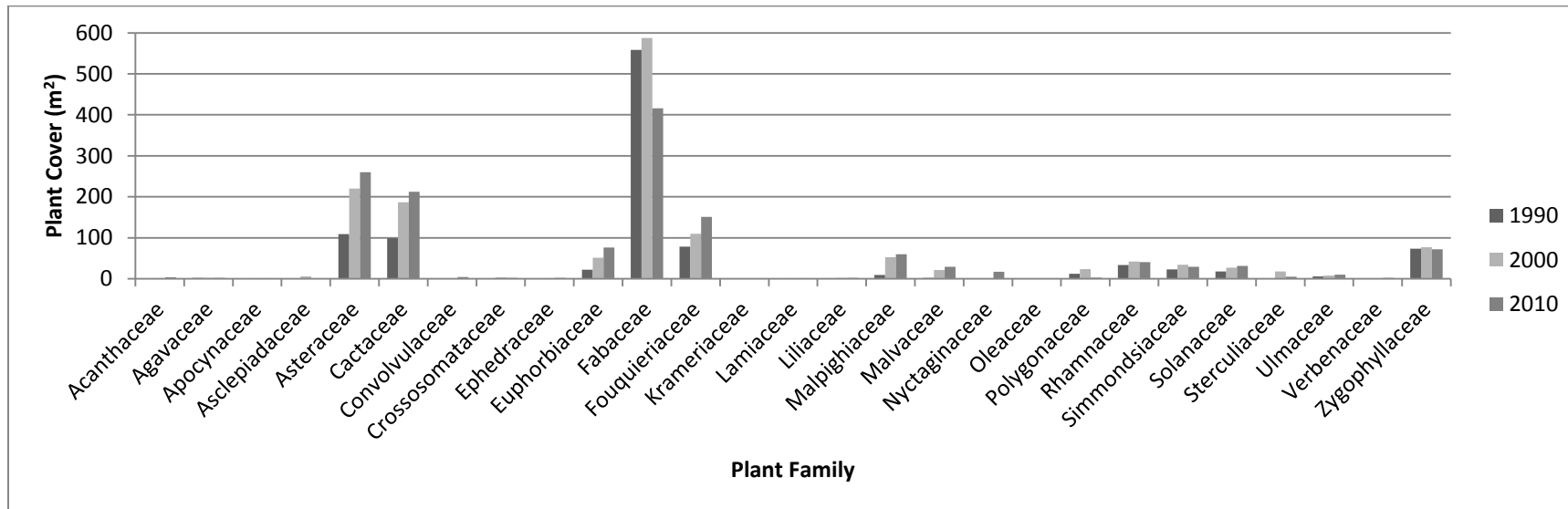


Figure 18. Total plant cover (m²) by family at RMD (1990-2010).

Appendix C. Plot level characteristics for perennial species. Annuals, grasses, and ferns are not included because of inconsistent mapping between surveys.

Plot	District	No. of Individuals (1990)	No. of Individuals (2000)	No. of Individuals (2010)	Cover m2 (1990)	Cover m2 (2000)	Cover m2 (2010)	No. of Species (1990)	No. of Species (2000)	No. of Species (2010)	Simpson's Diversity Index (1990)	Simpson's Diversity Index (2000)	Simpson's Diversity Index (2010)
1	RMD	48	257	687	24.57	48.87	51.36	11	12	10	0.19	0.57	0.94
2	RMD	199	256	579	44.97	69.78	41.09	17	21	20	0.21	0.27	0.77
3	RMD	67	64	235	22.09	32.54	42.24	9	9	9	0.19	0.27	0.59
4	RMD	121	130	674	38.75	57.63	47.25	14	20	25	0.16	0.13	0.32
5	RMD	123	95	210	46.42	58.39	55.58	6	11	11	0.80	0.44	0.39
6	RMD	132	182	735	34.03	64.76	73.54	16	18	19	0.14	0.11	0.47
7	RMD	76	170	529	28.01	34.79	56.15	15	18	18	0.18	0.24	0.42
8	RMD	27	26	28	89.88	93.19	71.86	6	7	5	0.51	0.41	0.68
9	RMD	59	49	48	41.54	59.11	58.95	12	13	13	0.26	0.12	0.21
10	RMD	102	102	187	42.20	70.64	63.62	12	16	17	0.29	0.22	0.30
11	RMD	85	105	246	39.80	49.81	51.00	15	23	20	0.16	0.12	0.21
12	RMD	100	192	359	29.75	51.45	49.33	13	19	19	0.20	0.18	0.23
13	RMD	61	49	76	46.13	47.32	38.77	11	13	19	0.23	0.12	0.12
14	RMD	142	141	718	56.51	70.70	88.09	15	17	18	0.37	0.16	0.69
15	RMD	207	102	105	56.10	32.30	15.81	10	10	10	0.53	0.37	0.48
16	RMD	73	70	335	33.57	55.67	49.02	13	16	20	0.16	0.10	0.40
17	RMD	212	181	204	55.69	74.54	61.67	18	23	21	0.38	0.13	0.15
18	RMD	40	159	340	23.29	47.33	58.27	13	18	17	0.16	0.42	0.81
19	RMD	132	296	496	33.88	58.93	55.23	17	20	20	0.16	0.18	0.34
20	RMD	94	162	185	36.67	46.45	50.95	21	21	20	0.13	0.09	0.13
21	RMD	181	364	734	38.06	60.69	53.12	12	18	18	0.36	0.47	0.55
22	RMD	51	106	223	51.85	91.34	94.93	14	20	22	0.10	0.11	0.16
23	RMD	147	241	214	40.47	71.47	57.92	15	22	22	0.20	0.10	0.17

24	RMD	114	214	481	58.91	89.09	66.43	13	13	10	0.22	0.32	0.66
25	RMD	69	128	81	36.36	52.09	51.52	17	17	11	0.13	0.14	0.16
26	TMD	102	98	86	41.64	53.58	29.81	15	16	20	0.16	0.13	0.13
27	TMD	115	189	149	56.24	69.51	58.05	15	17	17	0.14	0.12	0.15
28	TMD	168	255	212	52.16	57.20	56.04	11	14	14	0.57	0.47	0.48
29	TMD	60	79	68	22.81	25.44	19.81	3	6	5	0.76	0.46	0.54
30	TMD	77	93	110	52.64	59.65	51.19	9	15	14	0.29	0.20	0.19
31	TMD	167	156	142	53.22	60.35	34.03	4	4	6	0.81	0.85	0.83
32	TMD	202	267	168	71.15	78.69	65.56	11	10	10	0.61	0.47	0.40
33	TMD	90	90	110	22.45	33.49	25.95	6	5	4	0.72	0.79	0.67
34	TMD	129	129	104	51.95	60.73	54.40	15	18	20	0.22	0.17	0.18
35	TMD	66	79	62	26.55	26.82	39.57	7	10	10	0.70	0.61	0.58
36	TMD	221	427	504	40.31	66.42	67.49	18	26	26	0.18	0.15	0.29
37	TMD	216	210	238	62.31	80.30	57.33	19	19	20	0.19	0.14	0.15
38	TMD	189	213	123	36.70	47.66	33.70	14	15	12	0.46	0.33	0.30
39	TMD	137	150	159	23.09	42.05	42.17	16	17	12	0.22	0.18	0.23
40	TMD	235	248	214	38.41	51.47	58.66	11	16	16	0.71	0.60	0.32
41	TMD	108	170	294	15.81	40.06	48.13	13	18	15	0.17	0.23	0.53
42	TMD	179	243	182	44.12	45.37	44.85	16	18	15	0.18	0.19	0.21
43	TMD	199	262	526	34.06	49.94	59.25	17	22	21	0.13	0.13	0.37
44	TMD	115	103	45	61.26	62.81	39.76	12	13	10	0.66	0.50	0.21
45	TMD	49	217	396	30.91	53.93	45.36	11	26	26	0.17	0.13	0.26

Appendix D. Plot characteristics.

Plot	Elevation	Slope	Aspect	Microsite
1	2970	20	260	rocky flat
2	2880	18	250	soil slope
3	3220	31	252	rocky slope
4	3240	16	266	rocky slope
5	2840	5	40	soil flat
6	3170	8	255	rocky slope
7	3260	27	246	rocky slope
8	2700	1	26	soil flat
9	2920	4	270	soil flat
10	2920	7	130	soil flat
11	2800	31	240	rocky slope
12	3740	49	212	rocky slope
13	2930	10	360	rocky slope
14	3450	14	170	rocky slope
15	2760	3	120	soil flat
16	3340	24	194	rocky slope
17	2770	7	330	soil slope
18	3015	17	210	rocky slope
19	2760	13	30	soil slope
20	3440	32	73	rocky slope
21	3570	26	170	rocky slope
22	3440	27	194	rocky slope
23	3980	62	93	rocky slope
24	3550	35	180	rocky slope
25	3620	38	180	rocky slope
26	2450	11	320	rocky slope
27	2800	25	244	rocky slope
28	2640	4	210	soil flat
29	2260	3	300	soil flat
30	2830	2	220	soil flat
31	2390	2	10	soil flat
32	2560	6	322	soil flat
33	2250	2	320	soil flat

34	2960	31	110	rocky slope
35	2240	1	270	soil flat
36	3480	25	200	rocky slope
37	2595	11	136	rocky slope
38	2740	15	216	ridge
39	2535	20	330	rocky slope
40	2420	3	280	soil flat
41	3575	70	250	rocky slope
42	2650	16	92	rocky slope
43	3140	28	210	rocky slope
44	2460	2	330	soil flat
45	4140	16	210	soil slope

Appendix E. Plot coordinates (coordinate system: UTM; datum: NAD 83).

Plot No.	NE_E	NE_N	NW_E	NW_N	SE_E	SE_N	SW_E	SW_N
1	525493	3561877	525483	3561877	525493	3561867	525483	3561867
2	527342	3562799	527332	3562800	527342	3562789	527332	3562790
3	528846	3563268	528836	3563268	528845	3563258	528835	3563258
4	528990	3563487	528981	3563487	528990	3563477	528980	3563477
5	524949	3563709	524939	3563709	524939	3563699	524949	3563699
6	526376	3559047	526366	3559047	526376	3559038	526366	3559038
7	526246	3558431	526236	3558431	526246	3558421	526235	3558421
8	527344	3566386	527334	3566386	527344	3566376	527334	3566376
9	526254	3561913	526245	3561913	526255	3561903	526245	3561903
10	526594	3563203	526584	3563203	526594	3563193	526584	3563193
11	529884	3566100	529874	3566100	529884	3566090	529873	3566090
12	527362	3559565	527352	3559565	527362	3559555	527352	3559555
13	527918	3562321	527908	3562321	527918	3562312	527908	3562312
14	531343	3566411	531334	3566411	531344	3566401	531334	3566401
15	525800	3564853	525791	3564853	525800	3564843	525790	3564843
16	529273	3562716	529263	3562716	529273	3562706	529263	3562706
17	527452	3564822	527443	3564822	527452	3564812	527442	3564812
18	526597	3557036	526587	3557036	526597	3557026	526587	3557026
19	528847	3564954	528837	3564954	528847	3564944	528837	3564944

20	537356	3557510	537346	3557510	537356	3557500	537346	3557500
21	536546	3558044	536536	3558044	536546	3558034	536536	3558034
22	538306	3556964	538296	3556964	538306	3556954	538296	3556954
23	536207	3558077	536197	3558077	536207	3558067	536197	3558067
24	529787	3557294	529777	3557293	529788	3557283	529778	3557283
25	531532	3556902	531523	3556902	531532	3556892	531523	3556892
26	487561	3576112	487551	3576112	487561	3576102	487551	3576103
27	484881	3573656	484871	3573656	484881	3573646	484871	3573646
28	482099	3568534	482089	3568534	482099	3568524	482089	3568524
29	478475	3571047	478465	3571047	478475	3571037	478465	3571037
30	482813	3571622	482803	3571622	482814	3571612	482803	3571612
31	484830	3577214	484820	3577214	484830	3577204	484820	3577204
32	484692	3575425	484682	3575425	484692	3575415	484682	3575415
33	479191	3574964	479181	3574964	479191	3574954	479181	3574954
34	484417	3573150	484407	3573150	484417	3573141	484407	3573141
35	478001	3571819	477991	3571819	478002	3571809	477992	3571809
36	485893	3569368	485882	3569368	485893	3569358	485883	3569357
37	481063	3569610	481053	3569610	481063	3569600	481053	3569599
38	481636	3571669	481626	3571669	481636	3571659	481626	3571659
39	486394	3575558	486384	3575558	486394	3575548	486384	3575548
40	480262	3569202	480252	3569202	480262	3569192	480252	3569192
41	483935	3569824	483924	3569824	483935	3569813	483925	3569815
42	486215	3578323	486205	3578323	486215	3578313	486206	3578313
43	487163	3572251	487153	3572251	487163	3572241	487153	3572241
44	481580	3574205	481570	3574205	481580	3574195	481570	3574195
45	485279	3570451	485288	3570451	485288	3570441	485278	3570441

Appendix F. Comprehensive plant list from 1990, 2000, and 2010 surveys.

Code (2010)	Current Name (2010)	Family	Lifeform
ABIN	<i>Abutilon incanum</i>	Malvaceae	Subshrub
ABsp	<i>Abutilon species</i>	Malvaceae	Subshrub
ACCO	<i>Acacia constricta</i>	Fabaceae	Tree
ACGR	<i>Acacia greggii</i>	Fabaceae	Tree
ADPO	<i>Adenophyllum porophylloides</i>	Asteraceae	Subshrub
AGSC	<i>Agave schottii</i>	Agavaceae	Succulent
AGsp	<i>Agave species</i>	Agavaceae	Succulent
ALWR	<i>Aloysia wrightii</i>	Verbenaceae	Shrub
AMAM	<i>Ambrosia ambrosioides</i>	Asteraceae	Subshrub
AMDE	<i>Ambrosia deltoidea</i>	Asteraceae	Subshrub
AMsp	<i>Ambrosia species</i>	Asteraceae	Subshrub
ARHA	<i>Aristida hamulosa</i>	Poaceae	Grass (Native)
ARPU	<i>Aristida purpurea</i>	Poaceae	Grass (Native)
ARTE	<i>Aristida ternipes</i>	Poaceae	Grass (Native)
AYFI	<i>Ayenia filiformis</i>	Sterculiaceae	Subshrub
AYMI	<i>Ayenia microphylla</i>	Sterculiaceae	Subshrub
AYsp	<i>Ayenia species</i>	Sterculiaceae	Subshrub
BABR	<i>Baccharis brachyphylla</i>	Asteraceae	Shrub
BAAB	<i>Bahia absinthifolia</i>	Asteraceae	Forb
BAMU	<i>Baileya multiradiata</i>	Asteraceae	Forb
BOSC	<i>Boerhavia scandens</i>	Nyctaginaceae	Forb
BOBA	<i>Bothriochloa barbinodis</i>	Poaceae	Grass (Native)
BOAR	<i>Bouteloua aristidoides</i>	Poaceae	Grass (Native)
BOCH	<i>Bouteloua chondrosoides</i>	Poaceae	Grass (Native)
BOCU	<i>Bouteloua curtipendula</i>	Poaceae	Grass (Native)
BOER	<i>Bouteloua eriopoda</i>	Poaceae	Grass (Native)
BORE	<i>Bouteloua repens</i>	Poaceae	Grass (Native)
BRCO	<i>Brickellia coulteri</i>	Asteraceae	Subshrub
BRRU	<i>Bromus rubens</i>	Poaceae	Grass (Non-native)
CAER	<i>Calliandra eriophylla</i>	Fabaceae	Shrub
CAWR	<i>Calycoseris wrightii</i>	Asteraceae	Forb
CAAR	<i>Carlwrightia arizonica</i>	Acanthaceae	Subshrub
CAGI	<i>Carnegiea gigantea</i>	Cactaceae	Succulent
CEPA	<i>Celtis pallida</i>	Ulmaceae	Tree
CEFL	<i>Cercidium floridum</i>	Fabaceae	Tree
CEMI	<i>Cercidium microphyllum</i>	Fabaceae	Tree
COWA	<i>Condalia warnockii</i>	Rhamnaceae	Shrub
COGL	<i>Coursetia glandulosa</i>	Fabaceae	Shrub
CRBI	<i>Crossosoma bigelovii</i>	Crossosomataceae	Shrub
CYAC	<i>Cylindropuntia acanthocarpa</i>	Cactaceae	Succulent
CYAR	<i>Cylindropuntia arbuscula</i>	Cactaceae	Succulent

CYBI	<i>Cylindropuntia bigelovii</i>	Cactaceae	Succulent
CYFU	<i>Cylindropuntia fulgida</i>	Cactaceae	Succulent
CYLE	<i>Cylindropuntia leptocaulis</i>	Cactaceae	Succulent
CYsp	<i>Cylindropuntia sp.</i>	Cactaceae	Succulent
CYVE	<i>Cylindropuntia versicolor</i>	Cactaceae	Succulent
DAPR	<i>Dalea pringlei</i>	Fabaceae	Subshrub
DAPU	<i>Dalea pulchra</i>	Fabaceae	Subshrub
DAWH	<i>Dasylirion wheeleri</i>	Liliaceae	Succulent
DICA	<i>Digitaria californica</i>	Poaceae	Grass (Native)
DILA	<i>Ditaxis lanceolata</i>	Euphorbiaceae	Subshrub
DINE	<i>Ditaxis neomexicana</i>	Euphorbiaceae	Forb
ECFA	<i>Echinocereus fasciculatus</i>	Cactaceae	Succulent
ECSP	<i>Echinocereus species</i>	Cactaceae	Succulent
ENFA	<i>Encelia farinosa</i>	Asteraceae	Subshrub
EPNE	<i>Ephedra nevadensis</i>	Ephedraceae	Shrub
EPTR	<i>Ephedra trifurca</i>	Ephedraceae	Shrub
ERCI	<i>Eragrostis cilianensis</i>	Poaceae	Grass (Native)
ERLE	<i>Eragrostis lehmanniana</i>	Poaceae	Grass (Non-native)
ERLA	<i>Ericameria laricifolia</i>	Asteraceae	Subshrub
ERWR	<i>Eriogonum wrightii</i>	Polygonaceae	Subshrub
ERPU	<i>Erioneuron pulchellum</i>	Poaceae	Grass (Native)
EUER	<i>Euphorbia eriantha</i>	Euphorbiaceae	Forb
EUsp	<i>Euphorbia species</i>	Euphorbiaceae	Forb
FEWI	<i>Ferocactus wislizeni</i>	Cactaceae	Succulent
FOSP	<i>Fouquieria splendens</i>	Fouquieriaceae	Shrub
GUSA	<i>Gutierrezia sarothrae</i>	Asteraceae	Subshrub
GUsp	<i>Gutierrezia sp.</i>	Asteraceae	Subshrub
HACR	<i>Haplophyton crooksii</i>	Apocynaceae	Subshrub
HECR	<i>Herissantia crispa</i>	Malvaceae	Subshrub
HECO	<i>Heteropogon contortus</i>	Poaceae	Grass (Native)
HIBI	<i>Hibiscus biseptus</i>	Malvaceae	Subshrub
HICO	<i>Hibiscus coulteri</i>	Malvaceae	Subshrub
HIDE	<i>Hibiscus denudatus</i>	Malvaceae	Subshrub
HIBE	<i>Hilaria belangeri</i>	Poaceae	Grass (Native)
HYSA	<i>Hymenoclea salsola</i>	Asteraceae	Subshrub
HYEM	<i>Hyptis emoryii</i>	Lamiaceae	Shrub
ISTE	<i>Isocoma tenuisecta</i>	Asteraceae	Subshrub
JAPR	<i>Jacquemontia pringlei</i>	Convolvulaceae	Shrub
JAGR	<i>Janusia gracilis</i>	Malpighiaceae	Vine
JACA	<i>Jatropha cardiophylla</i>	Euphorbiaceae	Shrub
JULO	<i>Justicia longii</i>	Acanthaceae	Subshrub
KRGR	<i>Krameria grayiI</i>	Krameriaceae	Shrub
LATR	<i>Larrea tridentata</i>	Zygophyllaceae	Shrub
LEPA	<i>Leptochloa panicea</i>	Poaceae	Grass (Native)
LYBE	<i>Lycium berlandieri</i>	Solanaceae	Shrub
LYsp	<i>Lycium species</i>	Solanaceae	Shrub

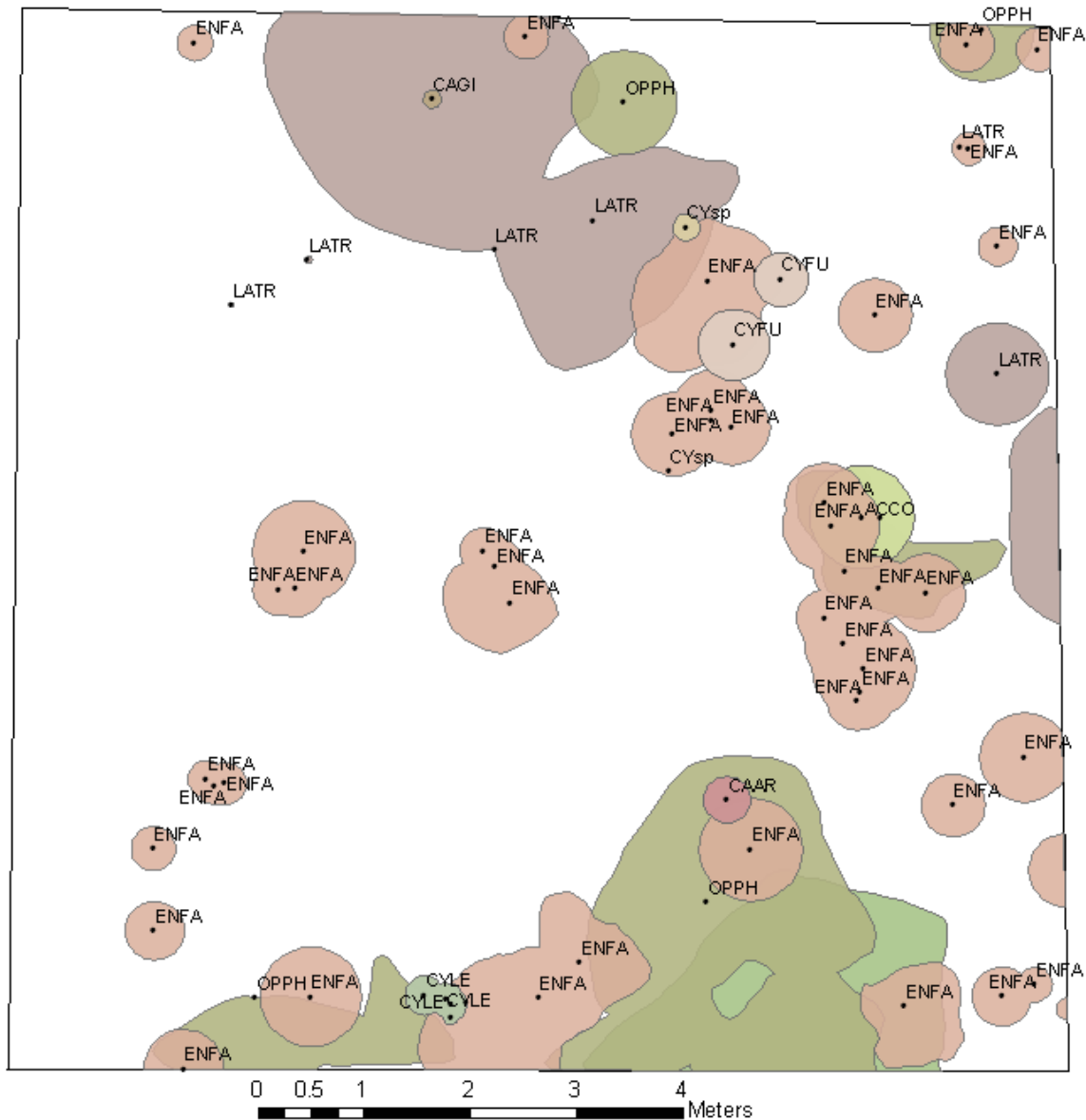
MAPI	<i>Machaeranthera pinnatifida</i>	Asteraceae	Forb
MAGR	<i>Mammillaria grahamii</i>	Cactaceae	Succulent
MAsp	<i>Mammillaria species</i>	Cactaceae	Succulent
MAPA	<i>Marina parryi</i>	Fabaceae	Subshrub
MATsp	<i>Matelea species</i>	Asclepiadaceae	Vine
MERE	<i>Melinis repens</i>	Poaceae	Grass (Non-native)
MESC	<i>Menodora scabra</i>	Oleaceae	Forb
MILA	<i>Mirabilis laevis</i>	Nyctaginaceae	Subshrub
MUPO	<i>Muhlenbergia porteri</i>	Poaceae	Grass (Native)
OLTE	<i>Olneya tesota</i>	Fabaceae	Tree
OPPH	<i>Opuntia phaeacantha</i>	Cactaceae	Succulent
PECI	<i>Pennisetum ciliare</i>	Poaceae	Grass (Non-native)
POGR	<i>Porophyllum gracile</i>	Asteraceae	Subshrub
PRVE	<i>Prosopis velutina</i>	Fabaceae	Tree
PSCO	<i>Psilostrophe cooperi</i>	Asteraceae	Subshrub
SCAR	<i>Schismus arabicus</i>	Poaceae	Grass (Non-native)
SECO	<i>Senna covesii</i>	Fabaceae	Subshrub
SEMA	<i>Setaria macrostachya</i>	Poaceae	Grass (Native)
SICH	<i>Simmondsia chinensis</i>	Simmondsiaceae	Shrub
SPAM	<i>Sphaeralcea ambigua</i>	Malvaceae	Subshrub
SPsp	<i>Sphaeralcea sp.</i>	Malvaceae	Subshrub
STPA	<i>Stephanomeria pauciflora</i>	Asteraceae	Forb
TRMU	<i>Tridens muticus</i>	Poaceae	Grass (Native)
TRCA	<i>Trixis californica</i>	Asteraceae	Subshrub
URAR	<i>Urochloa arizonica</i>	Poaceae	Grass (Native)
ZIAC	<i>Zinnia acerosa</i>	Asteraceae	Subshrub
ZIOB	<i>Ziziphus obtusifolia</i>	Rhamnaceae	Shrub

Appendix G. Notes on Plant Species.

Species	Notes
<i>Adenophyllum porophylloides</i>	Name changed from <i>Dyssodia porophylloides</i>
<i>Ayenia filiformis</i>	May have been inconsistently mapped in 1990; but mapped in 2000 and 2010
<i>Ayenia microcarpa</i>	May have been inconsistently mapped in 1990; but mapped in 2000 and 2010
<i>Bahia absinthifolia</i>	May not have been mapped in 1990; numerous seedlings were present in 2010. Individuals were counted and individuals were placed in size classes of 0 to 15 cm or 16 to 30 cm. Any plants greater than 30 cm in diameter were mapped.
<i>Baileya multiradiata</i>	May not have been mapped in 1990
<i>Boerhavia scandens</i>	Name changed from <i>Commicarpus scandens</i>
<i>Carlowrightia arizonica</i>	May not have been mapped in 1990
<i>Commicarpus scandens</i>	May not have been mapped in 1990
<i>Cylindropuntia acanthocarpa</i>	Name changed from <i>Opuntia acanthocarpa</i>
<i>Cylindropuntia arbuscula</i>	Name changed from <i>Opuntia arbuscula</i>
<i>Cylindropuntia bigelovii</i>	Name changed from <i>Opuntia bigelovii</i>
<i>Cylindropuntia fulgida</i>	Name changed from <i>Opuntia fulgida</i>
<i>Cylindropuntia leptocaulis</i>	Name changed from <i>Opuntia leptocaulis</i>
<i>Cylindropuntia species</i>	Name changed from <i>Opuntia species</i>
<i>Cylindropuntia versicolor</i>	Name changed from <i>Opuntia versicolor</i>
<i>Encelia farinosa</i>	Numerous seedlings were present in 2010. Individuals were counted and individuals were placed in size classes of 0 to 15 cm or 16 to 30 cm. Any plants greater than 30 cm in diameter were mapped.
<i>Erioneuron pulchellum</i>	Name changed from <i>Dasyochloa pulchella</i>
<i>Euphorbia polycarpa</i>	Not mapped in 1990 or 2000 due to seasonal fluctuations
<i>Evolvulus arizonicus</i>	Not mapped in 1990 or 2000 due to seasonal fluctuations
<i>Fern species</i>	Cover not estimated in 1990, but included in 2000 and 2010
<i>Justicia longii</i>	Name changed from <i>Siphonoglossa longiflora</i>
<i>Leptochloa panicea</i>	Name changed from <i>Leptochloa filiformis</i>
<i>Marina parryi</i>	Not mapped in 1990 or 2000 due to seasonal fluctuations
<i>Matelea species</i>	May not have been mapped in 1990
<i>Melinis repens</i>	Name changed from <i>Rhynchelytrum repens</i>
<i>Mirabilis laevis</i>	Name changed from <i>Mirabilis bigelovii</i>
<i>Phoradendron californicum</i>	Not mapped in 1990 or 2000 due to seasonal fluctuations
<i>Selaginella arizonica</i>	Cover not estimated in 1990; but included in 2000 and 2010
<i>Stephanomeria pauciflora</i>	May not have been mapped in 1990
<i>Urochloa arizonica</i>	Name changed from <i>Brachiaria arizonica</i>
<i>Zinnia acerosa</i>	Numerous seedlings were present in 2010. Individuals were counted and individuals were placed in size classes of 0 to 15 cm or 16 to 30 cm. Any plants greater than 30 cm in diameter were mapped.

Appendix H. Vegetation Maps 2010.

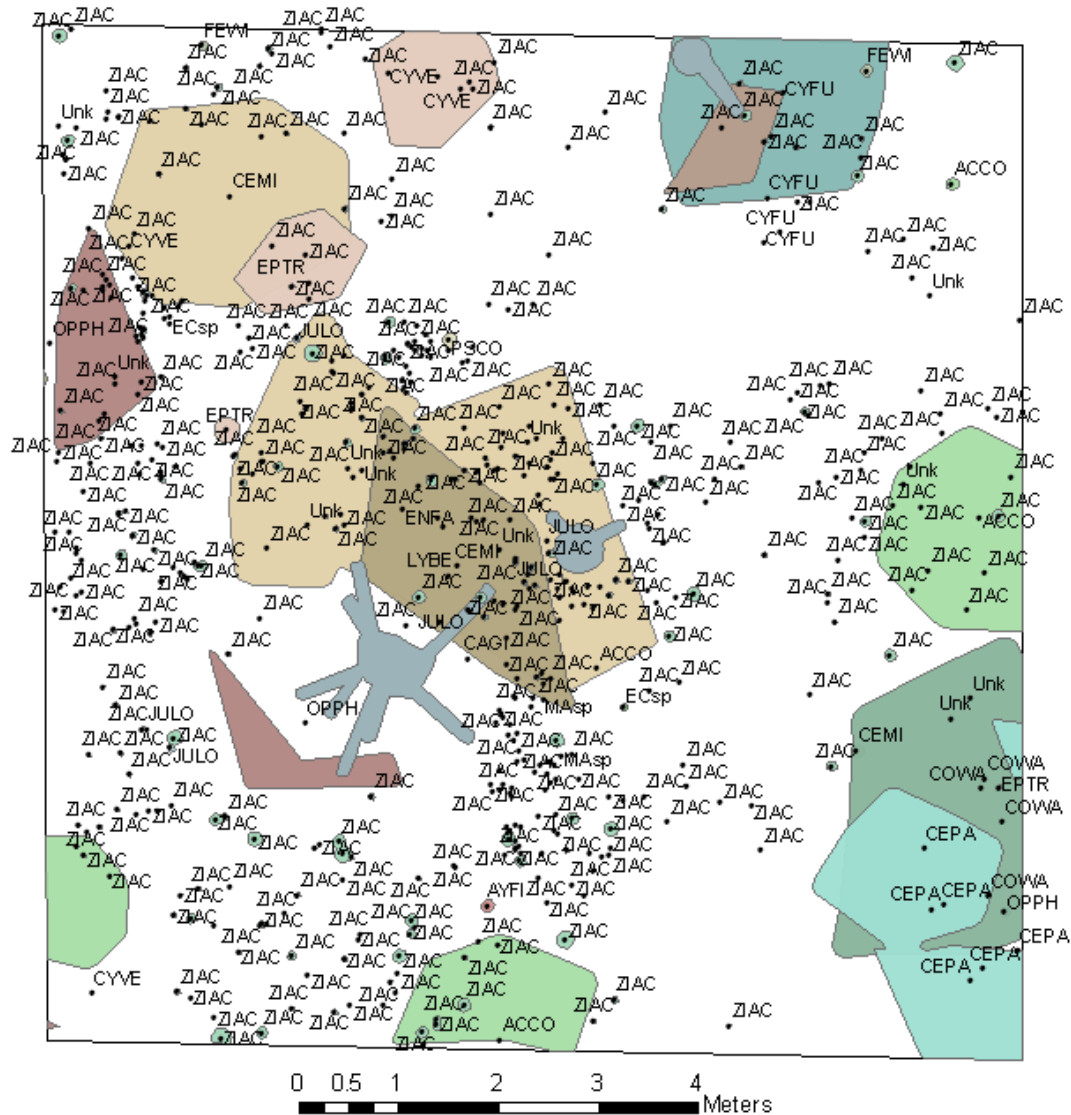
Plot 1: Rincon Mountain District



Label	Species	Density 2010	Cover 2010 (m2)
ACCO	<i>Acacia constricta</i>	1	0.75
CAAR	<i>Carlwrightia arizonica</i>	1	0.15
CAGI	<i>Carnegiea gigantea</i>	1	0.02
CYFU	<i>Cylindropuntia fulgida</i>	2	0.56
CYLE	<i>Cylindropuntia leptocaulis</i>	5	0.18
CYsp	<i>Cylindropuntia species</i>	2	0.05
ENFA	<i>Encelia farinosa</i>	665	24.47
LATR	<i>Larrea tridentata</i>	7	9.95
OPPH	<i>Opuntia phaeacantha</i>	2	10.77
PRVE	<i>Prosopis velutina</i>	1	4.44
	Grasses		0%
	Ferns & Allies		0%
Total		687	51.36

**Encelia farinosa* less than 30 cm in diameter were not mapped individually.

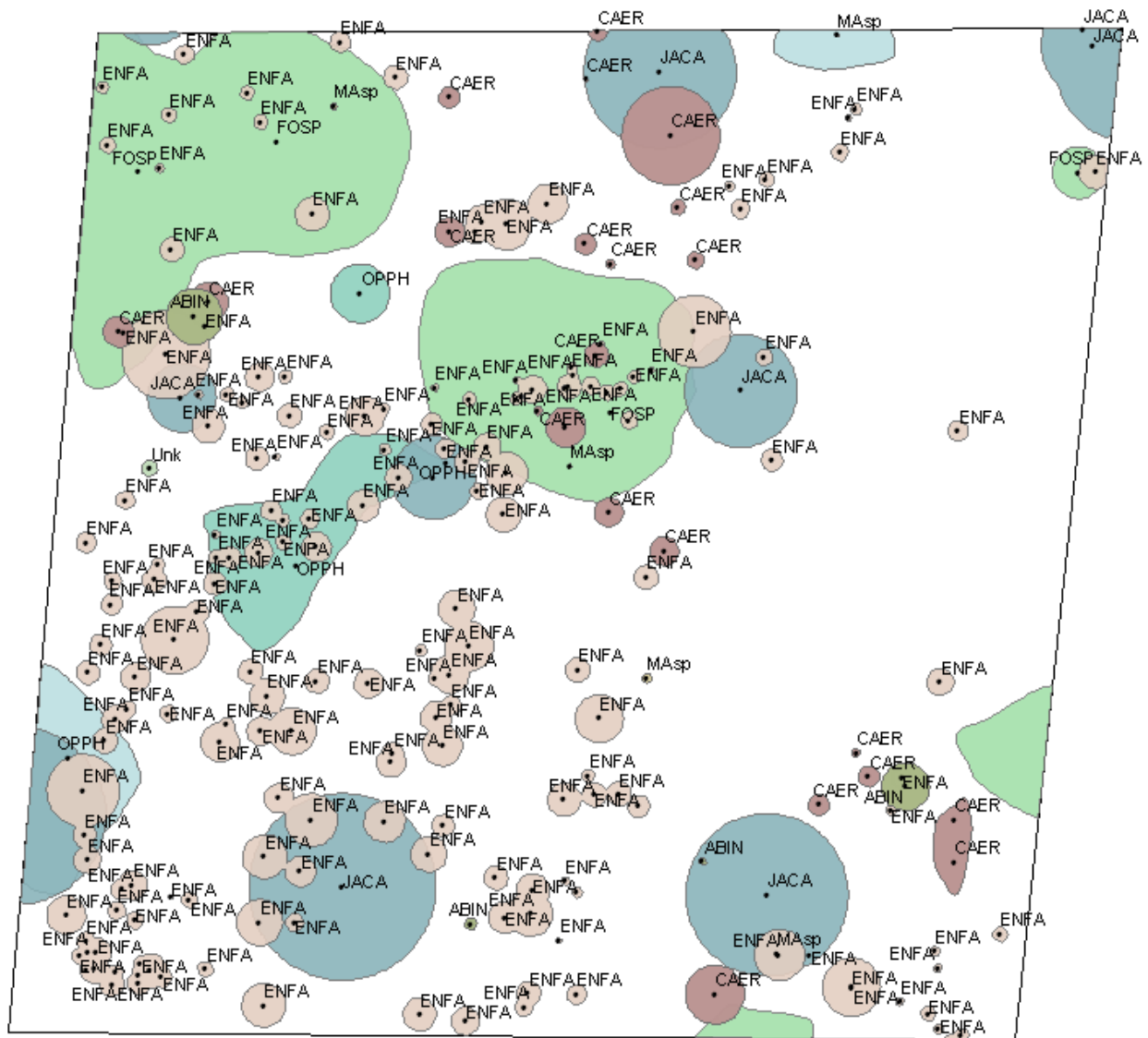
Plot 2: Rincon Mountain District



Label	Species	Density 2010	Cover 2010 (m2)
ACCO	<i>Acacia constricta</i>	5	5.00
AYFI	<i>Ayenia filiformis</i>	1	0.01
CAGI	<i>Carnegiea gigantea</i>	1	1.54
CEMI	<i>Cercidium microphyllum</i>	4	13.43
CEPA	<i>Celtis pallida</i>	7	3.53
COWA	<i>Condalia wernockii</i>	4	4.98
CYFU	<i>Cylindropuntia fulgida</i>	5	0.70
CYVE	<i>Cylindropuntia ericoides</i>	6	0.00
ECsp	<i>Echinocereus species</i>	2	0.00
ENFA	<i>Encelia farinosa</i>	1	0.00
EPTR	<i>Ephedra trifurca</i>	5	2.09
FEWI	<i>Ferocactus wislizenii</i>	2	0.02
JULO	<i>Justicia longii</i>	9	0.02
LYBE	<i>Lycium berlandieri</i>	1	3.33
MAPI	<i>Macraea pinnatifida</i>	2	0.00
OPPH	<i>Opuntia phaeantha</i>	4	2.22
PRVE	<i>Prosopis velutina</i>	1	3.32
PSCO	<i>Psilostrophe cooperi</i>	1	0.02
ZIAC	<i>Zinnia acerosa</i>	507	0.76
	Grasses		0%
	Ferns & Allies		0%
Total		568	40.98



Plot 3: Rincon Mountain District

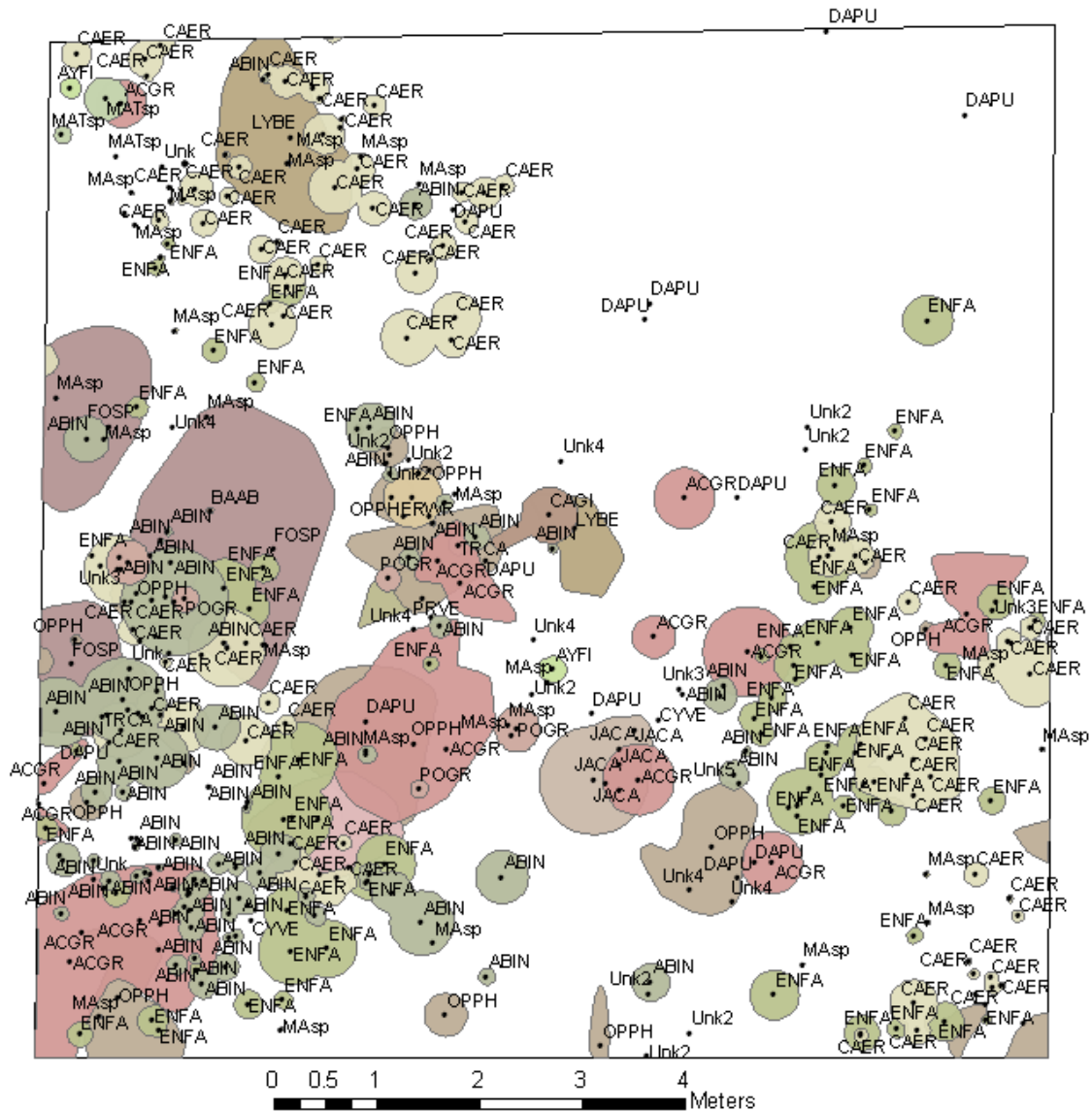


0 0.5 1 2 3 4 Meters

Label	Species	Density 2010	Cover 2010 (m ²)
ABIN	<i>Abutilon incanum</i>	4	0.45
CAER	<i>Calliandra eriophylla</i>	22	2.13
CEMI	<i>Cercidium microphyllum</i>	2	2.14
ENFA	<i>Encelia farinosa</i>	179	10.10
FOSP	<i>Fouquieria splendens</i>	6	14.55
JACA	<i>Jatropha cardiophylla</i>	10	10.25
JULO	<i>Justicia longii</i>	1	0.02
MAsp	<i>Mammillaria species</i>	7	0.02
OPPH	<i>Opuntia phaeacantha</i>	4	2.59
	Grasses		<1%
	Ferns & Allies		0%
	Selaginella species		50%
Total		235	42.24



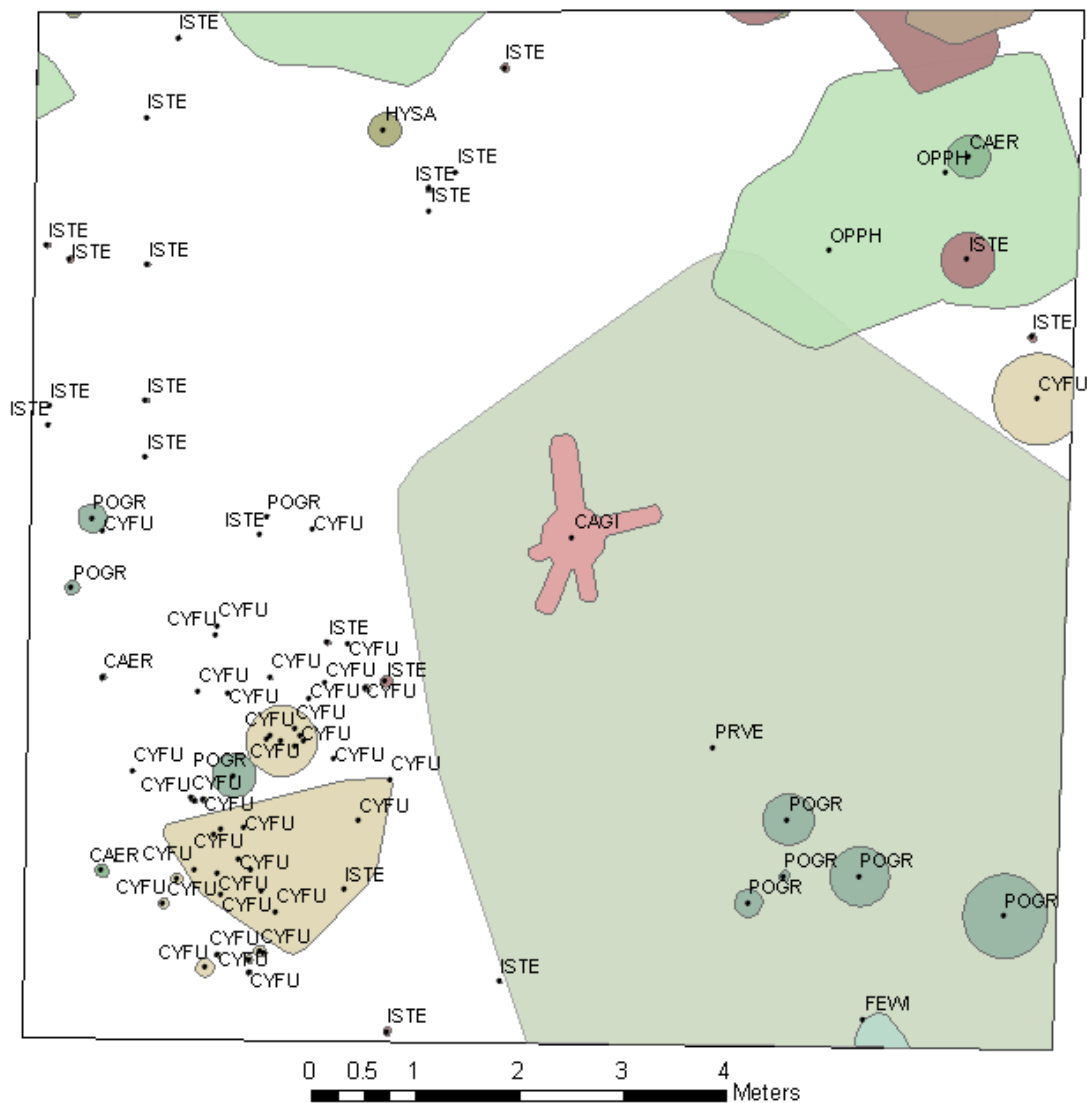
Plot 4: Rincon Mountain District



Label	Species	Density 2010	Cover 2010 (m2)
ABIN	<i>Abutilon tomentosum</i>	91	4.84
ACGR	<i>Acacia greggii</i>	16	7.68
AYFI	<i>Ayenia filiformis</i>	2	0.09
BAAB	<i>Bahia abacanthifolia</i>	1	0.00
CAER	<i>Calliandra eriophylla</i>	91	6.39
CAGI	<i>Carnegiea gigantea</i>	1	0.29
CEMI	<i>Cercidium microphyllum</i>	1	1.14
ENFA	<i>Encelia farinosa</i>	359	5.82
ERWR	<i>Eriogonum wrightii</i>	1	0.26
FOSP	<i>Fouquieria splendens</i>	3	6.30
JACA	<i>Jatropha cardiophylla</i>	6	0.99
LYBE	<i>Lycium berlandieri</i>	2	2.28
MAsp	<i>Mammillaria species</i>	29	0.02
MATsp	<i>Matelea species</i>	3	0.16
OPPH	<i>Opuntia phaeacantha</i>	22	6.14
POGR	<i>Porophyllum gracile</i>	5	0.42
PRVE	<i>Prosopis velutina</i>	1	0.36
TRCA	<i>Trichocereus californicus</i>	2	0.05
	Grasses		2%
	Ferns & Allies		0%
	<i>Selaginella species</i>		<1%
Total		636	43.24

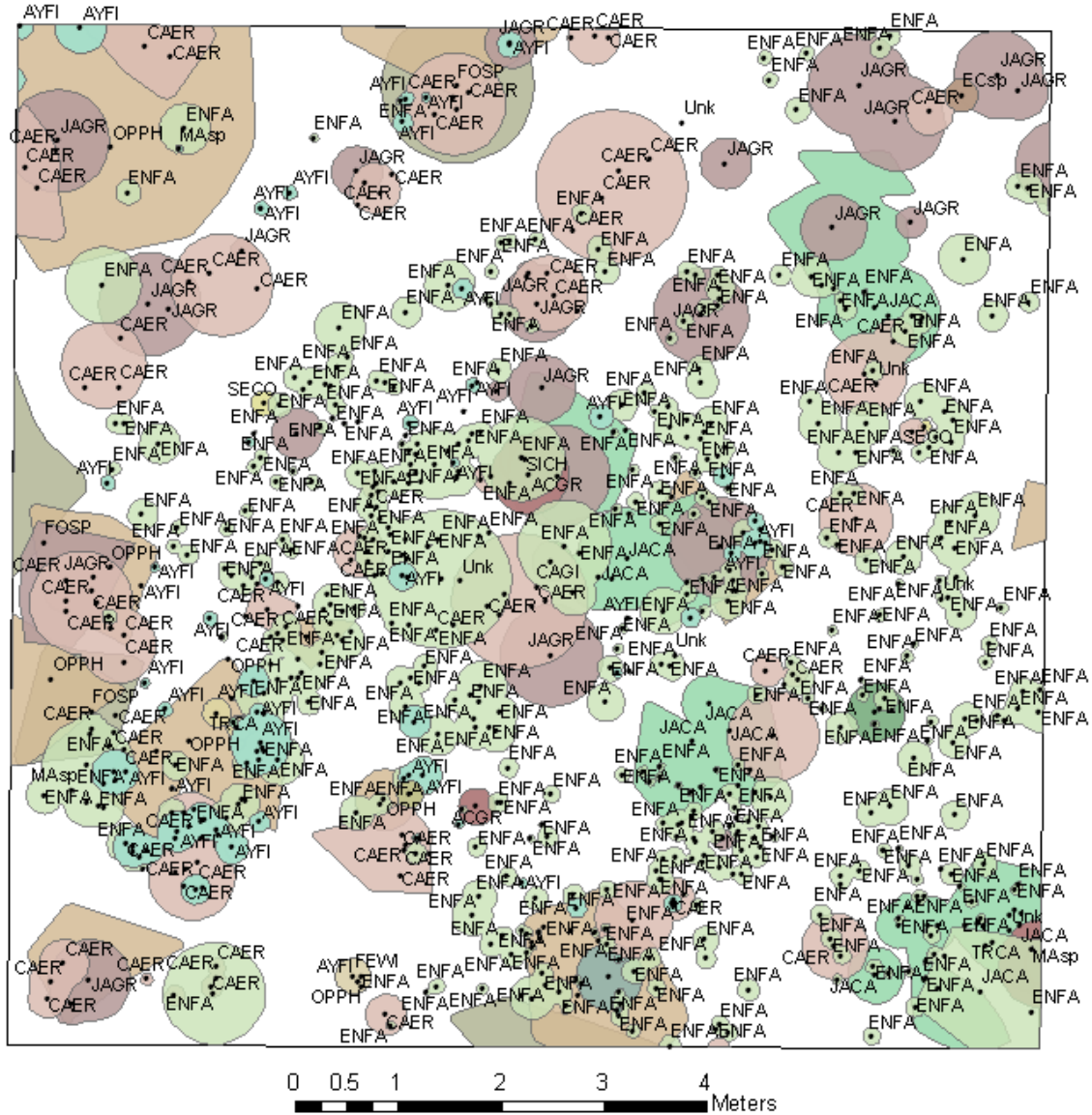
**Encelia farinosa* less than 30 cm in diameter were not mapped individually.

Plot 5: Rincon Mountain District



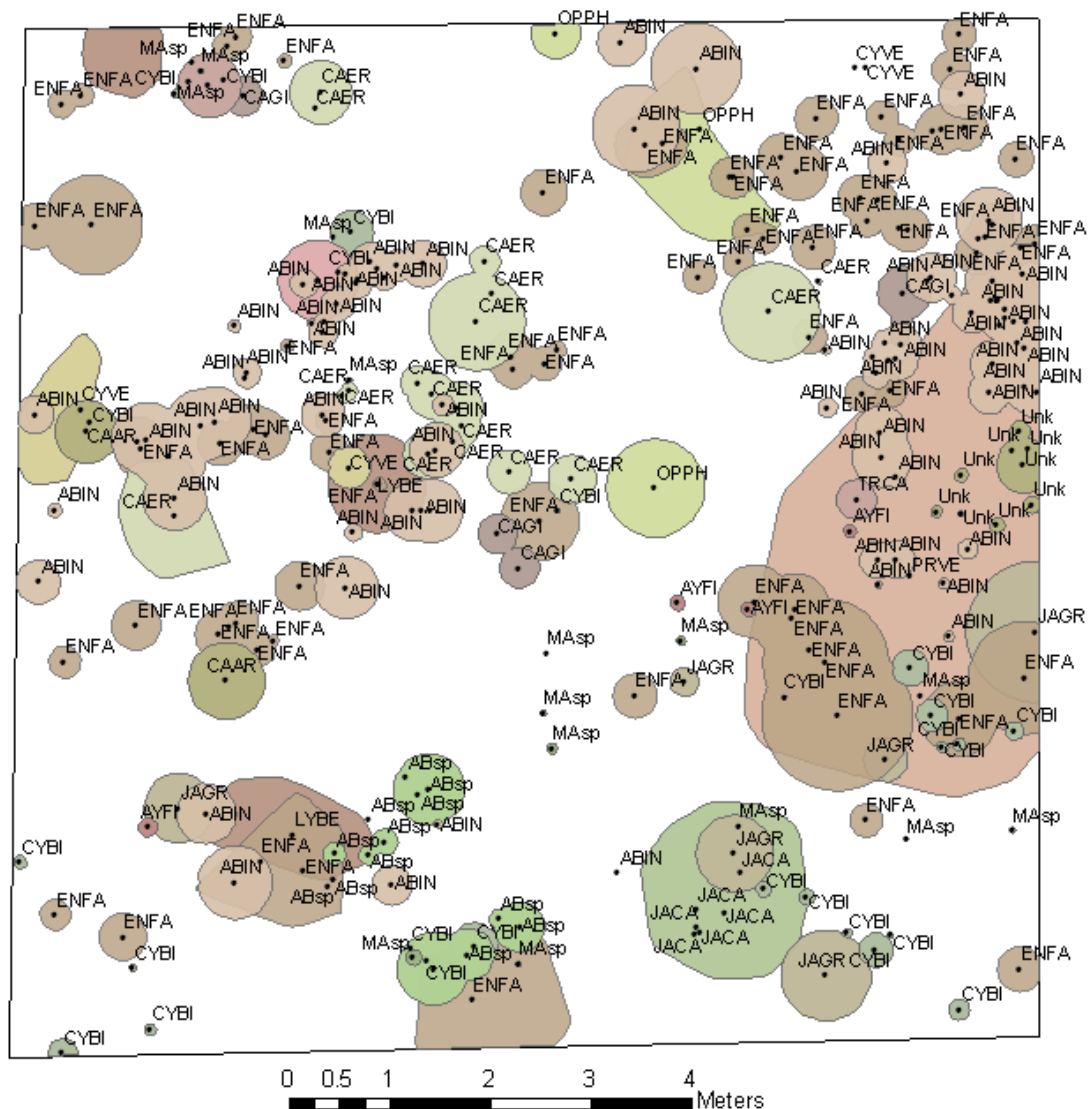
Label	Species	Density 2010	Cover 2010 (m2)
CAER	<i>Calliandra eriophylla</i>	3	0.15
CAGI	<i>Carnegiea gigantea</i>	1	0.75
CYFU	<i>Cylindropuntia fulgida</i>	44	3.31
CYVE	<i>Cylindropuntia versicolor</i>	1	0.25
EUsp	<i>Euphorbia species</i>	120	0.25
FEWI	<i>Ferocactus wislizenii</i>	1	0.12
HYSA	<i>Hymenoclea salsola</i>	3	0.10
ISTE	<i>Isocoma tenuisecta</i>	23	1.03
OPPH	<i>Opuntia phaeacantha</i>	4	8.56
POGR	<i>Porophyllum gracile</i>	9	1.23
PRVE	<i>Prosopis velutina</i>	1	39.82
	Grasses		<1%
	Ferns & Allies		0%
Total		210	55.58

Plot 6: Rincon Mountain District



Label	Species	Density 2010	Cover 2010 (m ²)
ABIN	<i>Abutilon incanum</i>	1	0.06
ACGR	<i>Acacia greggii</i>	3	0.82
AYFI	<i>Ayenia filiformis</i>	63	2.06
CAER	<i>Calliandra eriophylla</i>	101	13.43
CAGI	<i>Carnegiea gigantea</i>	1	0.12
CENI	<i>Cercidium microphyllum</i>	1	0.25
CYsp	<i>Cylindropuntia species</i>	1	0.33
ECsp	<i>Echinocereus species</i>	1	0.08
ENFA	<i>Encelia farinosa</i>	486	19.11
FEWI	<i>Ferocactus wislizeni</i>	1	0.10
FOSP	<i>Fouquieria splendens</i>	4	3.92
JAGR	<i>Janusia gracilis</i>	29	10.11
JACA	<i>Jatropha cardiophylla</i>	15	8.62
MAsp	<i>Mammillaria species</i>	4	0.01
OPPH	<i>Opuntia phaeacantha</i>	11	13.77
SECO	<i>Senna covesii</i>	2	0.06
SICH	<i>Simmondsia chinensis</i>	1	0.20
TRCA	<i>Trixis californica</i>	3	0.14
	Grasses		0%
	Ferns & Allies		0%
	Total	728	73.18

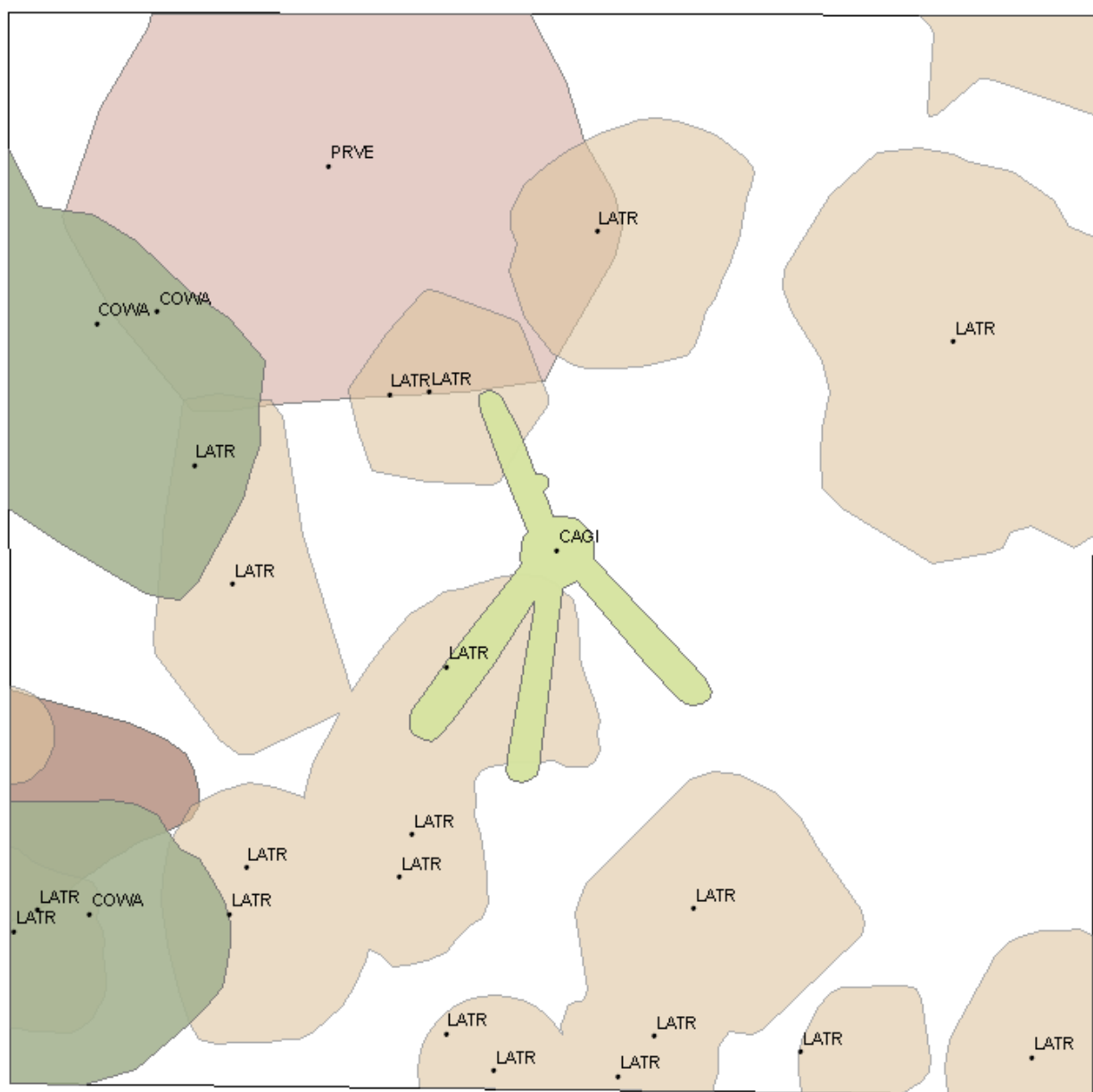
Plot 7: Rincon Mountain District



Label	Species	Density 2010	Cover 2010 (m ²)
ABIN	<i>Abutilon incanum</i>	81	8.50
ABsp	<i>Abutilon species</i>	13	1.26
AYFI	<i>Ayenia filiformis</i>	4	0.08
CAER	<i>Calliandra eriophylla</i>	18	3.78
CAAR	<i>Carlwrightia arizonica</i>	11	1.06
CAGI	<i>Carnegiea gigantea</i>	4	0.65
CEMI	<i>Cercidium microphyllum</i>	1	0.50
CYBI	<i>Cylindropuntia bigelovii</i>	25	0.81
CYVE	<i>Cylindropuntia verticilar</i>	4	0.94
ENFA	<i>Encelia farinosa</i>	332	17.22
JAGR	<i>Janusia gracilis</i>	6	2.49
JACA	<i>Jatropha cardiophylla</i>	6	2.36
LYBE	<i>Lycium berlandieri</i>	3	2.43
MAsp	<i>Mammillaria species</i>	15	0.04
OPPH	<i>Opuntia phaeacantha</i>	3	2.28
PRVE	<i>Prosopis velutina</i>	1	11.29
TRCA	<i>Trixis californica</i>	2	0.44
	Grasses		4%
	Ferns & Allies		0%
	Total	529	56.14

**Encelia farinosa* less than 30 cm in diameter were not mapped individually.

Plot 8: Rincon Mountain District

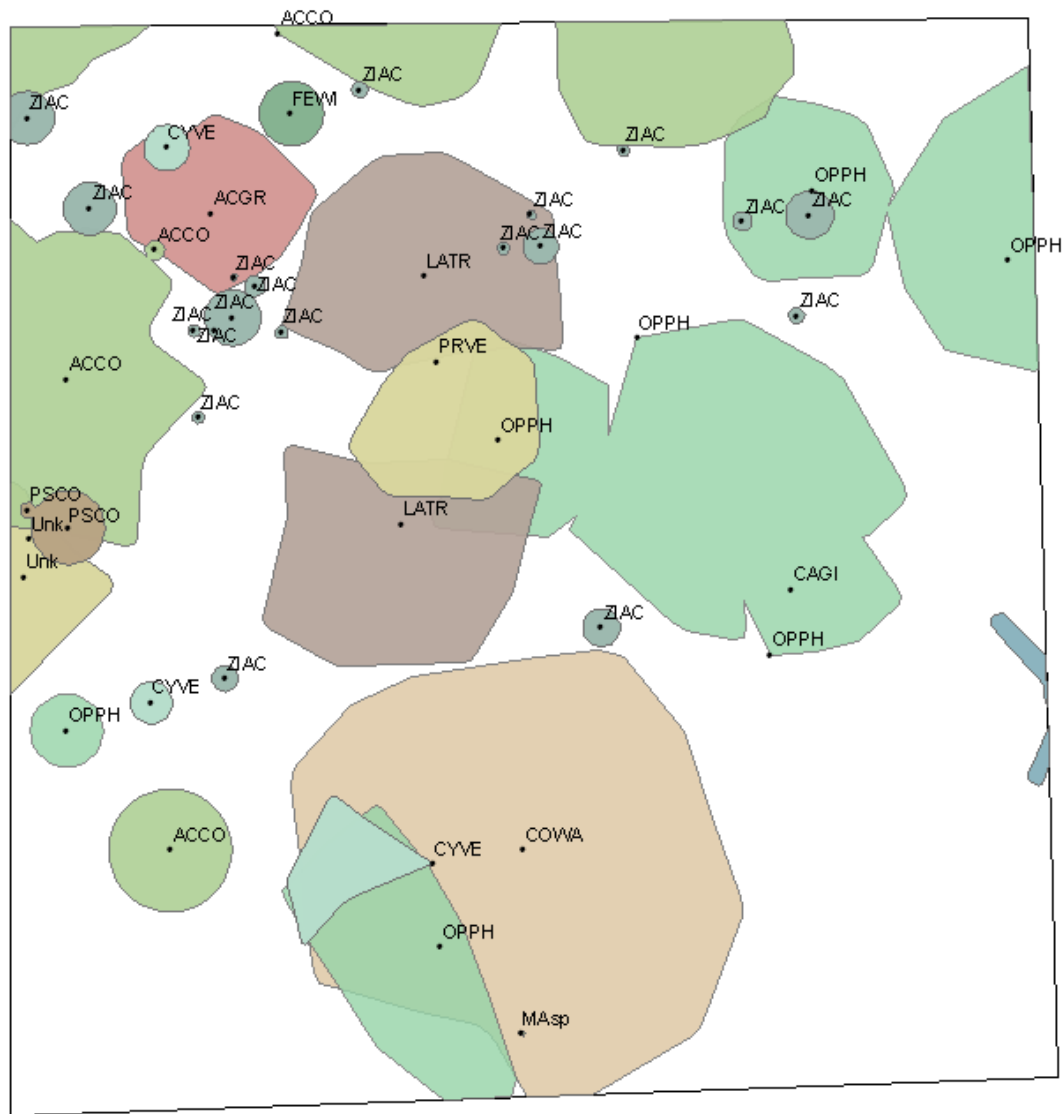


0 0.45 0.9 1.8 2.7 3.6 Meters

Label	Species	Density 2010	Cover 2010 (m2)
ACGR	<i>Acacia greggii</i>	1	2.40
CAGI	<i>Carnegiea gigantea</i>	1	2.28
COWA	<i>Condalia warnockii</i>	2	10.98
LATR	<i>Larrea tridentata</i>	23	40.63
PRVE	<i>Prosopis velutina</i>	1	15.57
	Grasses		0%
	Ferns & Allies		0%
Total		28	71.86



Plot 9: Rincon Mountain District

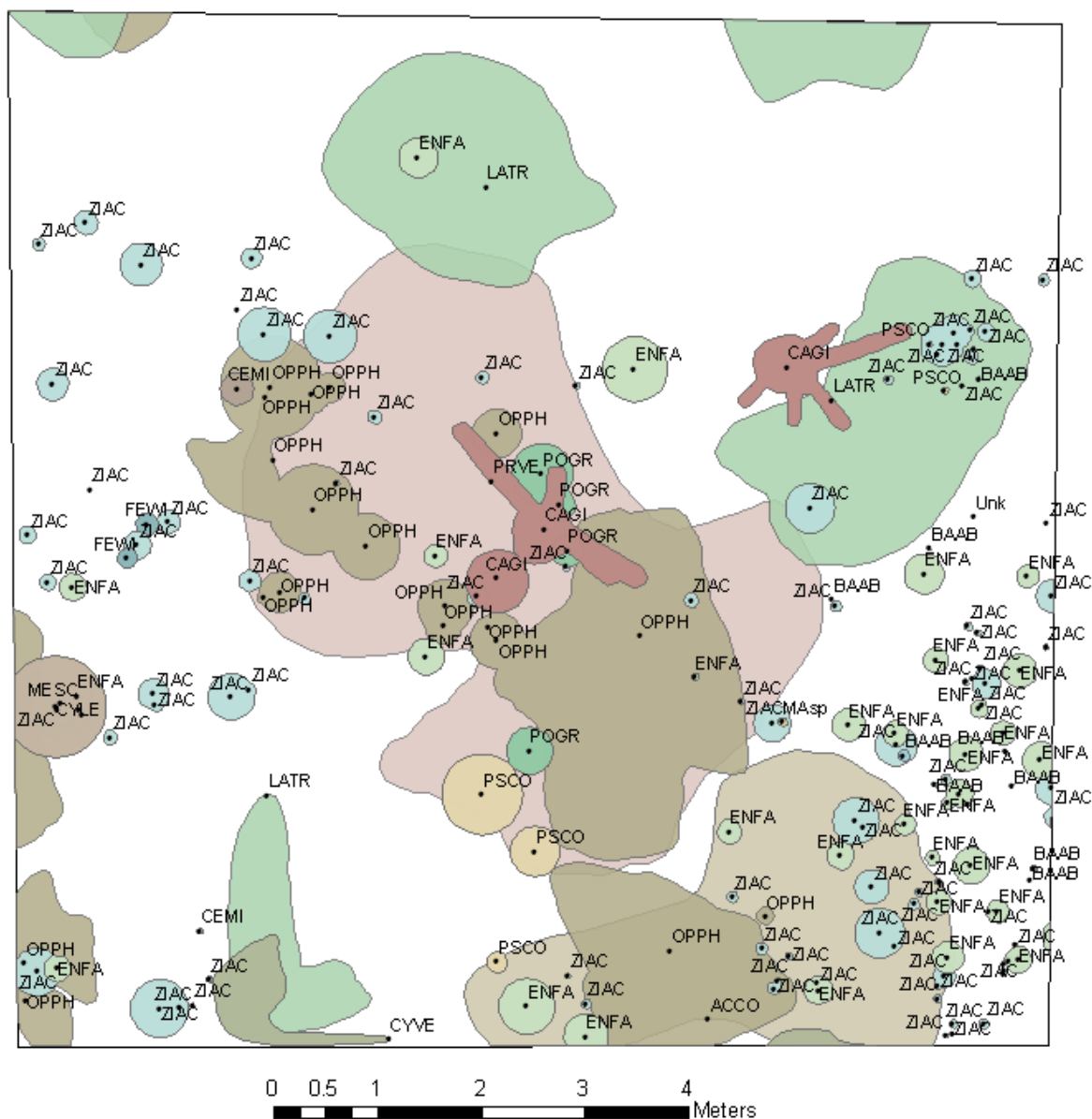


0 0.5 1 2 3 4 Meters

Label	Species	Density 2010	Cover 2010 (m ²)
ACCO	<i>Acacia constricta</i>	6	9.39
ACGR	<i>Acacia greggii</i>	1	2.16
CAGI	<i>Carnegiea gigantea</i>	1	0.21
COWA	<i>Condalia wernockii</i>	1	13.58
CYVE	<i>Cylindropuntia versicolor</i>	3	1.17
FEWI	<i>Ferocactus wislizenii</i>	1	0.30
LATR	<i>Larrea tridentata</i>	2	8.57
MASp	<i>Mammillaria species</i>	1	0.00
OPPH	<i>Opuntia phaeacantha</i>	7	18.61
PRVE	<i>Prosopis velutina</i>	2	3.29
PSCO	<i>Psilostrophe cooperi</i>	2	0.41
ZIAC	<i>Zinnia acerosa</i>	19	1.16
	Grasses		4%
	Ferns & Allies		0%
Total		46	58.85

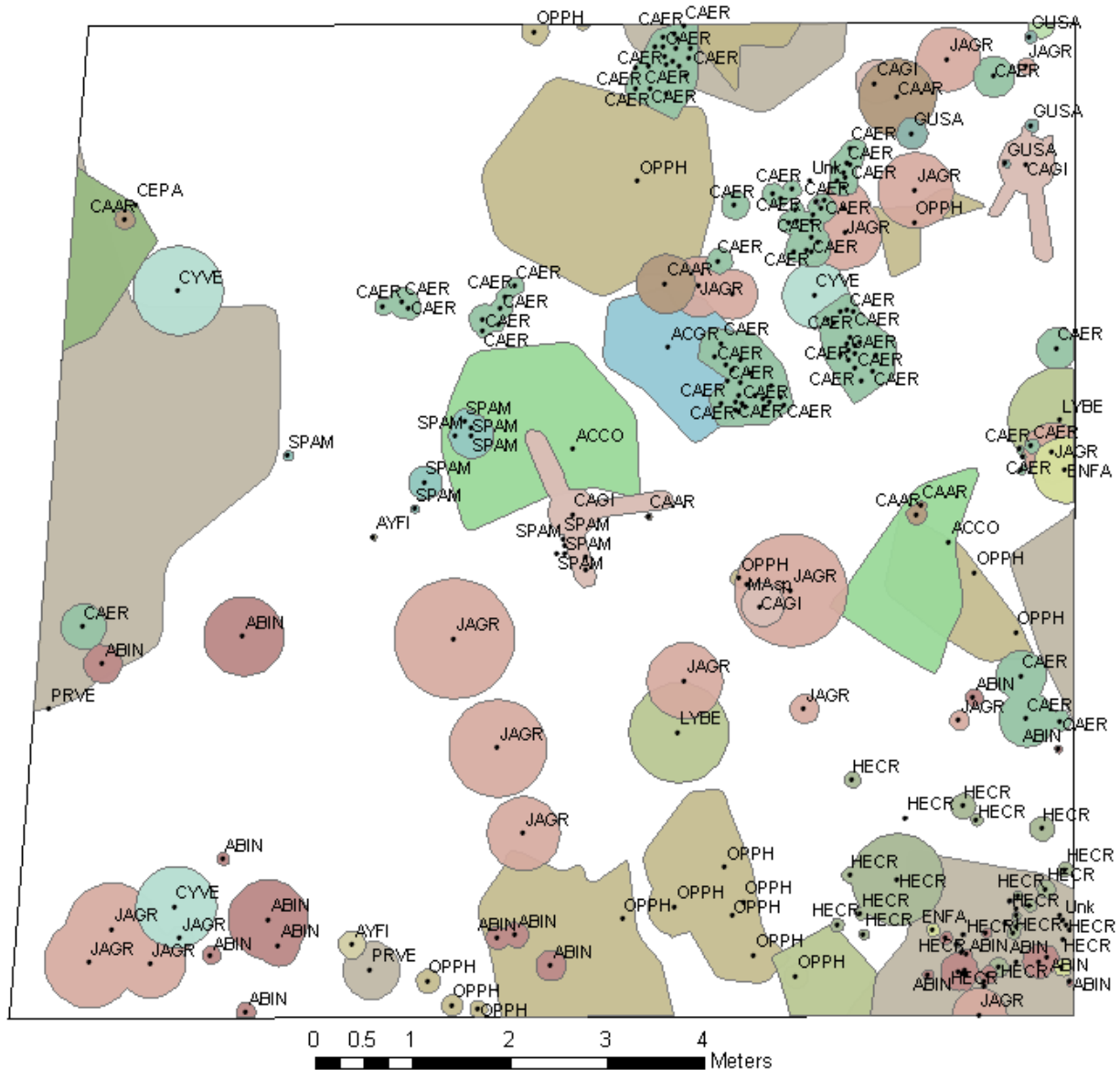


Plot 10: Rincon Mountain District



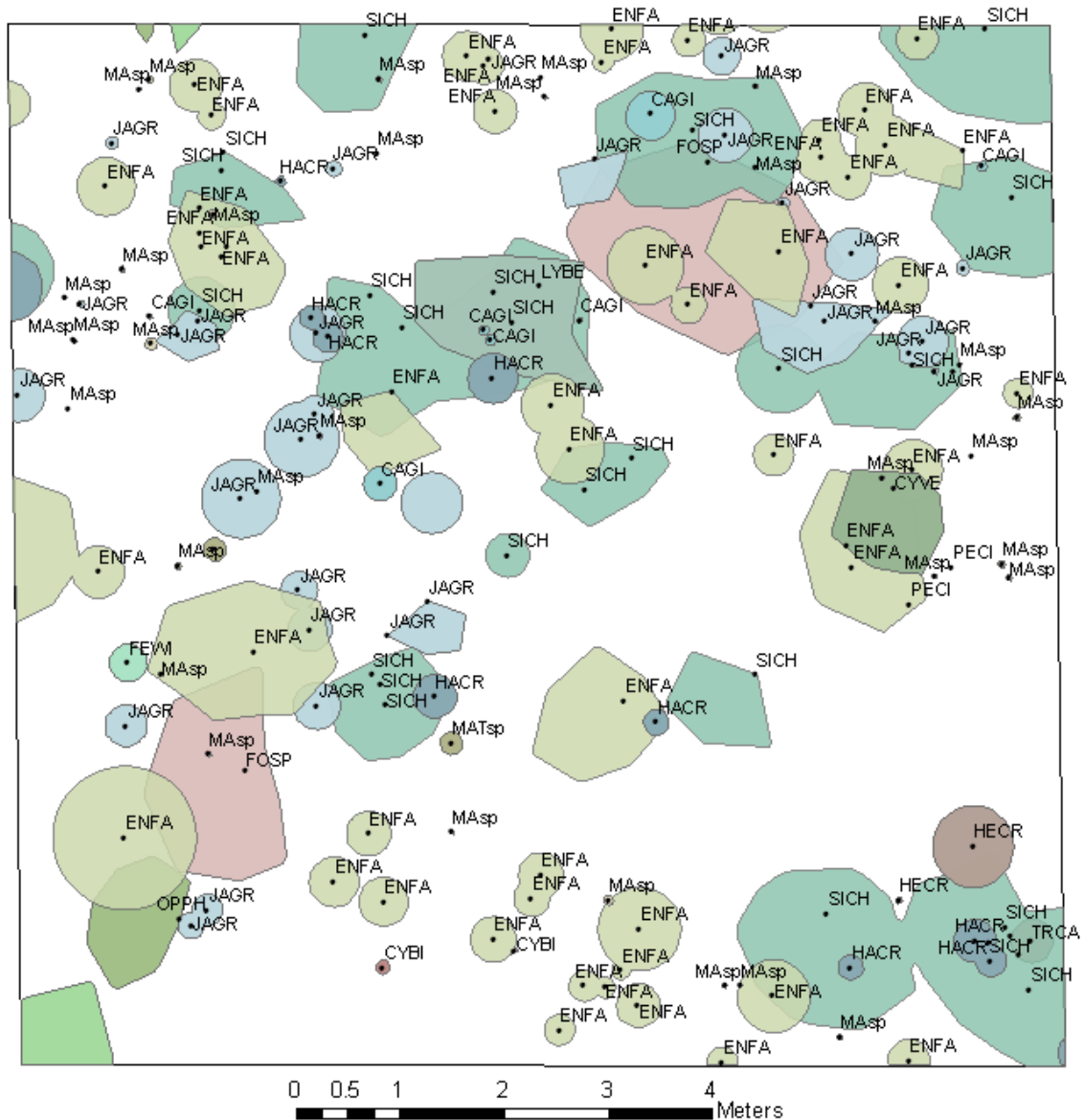
Label	Species	Density 2010	Cover 2010 (m ²)
ACCO	<i>Acacia constricta</i>	1	8.12
BAAB	<i>Banksia obtusifolia</i>	10	0.02
CAGI	<i>Carnegiea gigantea</i>	3	1.69
CEMI	<i>Cercidium microphyllum</i>	2	0.08
CYLE	<i>Cylindropuntia leptocaulis</i>	1	0.71
CYVE	<i>Cylindropuntia versicolor</i>	2	0.74
ENFA	<i>Encelia farinosa</i>	33	2.31
FEWI	<i>Ferocactus wislizenii</i>	2	0.06
LATR	<i>Larrea tridentata</i>	5	12.43
MAap	<i>Mammillaria species</i>	1	0.01
MESC	<i>Menodora acabra</i>	1	0.13
OPPH	<i>Opuntia phaeoantha</i>	21	13.03
POGR	<i>Porophyllum gracile</i>	4	0.56
PRVE	<i>Prosopis velutina</i>	1	19.75
PSCO	<i>Psilostrophe cooperi</i>	5	0.69
ZIAC	<i>Zinnia acerosa</i>	94	3.28
	Grasses		<1%
	Ferns & Allies		0%
	Total	186	63.62

Plot 11: Rincon Mountain District



Label	Species	Density 2010	Cover 2010 (m2)
ABIN	<i>Abutilon incanum</i>	26	1.72
ACCO	<i>Acacia constricta</i>	2	4.49
ACGR	<i>Acacia greggii</i>	1	1.69
AYFI	<i>Ayenia fulformis</i>	2	0.06
CAER	<i>Calliandra eriophylla</i>	102	3.61
CAAR	<i>Carlownrightia arizonica</i>	6	0.84
CAGI	<i>Carnegiea gigantea</i>	4	1.37
CEPA	<i>Celtis pallida</i>	1	1.03
CYVE	<i>Cylindropuntia versicolor</i>	3	1.56
ENFA	<i>Encelia farinosa</i>	3	0.28
FEWI	<i>Ferocactus wislizenii</i>	1	0.03
GUSA	<i>Gutierrezia sarothrae</i>	4	0.11
HECR	<i>Herrisantia crispata</i>	28	1.01
JAGR	<i>Janusia gracilis</i>	20	7.53
LYBE	<i>Lycium berlandieri</i>	3	2.15
MAsp	<i>Mammillaria species</i>	2	0.00
OPPH	<i>Opuntia phaeoantha</i>	19	10.32
PRVE	<i>Prosopis velutina</i>	4	12.80
SPAM	<i>Sphaeralcea ambigua</i>	13	0.28
	Grasses		8%
	Ferns & Allies		0%
Total		244	50.87

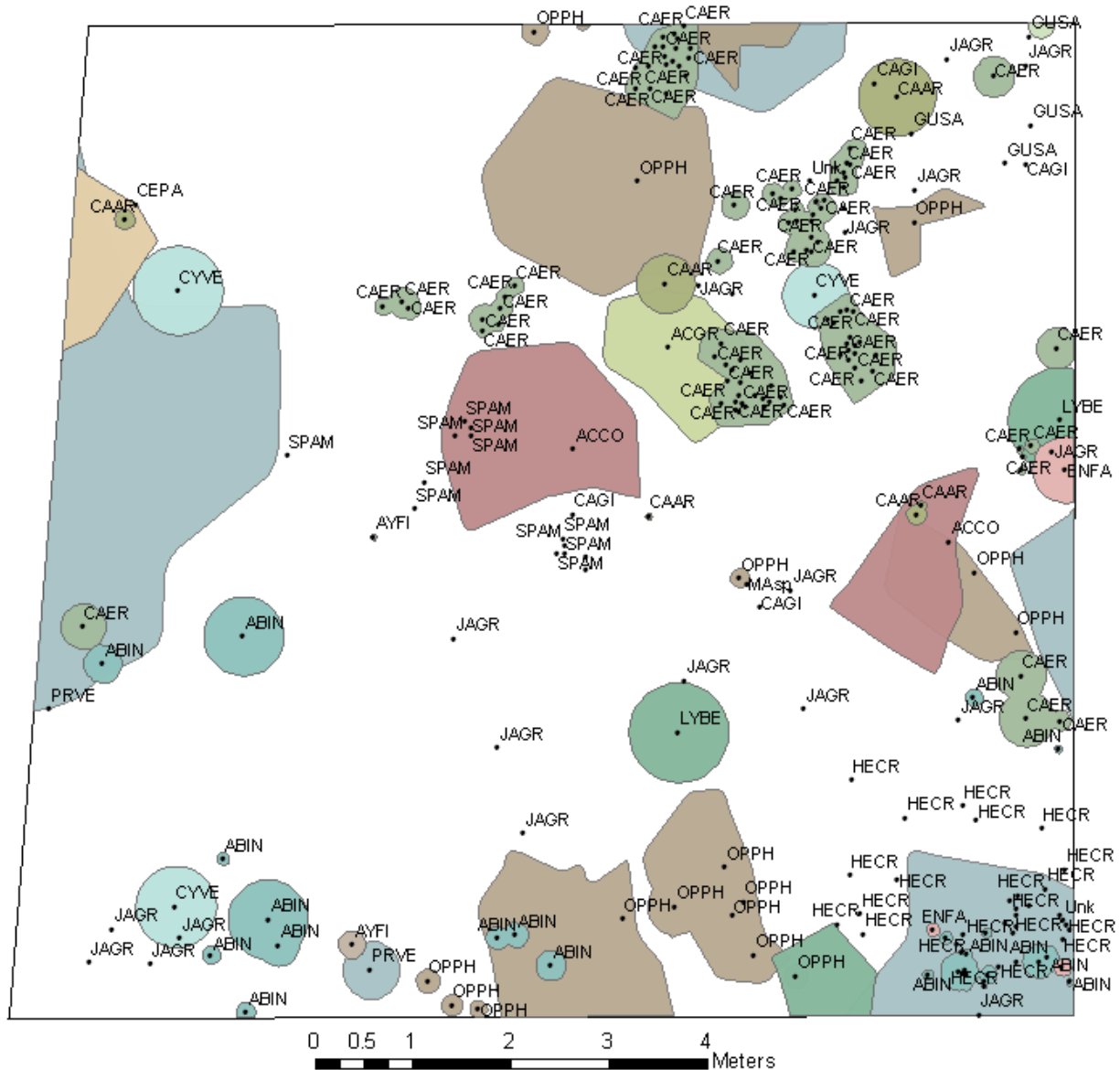
Plot 12: Rincon Mountain District



Label	Species	Density 2010	Cover 2010 (m ²)
BAAB	<i>Bahia absinthifolia</i>	108	0.42
CAGI	<i>Carnegiea gigantea</i>	7	0.28
CEMI	<i>Cercidium microphyllum</i>	2	0.62
CYBI	<i>Cylindropuntia bigelovii</i>	2	0.01
CYVE	<i>Cylindropuntia versicolor</i>	1	0.83
ENFA	<i>Encelia farinosa</i>	124	15.41
FEVI	<i>Ferocactus wislizenii</i>	1	0.10
FOSP	<i>Fouquieria splendens</i>	2	5.51
HACR	<i>Haplophylon crookii</i>	11	0.87
HEGR	<i>Hemizantia crispata</i>	2	0.48
JAGR	<i>Janusia gracilis</i>	30	4.18
LYBE	<i>Lycium berlandieri</i>	1	1.62
MAsp	<i>Mammillaria species</i>	34	0.06
MATsp	<i>Matelea species</i>	2	0.07
OPPH	<i>Opuntia phaeacantha</i>	2	0.86
SICH	<i>Simmondsia chinensis</i>	26	17.42
TRCA	<i>Trichocalymma</i>	1	0.13
	Grasses		0%
	Ferns & Allies		<1%
Total		356	48.88

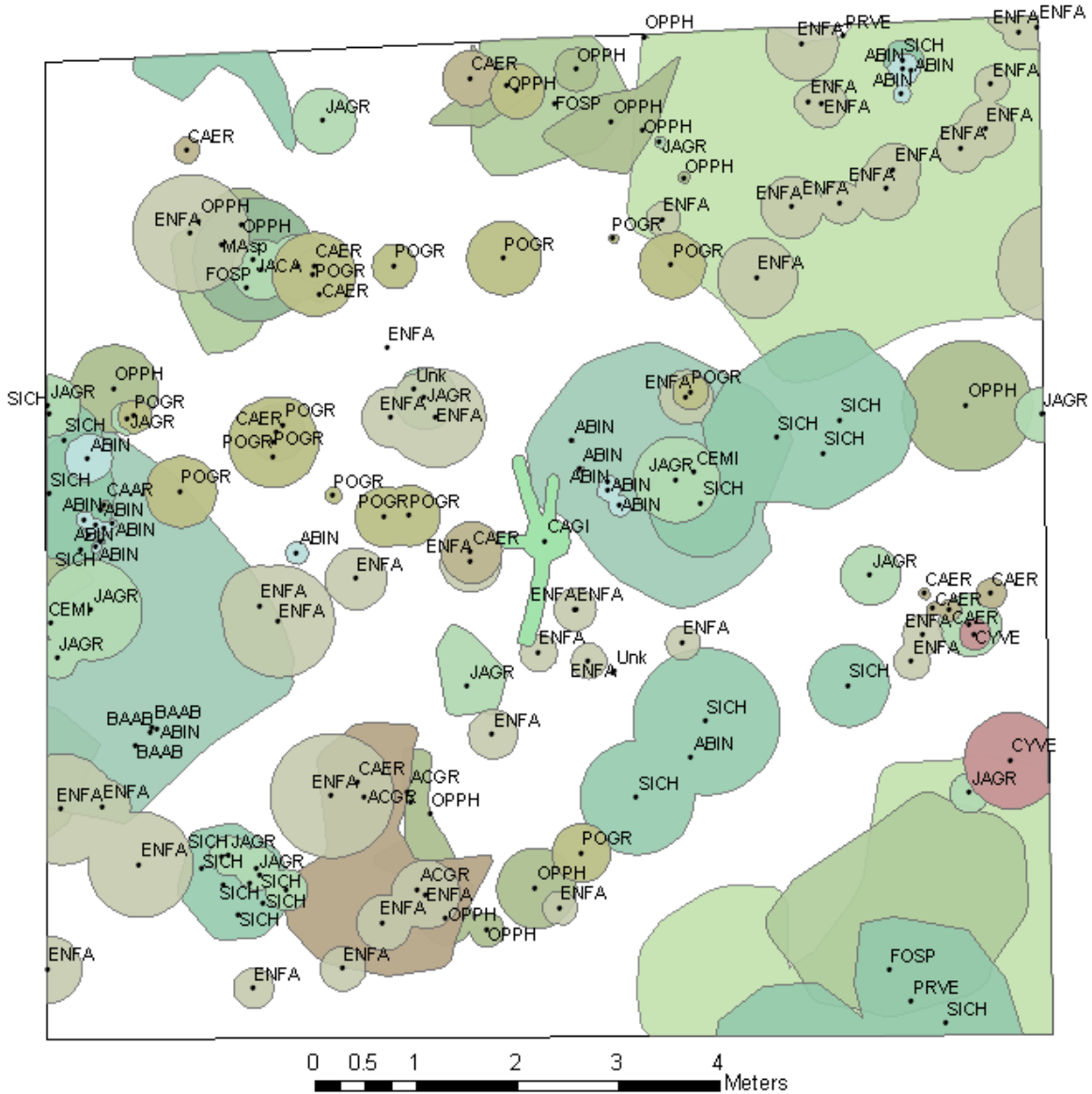
**Encelia farinosa* less than 30 cm in diameter were not mapped individually.

Plot 13: Rincon Mountain District



Label	Species	Density 2010	Cover2010 (m2)
ABIN	<i>Abutilon incanum</i>	1	0.26
ACCO	<i>Acacia constricta</i>	2	5.16
ACGR	<i>Acacia greggii</i>	4	5.00
AMAM	<i>Ambrosia ambrosioides</i>	2	0.11
AYFI	<i>Ayenia filiformis</i>	4	0.19
BRCO	<i>Brickellia coulteri</i>	14	3.79
CAER	<i>Calliandra eriophylla</i>	1	0.09
CAAR	<i>Carlowrightia arizonica</i>	1	0.10
CEPA	<i>Celtis pallida</i>	3	2.59
CYVE	<i>Cylindropuntia verticilar</i>	1	1.67
ENFA	<i>Encelia farinosa</i>	1	0.26
FEWI	<i>Ferocactus wislizeni</i>	2	0.19
LYBE	<i>Lycium berlandieri</i>	1	0.58
MAsp	<i>Mammillaria species</i>	15	0.02
OPPH	<i>Opuntia phaeacantha</i>	12	8.45
PRVE	<i>Prosopis velutina</i>	6	9.86
SECO	<i>Senna covesii</i>	1	0.03
	Grasses		6%
	Ferns & Allies		0%
Total		71	38.36

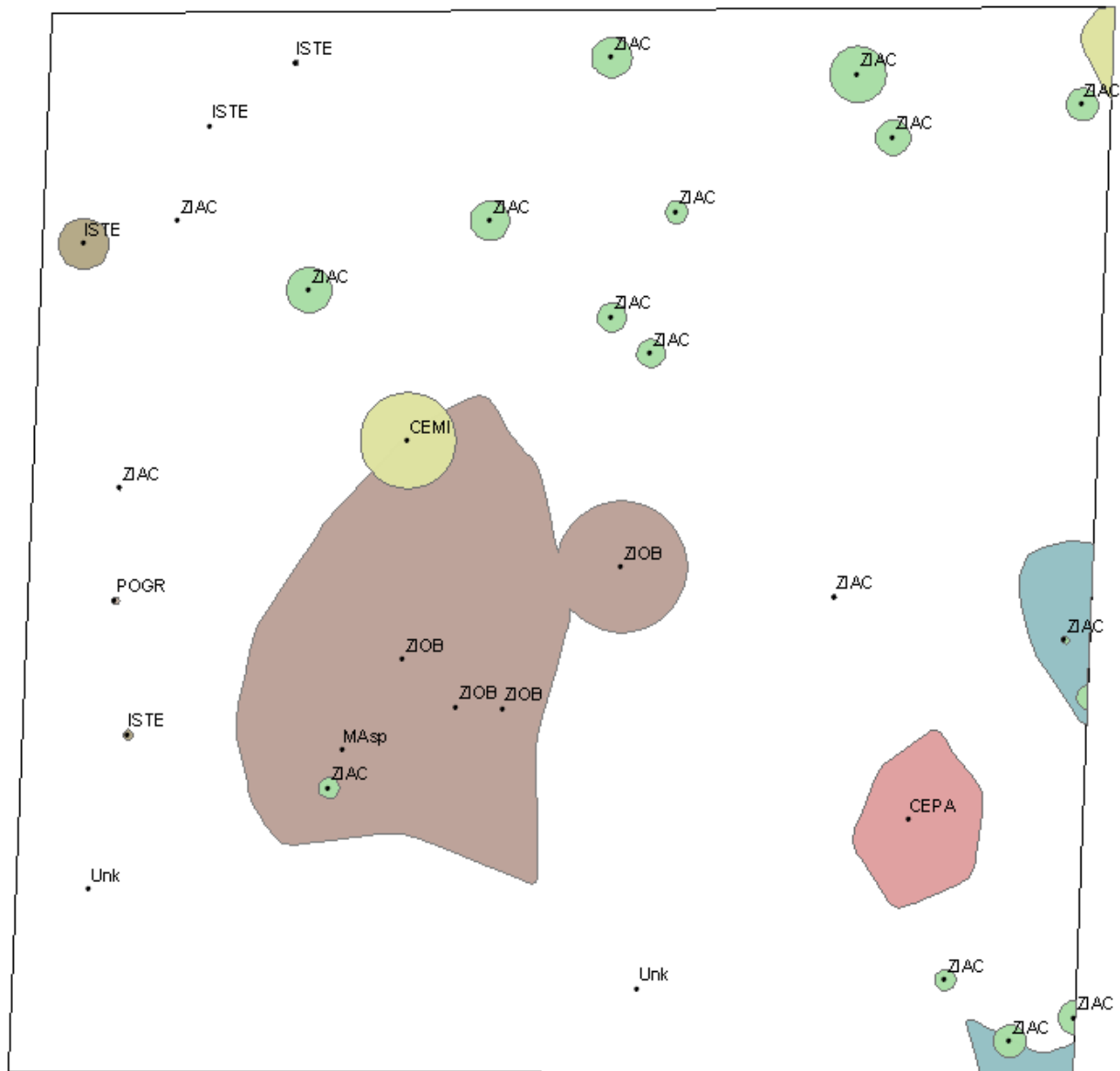
Plot 14: Rincon Mountain District



Label	Species	Density 2010	Cover 2010 (m ²)
ABIN	<i>Abutilon incanum</i>	21	0.46
ACGR	<i>Acacia greggii</i>	3	2.98
BAAB	<i>Bahia acanthifolia</i>	3	0.00
CAER	<i>Calliandra eriophylla</i>	11	1.04
CAAR	<i>Carlwrightia arizonica</i>	1	0.01
CAGI	<i>Carnegiea gigantea</i>	1	0.51
CEMI	<i>Cercidium microphyllum</i>	2	11.44
CYVE	<i>Cylindropuntia versicolor</i>	2	0.73
ENFA	<i>Encelia farinosa</i>	593	18.62
FOSP	<i>Fouquieria splendens</i>	4	7.31
JAGR	<i>Janusia gracilis</i>	18	4.42
JACA	<i>Jatropha cardiophylla</i>	1	1.16
MAsp	<i>Mammillaria species</i>	2	0.00
OPPH	<i>Opuntia phaeacantha</i>	15	5.03
POGR	<i>Porophyllum gracile</i>	16	3.60
PRVE	<i>Prosopis velutina</i>	2	19.43
SICH	<i>Sismondia chinensis</i>	21	11.25
	Grasses		29%
	Ferns & Allies		0%
	Total	716	88.01

**Encelia farinosa* less than 30 cm in diameter were not mapped individually.

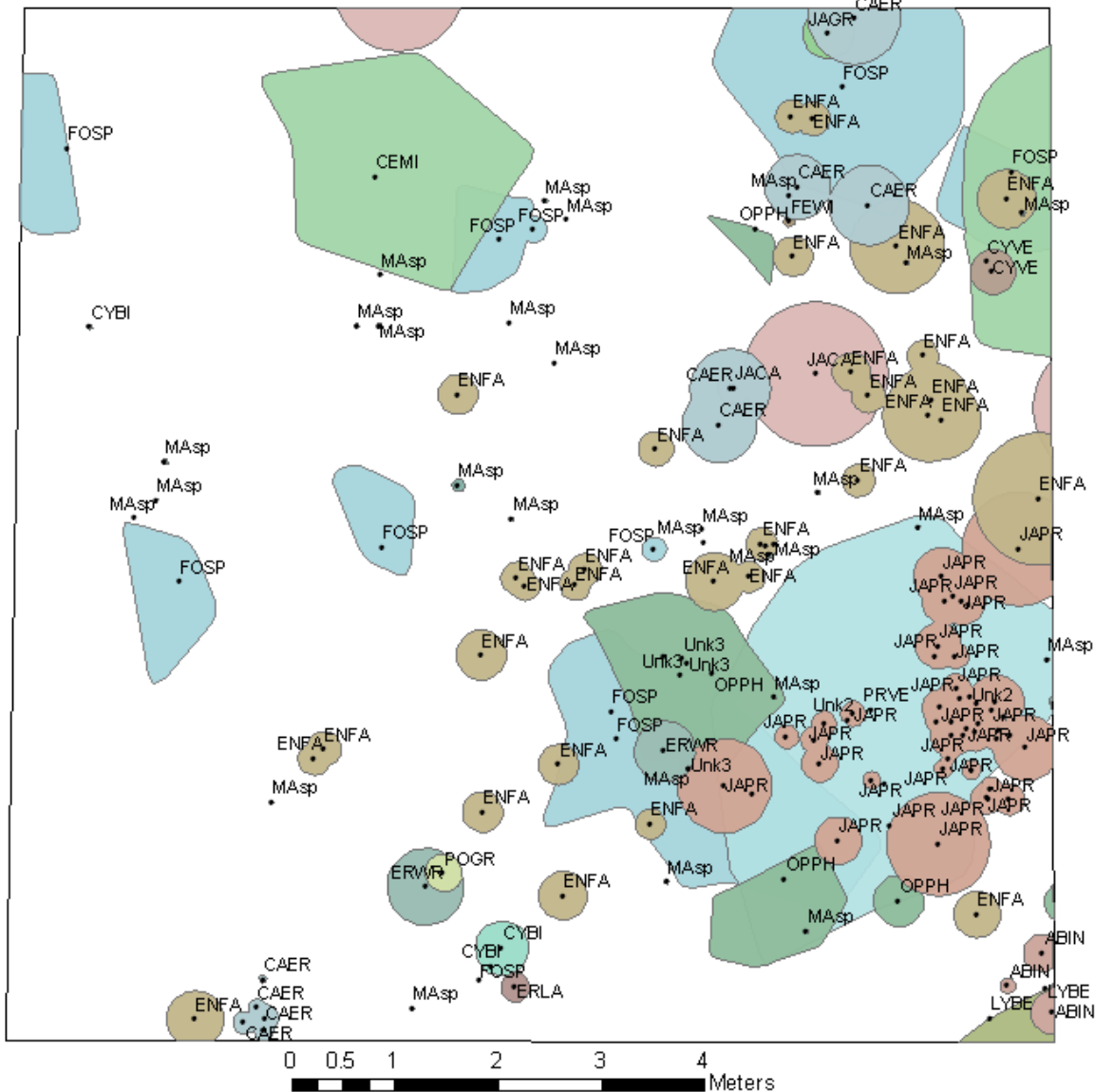
Plot 15: Rincon Mountain District



0 0.5 1 2 3 4 Meters

Label	Species	Density 2010	Cover 2010 (m2)
ACCO	<i>Acacia constricta</i>	2	1.11
CEPA	<i>Celtis pallida</i>	1	1.40
CEMI	<i>Cercidium microphyllum</i>	2	0.80
EUsp	<i>Euphorbia species</i>	70	0.15
ISTE	<i>Isocoma tenuisecta</i>	4	0.19
MA sp	<i>Mammillaria species</i>	1	0.00
POGR	<i>Porophyllum gracile</i>	1	0.00
ZIAC	<i>Zinnia acerosa</i>	18	1.09
ZIOB	<i>Ziziphus obtusifolia</i>	4	11.02
	Grasses		<1%
	Ferns & Allies		0%
Total		103	15.76

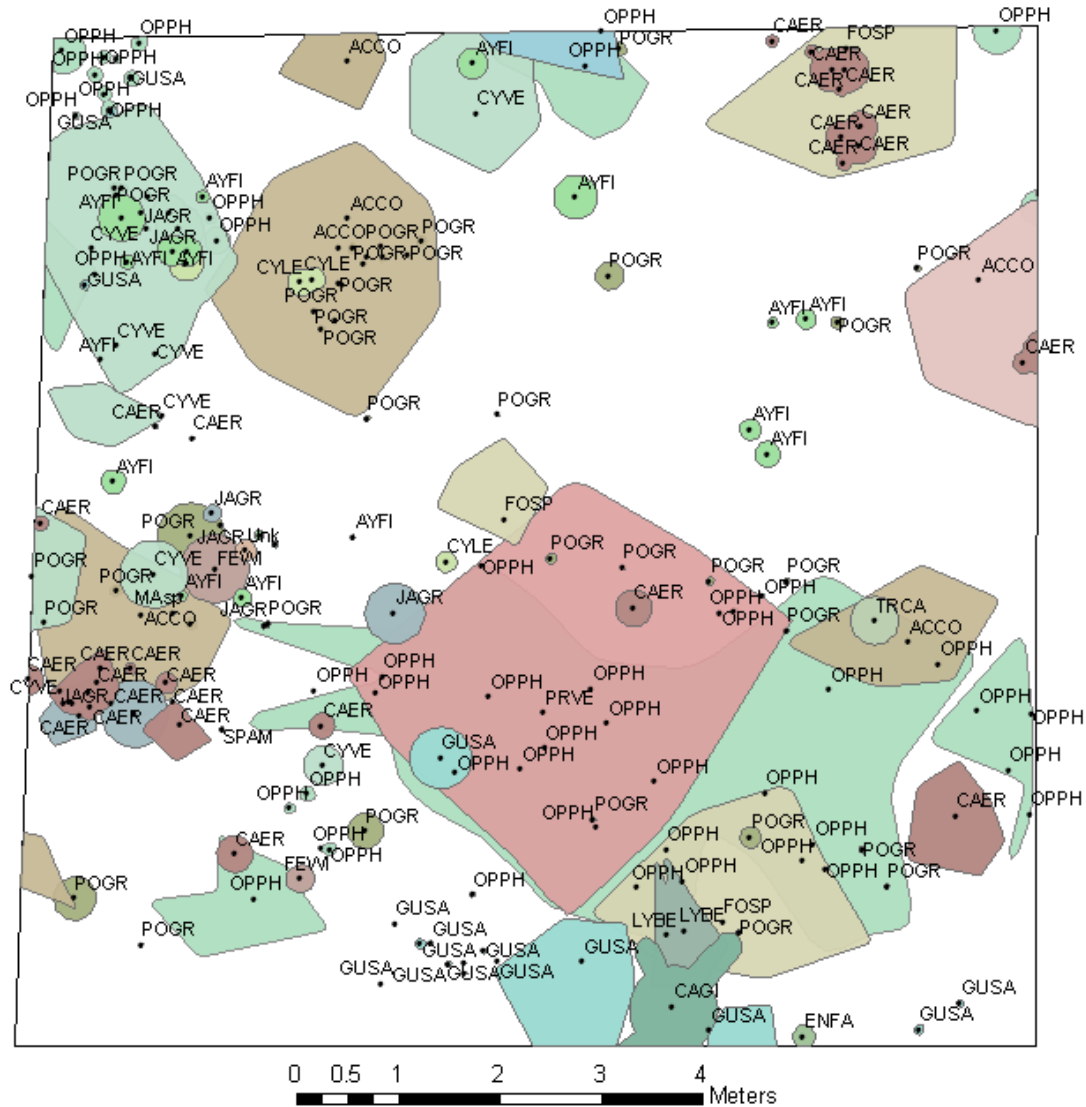
Plot 16: Rincon Mountain District



Label	Species	Density 2010	Cover 2010 (m ²)
ABIN	<i>Abutilon inaequalum</i>	4	0.18
CAER	<i>Calliandra eriophylla</i>	10	1.99
CEMI	<i>Cercidium microphyllum</i>	2	6.10
CYBI	<i>Cylindropuntia bigelovii</i>	3	0.21
CYVE	<i>Cylindropuntia versicolor</i>	2	0.15
ENFA	<i>Eriola farinosa</i>	204	7.27
ERLA	<i>Eriocameria laricifolia</i>	1	0.06
ERWR	<i>Eriogonum Wrightii</i>	2	0.70
FEWI	<i>Ferocactus wislizenii</i>	1	0.01
FOSP	<i>Fouquieria splendens</i>	12	12.22
JAPR	<i>Jacquemontia pringlei</i>	44	4.30
JAGR	<i>Janusia gracilis</i>	1	0.19
JACA	<i>Jatropha cardiophylla</i>	4	2.05
LYBE	<i>Lycium berlandieri</i>	2	0.28
MAsp	<i>Mammillaria species</i>	30	0.04
OPPH	<i>Opuntia phaeacantha</i>	5	3.46
POGR	<i>Porophyllum gracile</i>	1	0.10
PRVE	<i>Prosopis velutina</i>	1	9.64
	Grasses		0%
	Ferns & Allies		<1%
	Sesuvietell species		33%
	Total	329	48.95

**Encelia farinosa* less than 30 cm in diameter were not mapped individually.

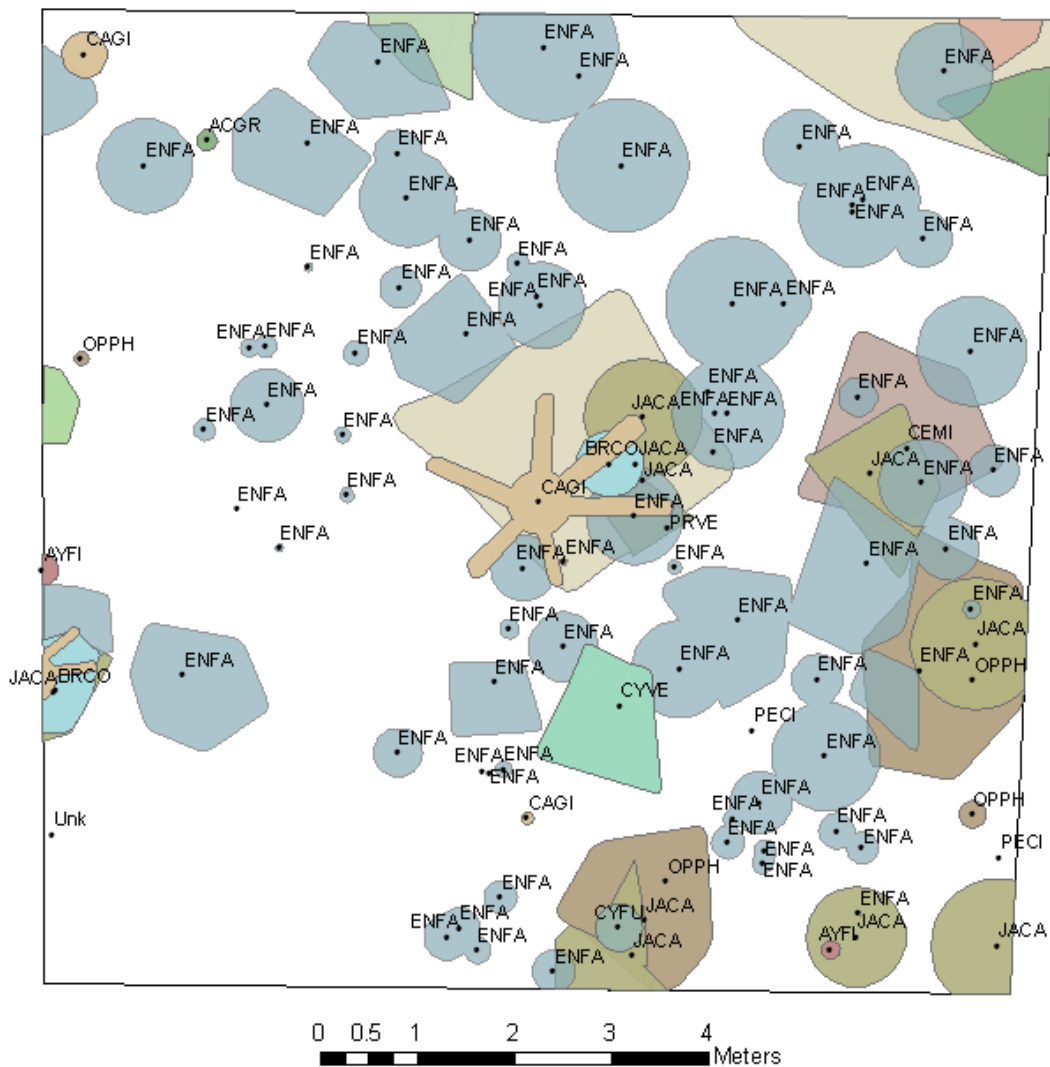
Plot 17: Rincon Mountain District



Label	Species	Density 2010	Cover 2010 (m2)
ACCO	<i>Acacia constricta</i>	10	8.93
ACGR	<i>Acacia greggii</i>	1	0.42
AYFI	<i>Avena filiformis</i>	17	0.72
CAER	<i>Calliandra eriophylla</i>	28	2.10
CAGI	<i>Carnegiea gigantea</i>	1	0.80
CEMI	<i>Cercidium mitisophyllum</i>	1	1.97
CYLE	<i>Cylindropuntia leptocaulis</i>	4	0.20
CYVE	<i>Cylindropuntia versicolor</i>	9	6.36
ENFA	<i>Encelia farinosa</i>	1	0.04
FEWI	<i>Ferocactus wislizenii</i>	2	0.42
FOSP	<i>Fouquieria splendens</i>	3	6.41
GUSA	<i>Gutierrezia sarothrae</i>	18	1.89
JAGR	<i>Janusia gracilis</i>	9	0.90
LYBE	<i>Lycium berlandieri</i>	2	0.58
MASp	<i>Mammillaria species</i>	1	0.00
MATsp	<i>Matelea species</i>	1	0.03
OPPH	<i>Opuntia phaeacantha</i>	52	18.78
POGR	<i>Porophyllum gracile</i>	41	0.81
PRVE	<i>Prosopis velutina</i>	1	10.15
SPAM	<i>Sphaeralcea ambigua</i>	1	0.00
TRCA	<i>Trixie californica</i>	1	0.17
	Grasses		<1%
	Ferns & Allies		0%
Total		204	61.67



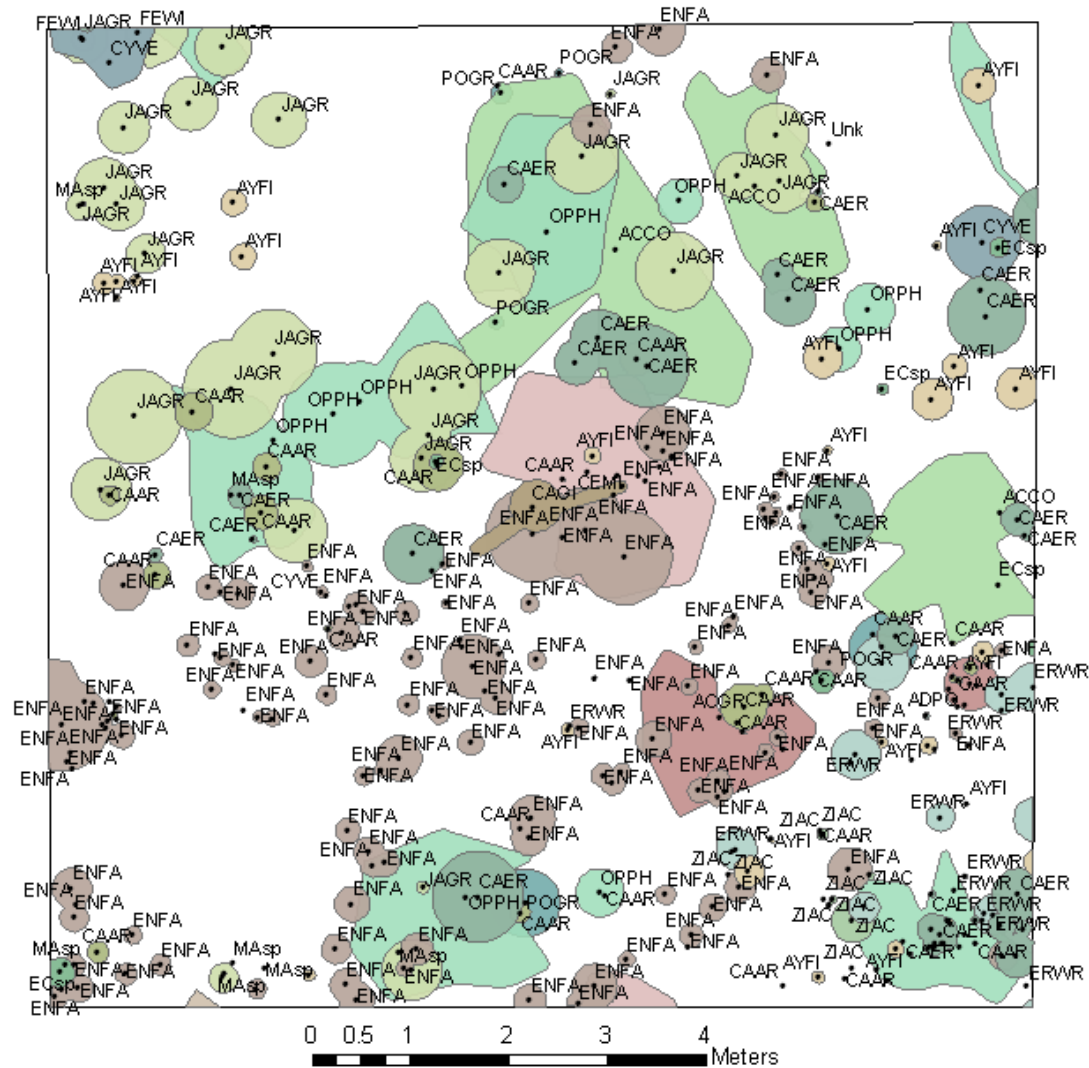
Plot 18: Rincon Mountain District



Label	Species	Density 2010	Cover 2010 (m2)
ACGR	<i>Acacia greggii</i>	2	0.80
AYFI	<i>Ayenia filiformis</i>	2	0.07
BRCA	<i>Brickellia coulteri</i>	2	0.85
CAGI	<i>Carnegiea gigantea</i>	4	1.61
CEPA	<i>Celtis pallida</i>	1	0.65
CEMI	<i>Cercidium microphyllum</i>	1	2.61
CYFU	<i>Cylindropuntia fulgida</i>	1	0.19
CYVE	<i>Cylindropuntia versicolor</i>	1	1.30
ENFA	<i>Encelia farinosa</i>	304	28.08
JAGR	<i>Janusia gracilis</i>	1	0.24
JACA	<i>Jatropha cardiophylla</i>	10	7.18
LYBE	<i>Lycium berlandieri</i>	1	0.12
OPPH	<i>Opuntia phaeacantha</i>	4	5.15
PRVE	<i>Prosopis velutina</i>	2	9.06
TRCA	<i>Trixis californica</i>	1	0.32
	Grasses		3%
	Ferns & Allies		0%
Total		337	58.23

**Encelia farinosa* less than 30 cm in diameter were not mapped individually.

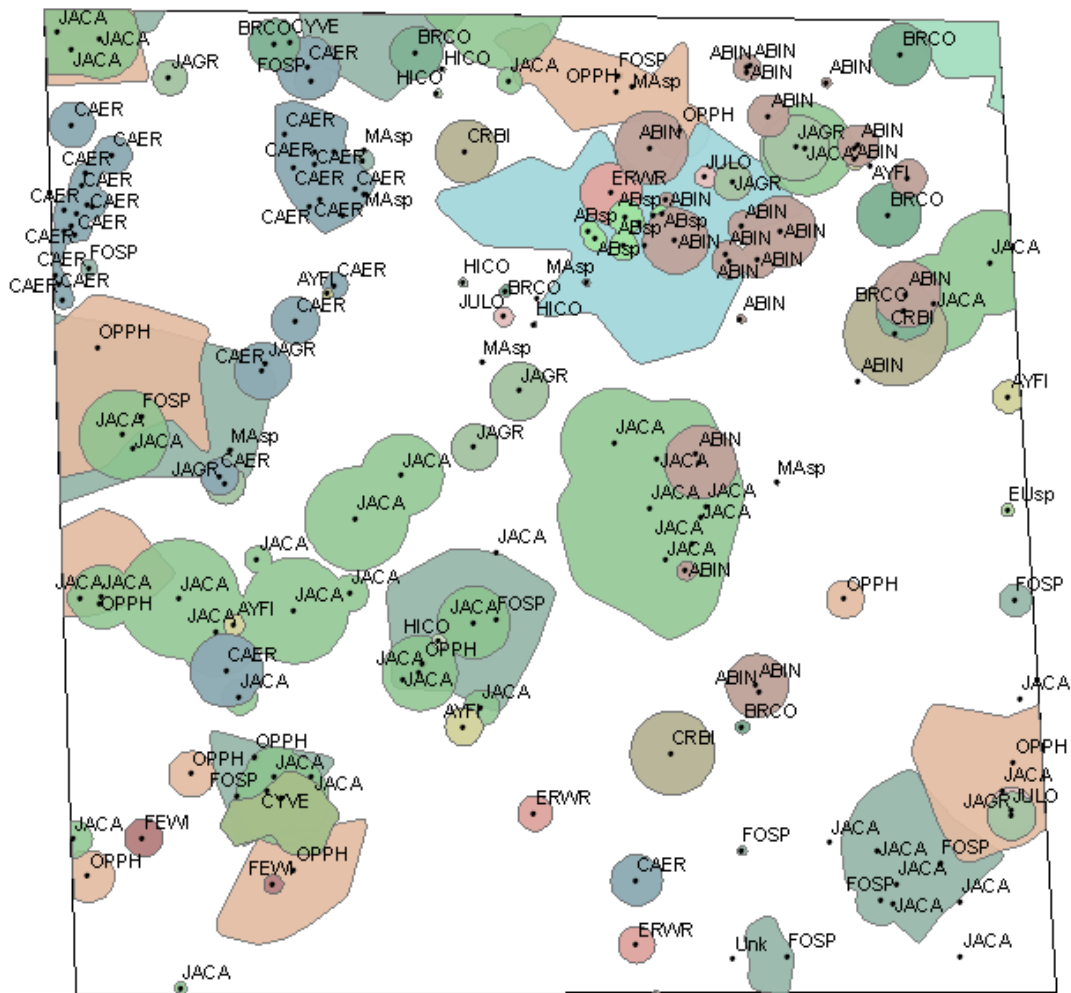
Plot 19: Rincon Mountain District



Label	Species	Density 2010	Cover 2010 (m2)
ACCO	<i>Acacia constricta</i>	3	10.26
ACGR	<i>Acacia greggii</i>	2	1.97
ADPO	<i>Adenophyllum porophylloides</i>	4	0.00
AYFI	<i>Ayenia filiformis</i>	29	1.02
CAER	<i>Calliandra eriophylla</i>	38	4.11
CAAR	<i>Carlowrightia arizonica</i>	34	1.02
CAGI	<i>Carnegiea gigantea</i>	1	0.40
CEMI	<i>Cercidium microphyllum</i>	2	3.72
CYVE	<i>Cylindropuntia versicolor</i>	3	0.86
ECsp	<i>Echinocereus species</i>	8	0.18
ENFA	<i>Encelia farinosa</i>	280	10.12
ERWR	<i>Eriogonum wrightii</i>	19	1.12
FEWI	<i>Ferocactus wislizenii</i>	2	0.08
JAGR	<i>Janusia gracilis</i>	28	7.81
MAsp	<i>Mammillaria species</i>	10	0.00
OPPH	<i>Opuntia phaeacantha</i>	13	11.47
POGR	<i>Porophyllum gracile</i>	6	0.85
PRVE	<i>Prosopis velutina</i>	1	0.03
ZIAC	<i>Zinnia acerosa</i>	12	0.18
	Grasses		<1%
	Ferns & Allies		0%
Total		495	55.23

**Encelia farinosa* less than 30 cm in diameter were not mapped individually.

Plot 20: Rincon Mountain District

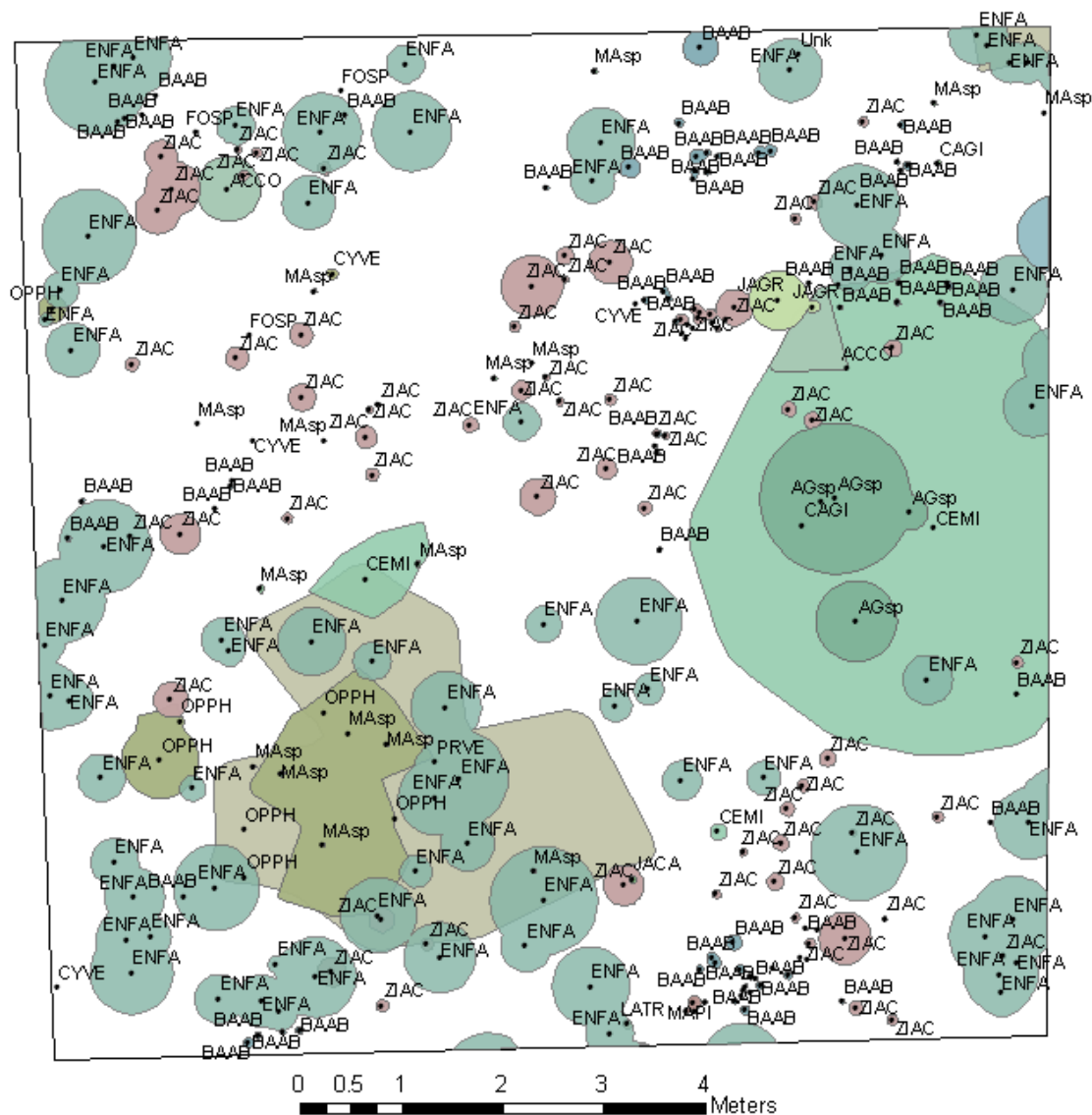


0 0.5 1 2 3 4 Meters

Label	Species	Density 2010	Cover 2010 (m ²)
ABIN	<i>Abutilon incanum</i>	24	3.09
ABsp	<i>Abutilon species</i>	7	0.26
ACGR	<i>Acacia greggii</i>	1	4.80
AYFI	<i>Ayeria filiformis</i>	6	0.28
BRCO	<i>Brickellia coulteri</i>	7	1.41
CAER	<i>Calliandra eriophylla</i>	30	3.24
CEPA	<i>Celtis pallida</i>	1	0.50
CRBI	<i>Crassosoma bigelovii</i>	3	1.82
CYVE	<i>Cylindropuntia versicolor</i>	2	0.67
ERWR	<i>Eriogonum wrightii</i>	3	0.52
EUSP	<i>Euphorbia species</i>	1	0.01
FEWI	<i>Ferocactus wislizenii</i>	2	0.15
FOSP	<i>Fouquieria splendens</i>	14	9.87
HICO	<i>Hibiscus coulteri</i>	5	0.03
JAGR	<i>Jarvisia gracilis</i>	8	1.38
JACA	<i>Jatropha cardiophylla</i>	47	13.73
JULO	<i>Justicia longii</i>	3	0.25
MAsp	<i>Mammillaria species</i>	7	0.01
OPPH	<i>Opuntia phaeacantha</i>	13	8.79
	Grasses		2%
	Ferns & Allies		<1%
	Total	184	50.83



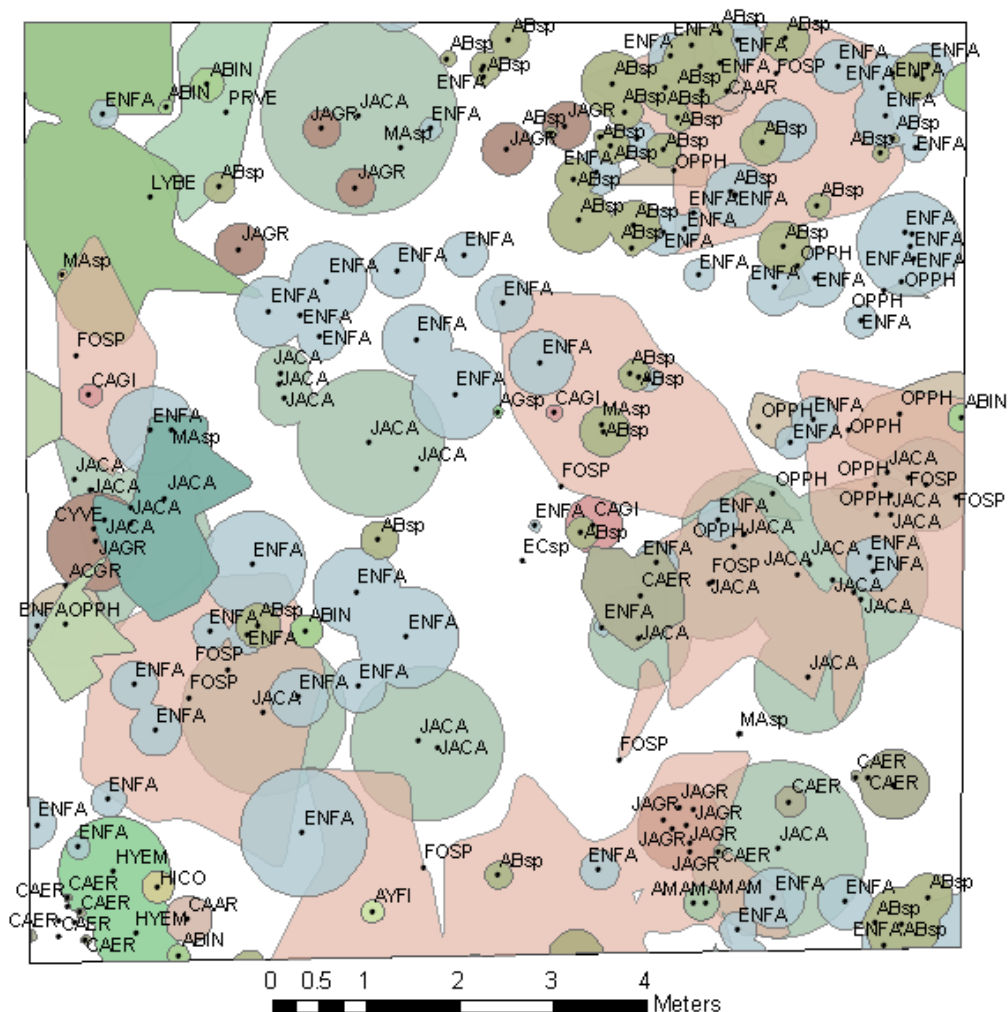
Plot 21: Rincon Mountain District



Label	Species	Density 2010	Cover 2010 (m ²)
ACCO	<i>Acacia constricta</i>	2	0.70
AGsp	<i>Agave species</i>	4	2.31
BAAB	<i>Bahia absointhifolia</i>	74	0.34
CAGI	<i>Carnegia gigantea</i>	3	0.01
CEMI	<i>Cercidium microphyllum</i>	3	14.48
CYBI	<i>Cylindropuntia bigelovii</i>	1	0.17
CYVE	<i>Cylindropuntia versicolor</i>	4	0.01
ENFA	<i>Encelia farinosa</i>	536	18.80
FOSP	<i>Fouquieria splendens</i>	3	0.00
JAGR	<i>Jarocia gracilis</i>	2	0.28
JACA	<i>Jatropha cardiophylla</i>	1	0.00
LATR	<i>Larrea tridentata</i>	1	0.01
MAPI	<i>Machaeranthera pinnatifida</i>	5	0.02
MASp	<i>Mammillaria species</i>	16	0.02
OPPH	<i>Opuntia phaeacantha</i>	7	3.20
PRVE	<i>Prosopis velutina</i>	2	10.13
ZIAC	<i>Zinnia acerosa</i>	69	2.45
	Grasses		3%
	Ferns & Allis		0%
Total		733	52.94

**Encelia farinosa* less than 30 cm in diameter were not mapped individually.

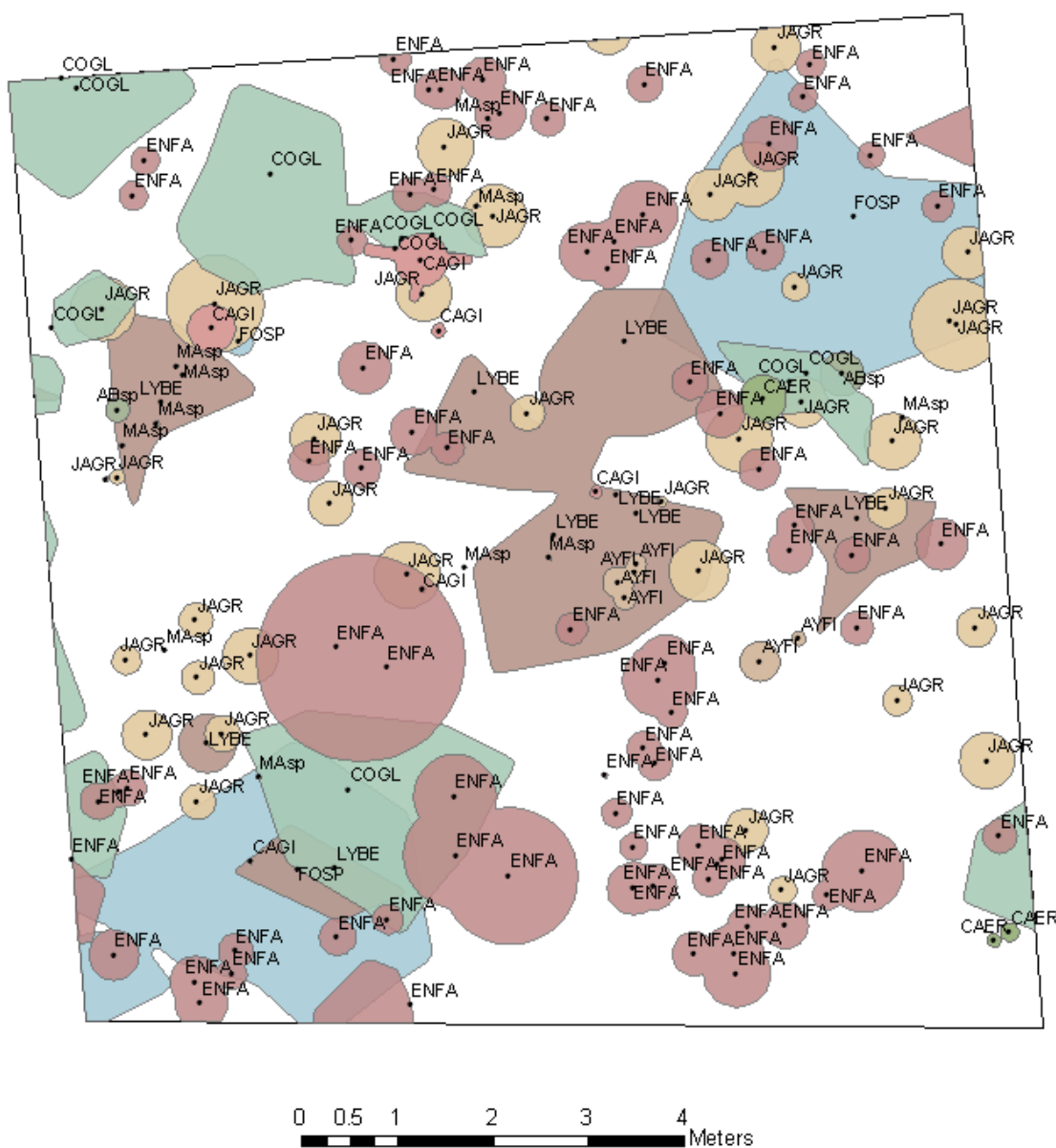
Plot 22: Rincon Mountain District



Label	Species	Density 2010	Cover 2010 (m ²)
ABIN	<i>Abutilon incarum</i>	6	0.39
ABsp	<i>Abutilon species</i>	39	4.70
ACGR	<i>Acacia greggii</i>	2	1.01
AGsp	<i>Agave species</i>	1	0.01
AMAM	<i>Ambrosia ambrosioides</i>	2	0.11
AYFI	<i>Ayenia filiformis</i>	1	0.05
CAER	<i>Calliandra eriophylla</i>	14	1.46
CAAR	<i>Carlowrightia arizonica</i>	2	0.33
CAGI	<i>Carnegiea gigantea</i>	3	0.36
CYVE	<i>Cylindropuntia verticillata</i>	1	2.03
ECsp	<i>Echinocereus species</i>	1	0.00
ENFA	<i>Encelia farinosa</i>	70	16.33
FEWI	<i>Ferocactus wislizenii</i>	1	0.11
FOSP	<i>Fouquieria splendens</i>	13	32.24
HICO	<i>Hibiscus coulteri</i>	1	0.09
HYEM	<i>Hyptis smoyii</i>	2	1.49
JAGR	<i>Janusia gracilis</i>	12	2.44
JACA	<i>Jatropha cardiophylla</i>	28	22.02
LYBE	<i>Lycium berlandieri</i>	2	4.83
MAsp	<i>Mammillaria species</i>	5	0.02
OPPH	<i>Opuntia phaeacantha</i>	15	3.29
PRVE	<i>Prosopis velutina</i>	2	1.63
	Grasses		<1%
	Ferns & Allies		0%
	Total	223	94.93

[illegible]

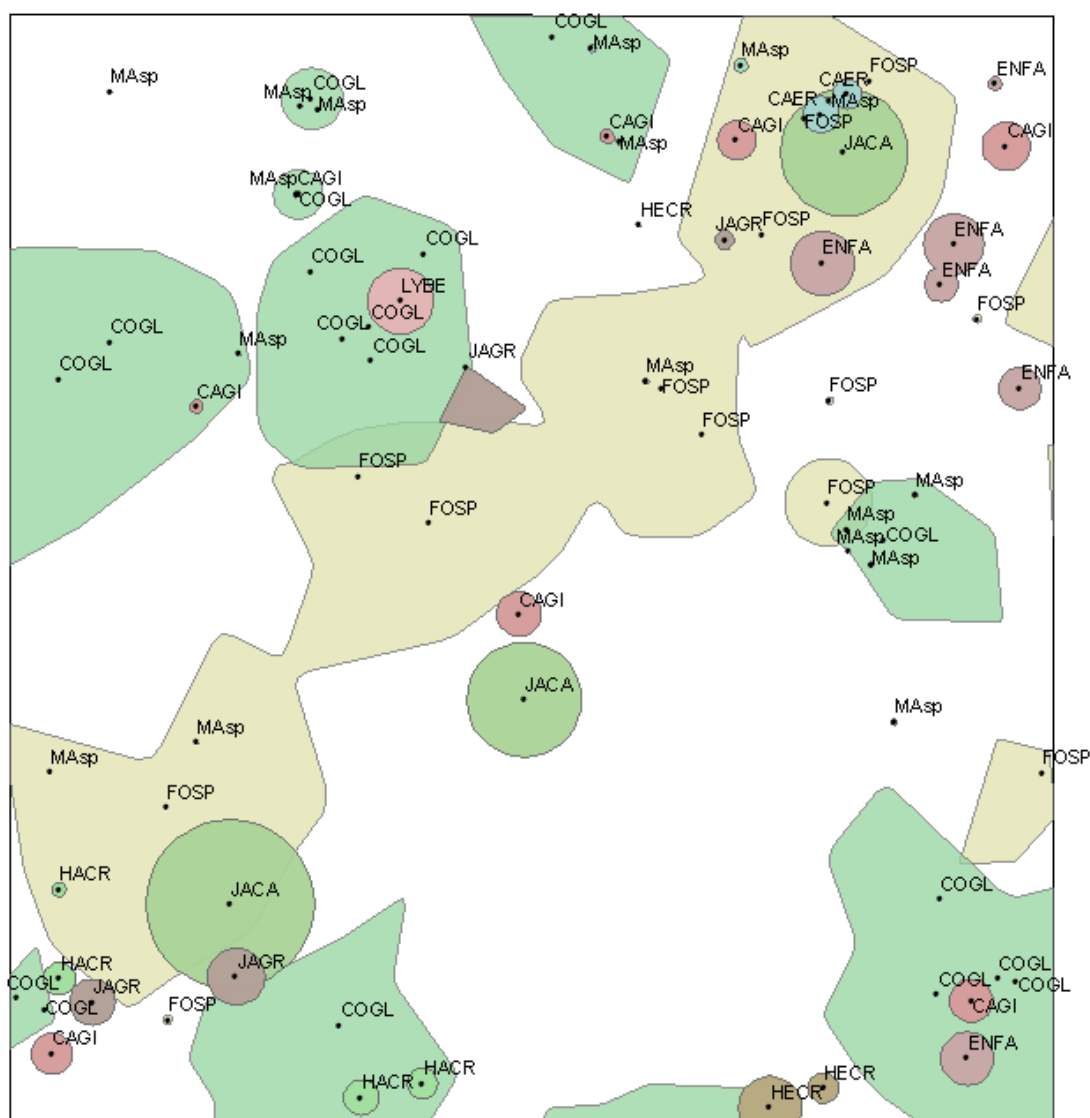
Plot 24: Rincon Mountain District



Label	Species	Density 2010	Cover 2010 (m2)
ABsp	<i>Abutilon species</i>	2	0.21
AYFI	<i>Ayenia filiformis</i>	6	0.31
CAER	<i>Calliandra eriophylla</i>	3	0.23
CAGI	<i>Carnegiea gigantea</i>	6	0.57
COGL	<i>Coursetia glandulosa</i>	15	12.60
ENFA	<i>Encelia farinosa</i>	388	18.00
FOSP	<i>Fouquieria splendens</i>	3	15.31
JAGR	<i>Janusia gracilis</i>	37	7.77
LYBE	<i>Lycium berlandieri</i>	10	11.42
MAsp	<i>Mammillaria species</i>	11	0.01
	Grasses		<1%
	Ferns & Allies		0%
Total		481	66.43

**Encelia farinosa* less than 30 cm in diameter were not mapped individually.

Plot 25: Rincon Mountain District

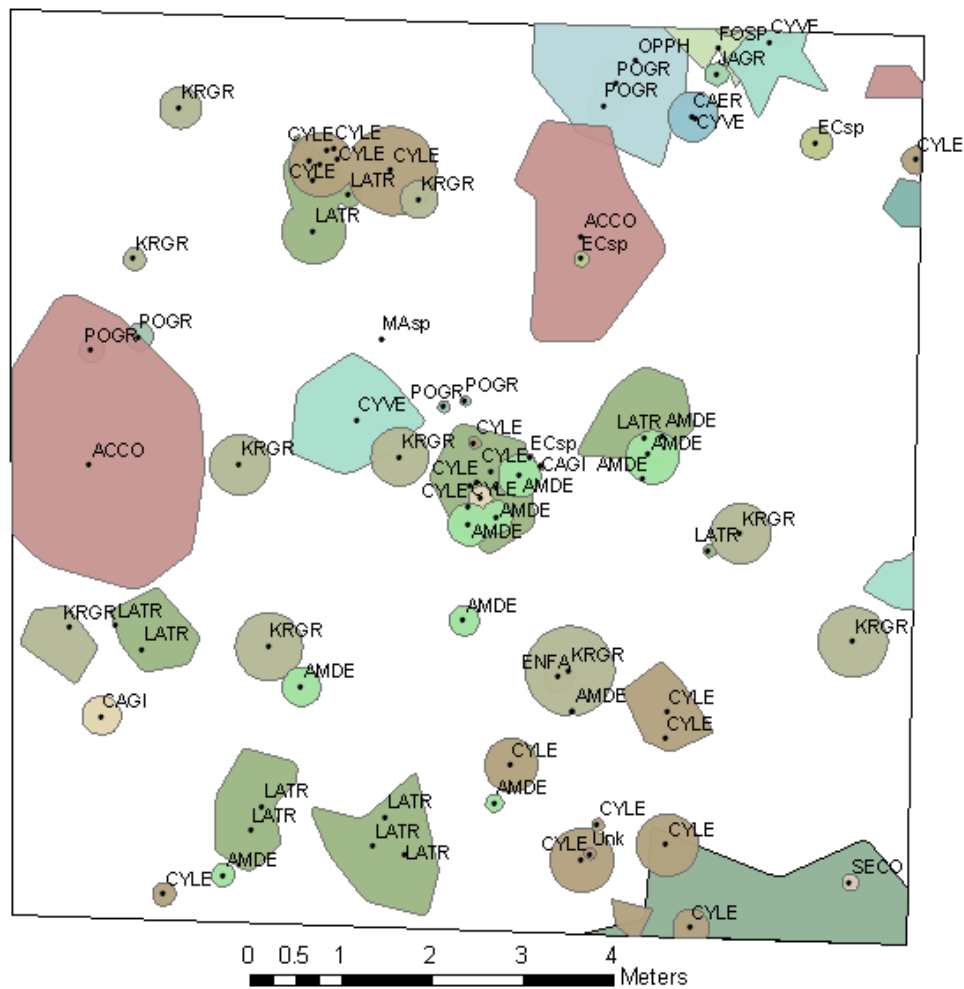


0 0.5 1 2 3 4 Meters

Label	Species	Density 2010	Cover 2010 (m2)
CAER	<i>Calliandra eriophylla</i>	2	0.15
CAGI	<i>Carnegiea gigantea</i>	8	0.68
COGL	<i>Coursetia glandulosa</i>	19	21.93
ENFA	<i>Encelia farinosa</i>	6	0.95
FOSP	<i>Fouquieria splendens</i>	15	22.27
HACR	<i>Haplophyton crooksii</i>	4	0.24
HECR	<i>Herrissantia crispa</i>	3	0.28
JAGR	<i>Janusia gracilis</i>	4	0.67
JACA	<i>Jatropha cardiophylla</i>	2	4.01
LYBE	<i>Lycium berlandieri</i>	1	0.30
MAsp	<i>Mammillaria species</i>	17	0.03
	Grasses		<1%
	Ferns & Allies		1%
	Selaginella species		5%
Total		81	51.52

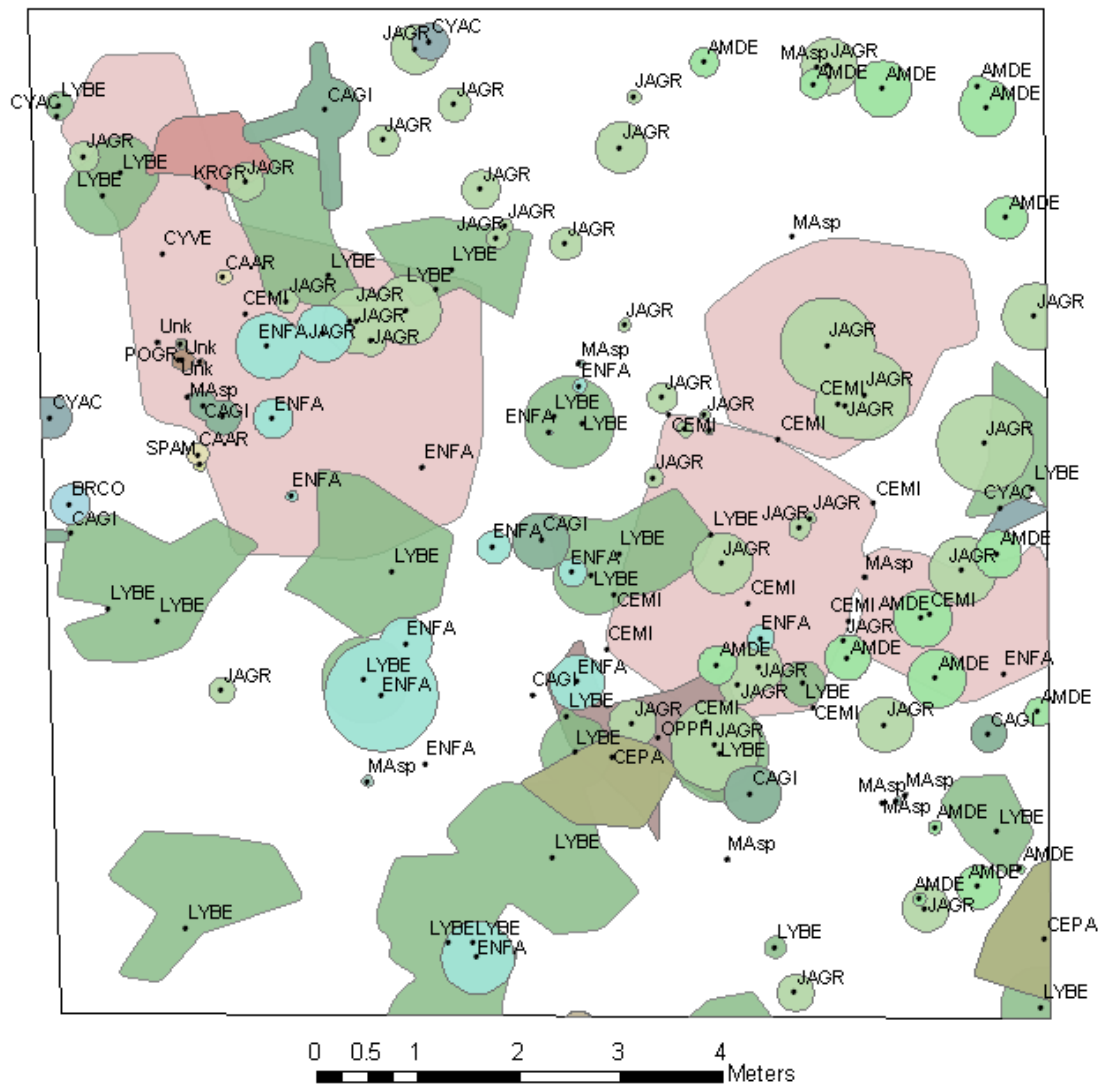


Plot 26: Tucson Mountain District



Label	Species	Density 2010	Cover 2010 (m2)
ACCO	<i>Acacia constricta</i>	3	8.22
AMDE	<i>Ambrosia deltoidea</i>	11	1.01
CAER	<i>Calliandra eriophylla</i>	1	0.23
CAGI	<i>Carnegiea gigantea</i>	3	0.21
CEMI	<i>Cercidium microphyllum</i>	1	2.75
CYLE	<i>Cylindropuntia leptocaulis</i>	22	3.07
CYVE	<i>Cylindropuntia versicolor</i>	4	2.18
ECsp	<i>Echinocereus species</i>	4	0.14
ENFA	<i>Encelia farinosa</i>	1	0.09
FEWI	<i>Ferocactus wislizenii</i>	1	0.04
FOSP	<i>Fouquieria splendens</i>	1	0.32
JAGR	<i>Janusia gracilis</i>	1	0.05
KRGR	<i>Krameria grayi</i>	10	3.42
LATR	<i>Larrea tridentata</i>	12	5.50
LYsp	<i>Lycium species</i>	1	0.16
MAsp	<i>Mammillaria species</i>	1	0.00
MATsp	<i>Matelea species</i>	1	0.01
OPPH	<i>Opuntia phaeacantha</i>	1	1.97
POGR	<i>Porophyllum gracile</i>	6	0.42
SECO	<i>Senna covesii</i>	1	0.02
	Grasses		0%
	Ferns & Allies		0%
Total		86	29.81

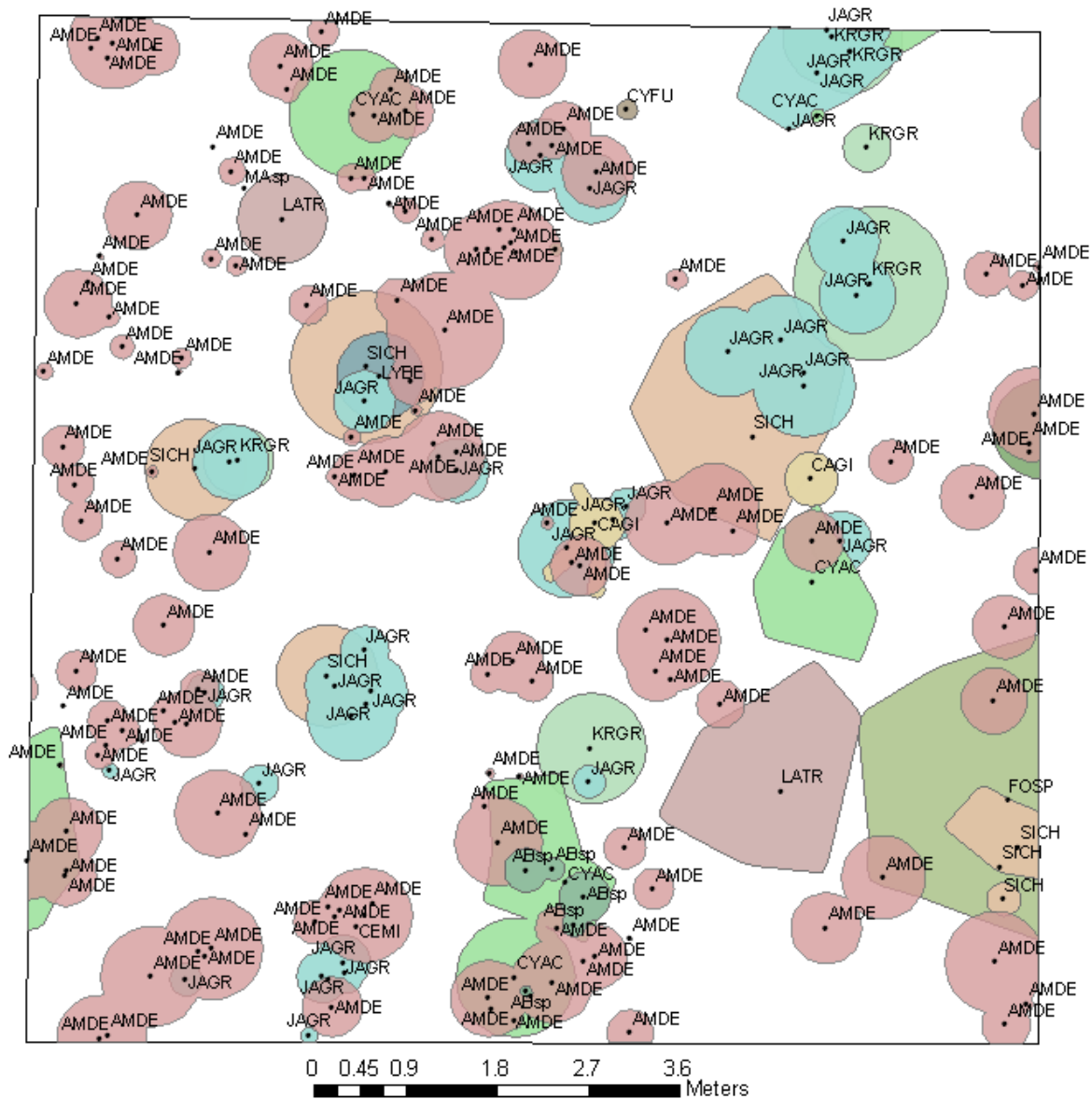
Plot 27: Tucson Mountain District



Label	Species	Density 2010	Cover 2010 (m2)
ABsp	<i>Abutilon species</i>	4	0.04
AMDE	<i>Ambrosia deltoidea</i>	16	1.96
BRCO	<i>Brickellia coulteri</i>	1	0.12
CAAR	<i>Carlwrightia arizonica</i>	2	0.06
CAGI	<i>Carnegiea gigantea</i>	9	1.38
CEPA	<i>Celtis pallida</i>	2	1.57
CEMI	<i>Cercidium microphyllum</i>	12	23.49
CYAC	<i>Cylindropuntia acanthocarpa</i>	4	0.32
ENFA	<i>Encelia farinosa</i>	16	2.66
FEWI	<i>Ferocactus wislizenii</i>	1	0.01
JAGR	<i>Janusia gracilis</i>	41	6.52
KRGR	<i>Krameria grayi</i>	1	0.67
LYBE	<i>Lycium berlandieri</i>	27	17.28
MAsp	<i>Mammillaria species</i>	10	0.03
OPPH	<i>Opuntia phaeacantha</i>	1	1.91
POGR	<i>Porophyllum gracile</i>	1	0.01
SPAM	<i>Sphaeralcea ambigua</i>	1	0.01
	Grasses		<1%
	Ferns & Allies		0%
Total		149	58.05



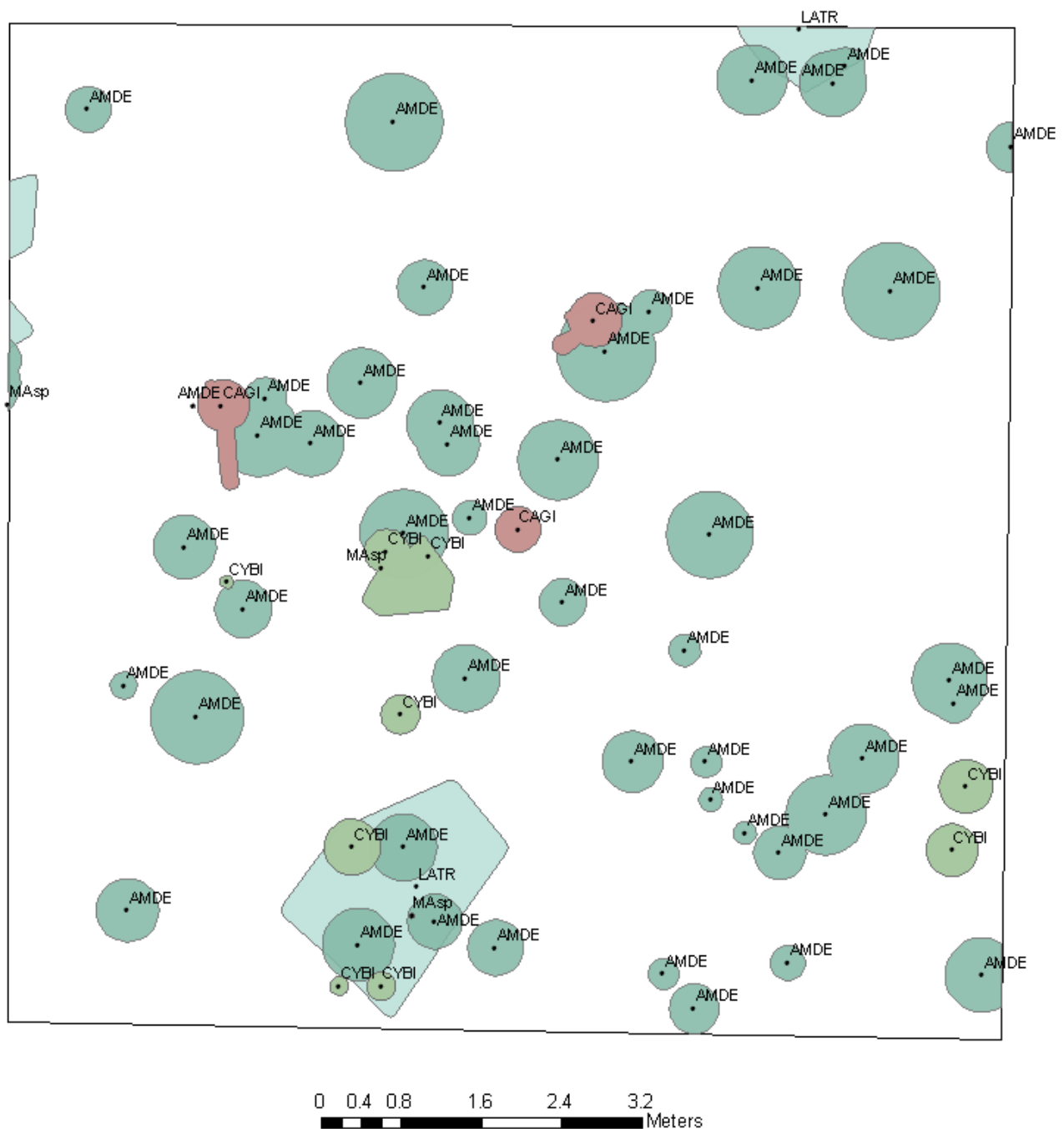
Plot 28: Tucson Mountain District



Label	Species	Density 2010	Cover 2010 (m ²)
ABsp	<i>Abutilon species</i>	5	0.42
AMDE	<i>Ambrosia deltoidea</i>	142	21.60
CAGI	<i>Carnegiea gigantea</i>	2	0.61
CEMI	<i>Cercidium microphyllum</i>	1	0.00
CYAC	<i>Cylindropuntia acanthocarpa</i>	8	5.74
CYFU	<i>Cylindropuntia fulgida</i>	1	0.03
FOSP	<i>Fouquieria splendens</i>	1	4.09
JAGR	<i>Janusia gracilis</i>	34	8.10
KRGR	<i>Krameria grayi</i>	6	3.82
LATR	<i>Larrea tridentata</i>	2	3.23
LYBE	<i>Lycium berlandieri</i>	1	0.58
Masp	<i>Mammillaria species</i>	1	0.00
OPPH	<i>Opuntia phaeacantha</i>	1	0.35
SICH	<i>Simmondsia chinensis</i>	7	7.47
	Grasses		<1%
	Ferns & Allies		0%
	Total	212	56.04



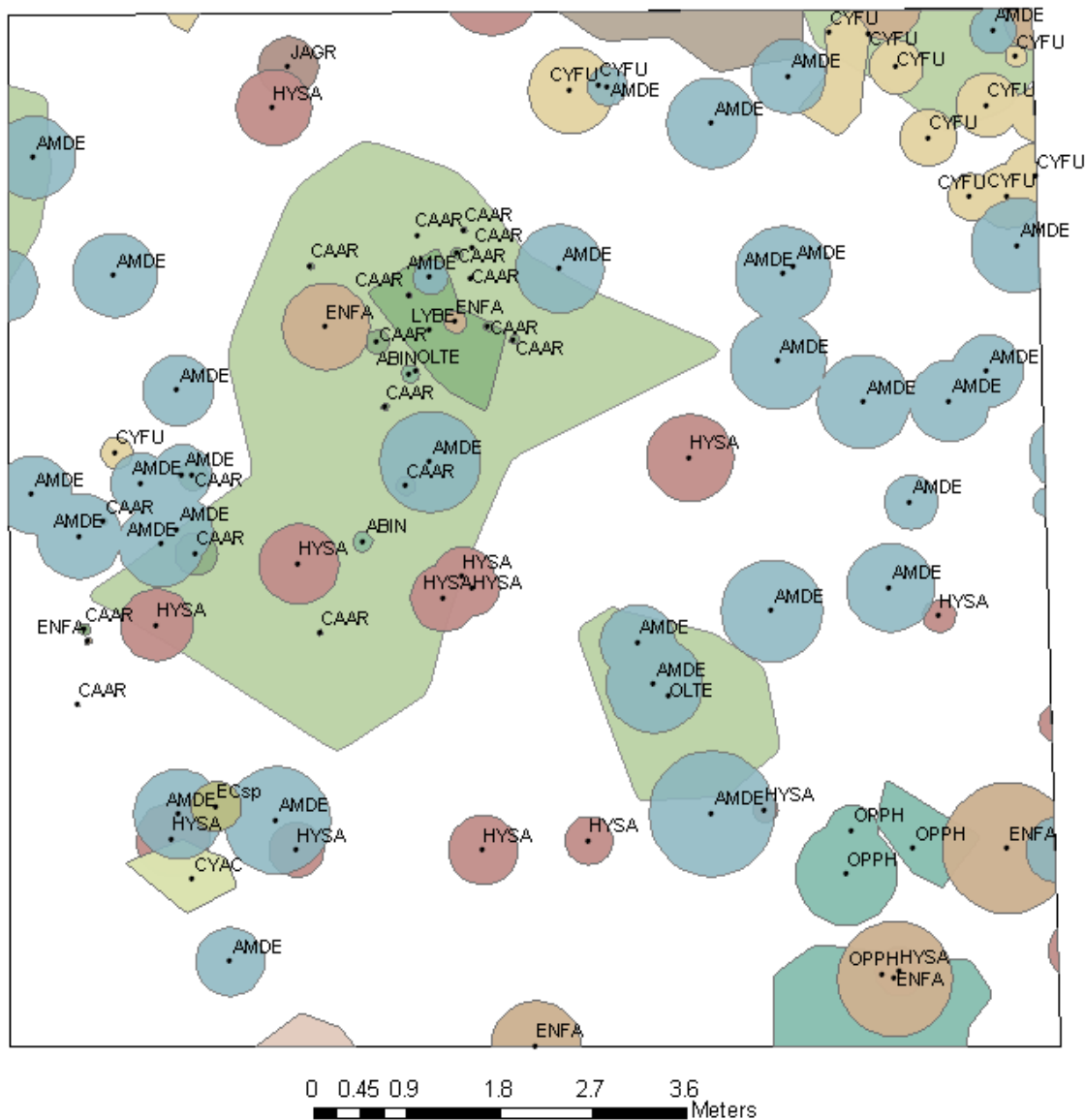
Plot 29: Tucson Mountain District



Label	Species	Density 2010	Cover 2010 (m ²)
AMDE	<i>Ambrosia deltoidea</i>	49	13.84
CAGI	<i>Carnegiea gigantea</i>	3	0.75
CYBI	<i>Cylindropuntia bigelovii</i>	9	1.50
LATR	<i>Larrea tridentata</i>	4	3.70
MAsp	<i>Mammillaria species</i>	3	0.01
	Grasses		0%
	Ferns & Allies		0%
Total		68	19.81

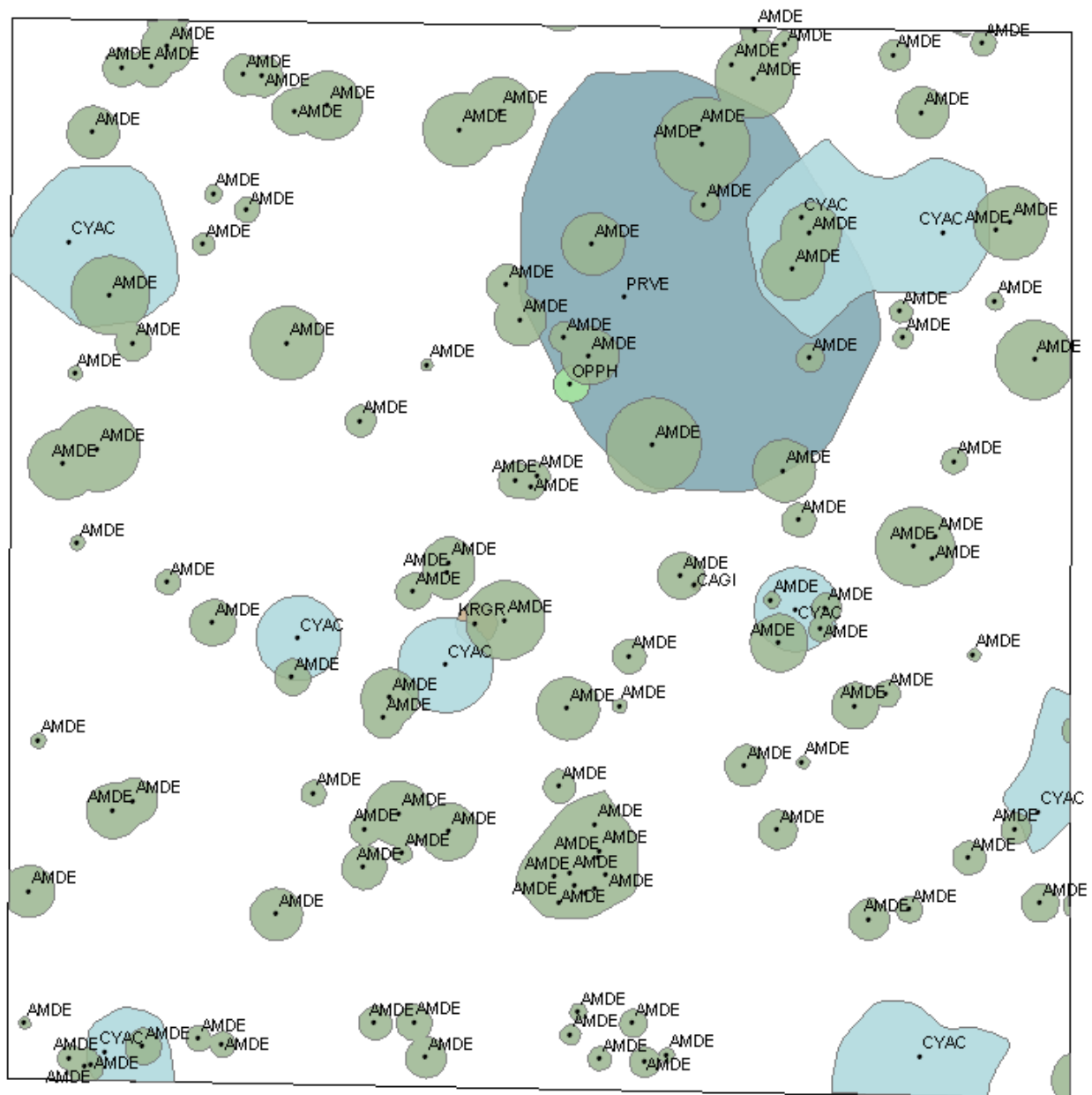


Plot 30: Tucson Mountain District



Label	Species	Density 2010	Cover 2010 (m ²)
ABIN	<i>Abutilon incanum</i>	2	0.05
ACGR	<i>Acacia greggii</i>	1	0.18
AMDE	<i>Ambrosia deltoidea</i>	37	14.68
CAAR	<i>Carlowrightia arizonica</i>	18	0.32
CYFU	<i>Cylindropuntia acanthocarpa</i>	1	0.42
CYFU	<i>Cylindropuntia fulgida</i>	14	2.42
ECsp	<i>Echinocereus species</i>	1	0.18
ENFA	<i>Encelia farinosa</i>	8	3.21
HYS A	<i>Hymenoclea salsola</i>	17	3.92
JAGR	<i>Janusia gracilis</i>	1	0.26
LYBE	<i>Lycium berlandieri</i>	1	0.98
OLTE	<i>Oleña tesota</i>	4	20.66
OPPH	<i>Opuntia phaeacantha</i>	4	3.08
ZIOB	<i>Ziziphus obtusifolia</i>	1	0.85
	Grasses		<1%
	Ferns & Allies		0%
Total		110	51.19

Plot 31: Tucson Mountain District

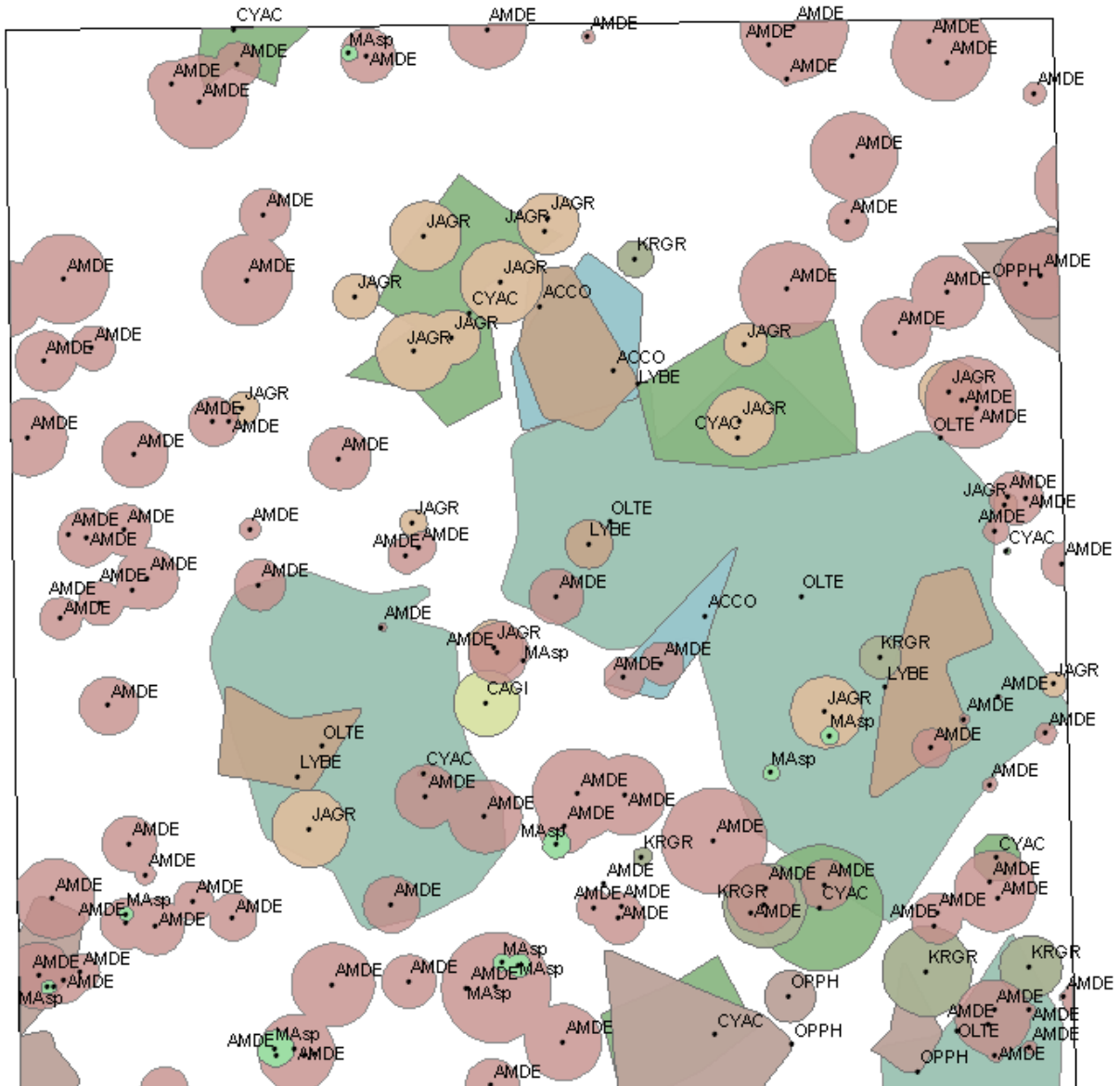


0 0.4 0.8 1.6 2.4 3.2 Meters

Label	Species	Density 2010	Cover 2010 (m ²)
AMDE	<i>Ambrosia deltoidea</i>	129	15.24
CAGI	<i>Carnegiea gigantea</i>	1	0.01
CYAC	<i>Cylindropuntia acanthocarpa</i>	9	8.45
KRGR	<i>Krameria grayi</i>	1	0.12
OPPH	<i>Opuntia phaeacantha</i>	1	0.09
PRVE	<i>Prosopis velutina</i>	1	10.13
	Grasses		0%
	Ferns & Allies		0%
Total		142	34.03



Plot 32: Tucson Mountain District

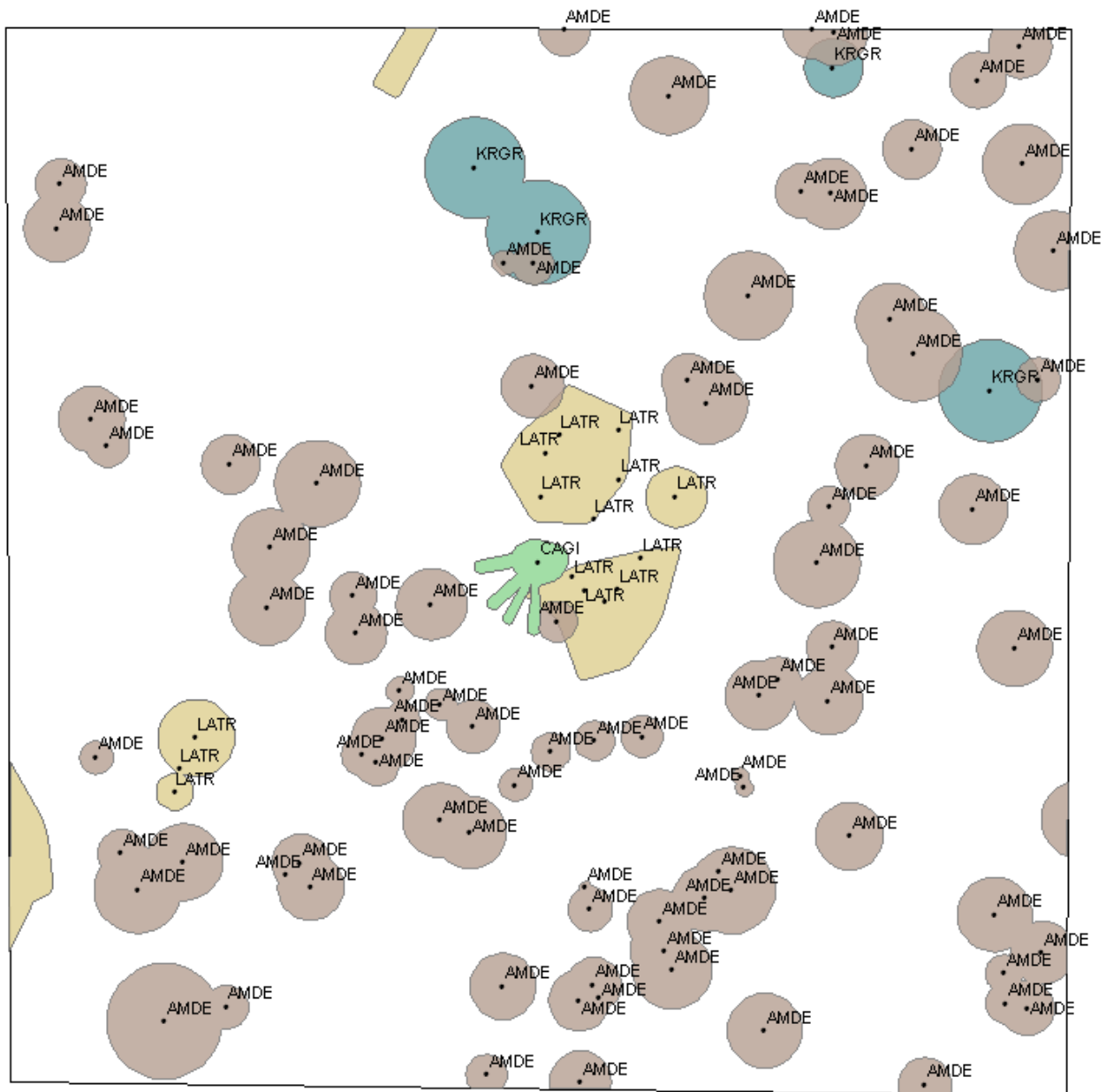


0 0.45 0.9 1.8 2.7 3.6 Meters

Label	Species	Density 2010	Cover 2010 (m ²)
ACCO	<i>Acacia constricta</i>	3	2.02
AMDE	<i>Ambrosia deltoidea</i>	103	19.83
CAGI	<i>Carnegia gigantea</i>	3	0.30
CYAC	<i>Cylindropuntia acanthocarpa</i>	8	7.25
JAGR	<i>Janusia gracilis</i>	17	3.78
KRGR	<i>Krameria grayi</i>	6	1.60
LYBE	<i>Lycium berlandieri</i>	4	3.47
MAsp	<i>Mammillaria species</i>	12	0.30
OLTE	<i>Olinya tesota</i>	6	23.57
OPPH	<i>Opuntia phaeacantha</i>	6	3.44
	Grasses		0%
	Ferns & Allies		0%
Total		168	65.56



Plot 33: Tucson Mountain District

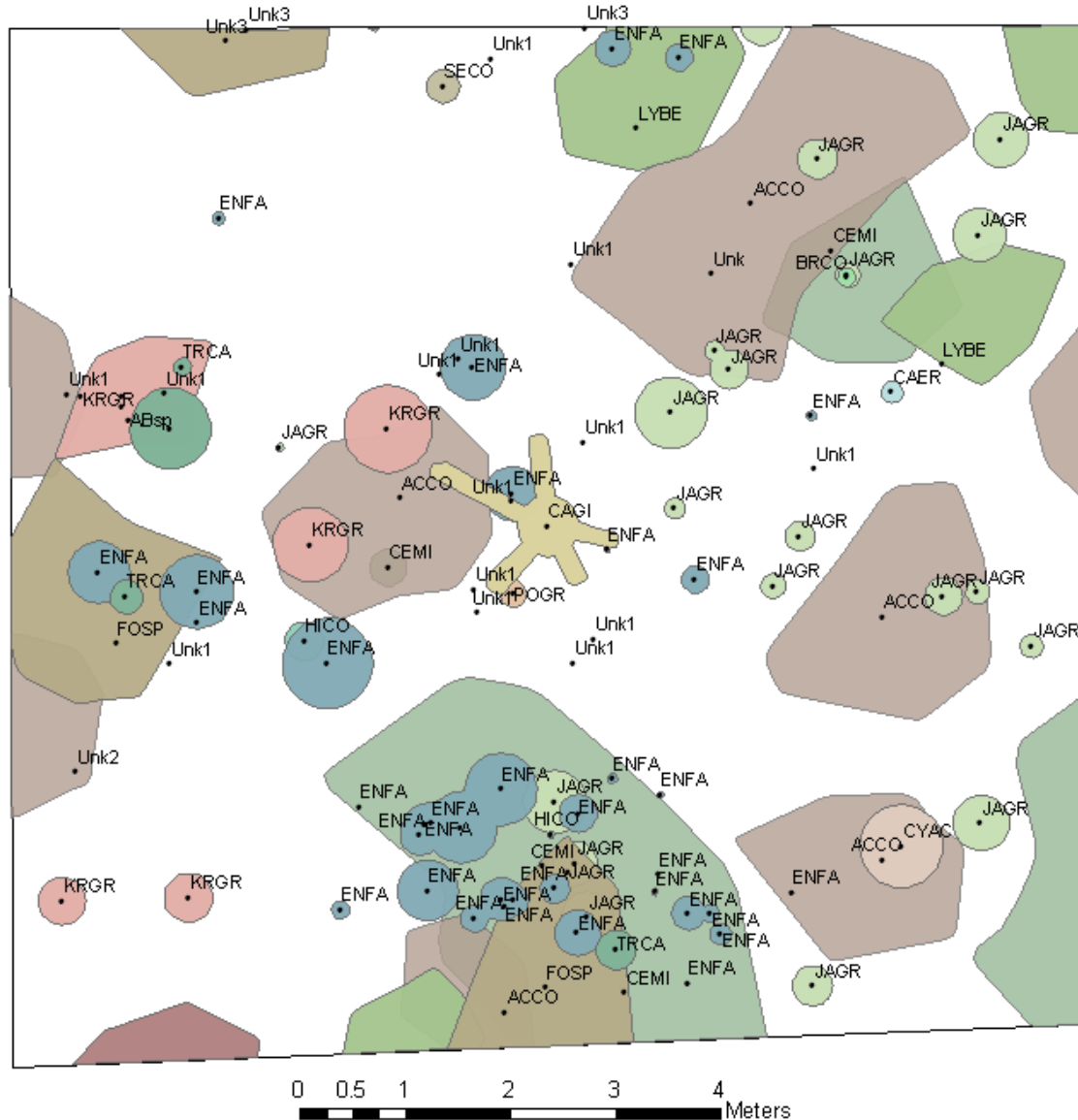


0 0.45 0.9 1.8 2.7 3.6 Meters

Label	Species	Density 2010	Cover 2010 (m2)
AMDE	<i>Ambrosia deltoidea</i>	88	19.53
CAGI	<i>Carnegiea gigantea</i>	1	0.36
KRGR	<i>Krameria grayi</i>	4	2.45
LATR	<i>Larrea tridentata</i>	17	3.60
	Grasses		0%
	Ferns & Allies		0%
Total		110	25.95

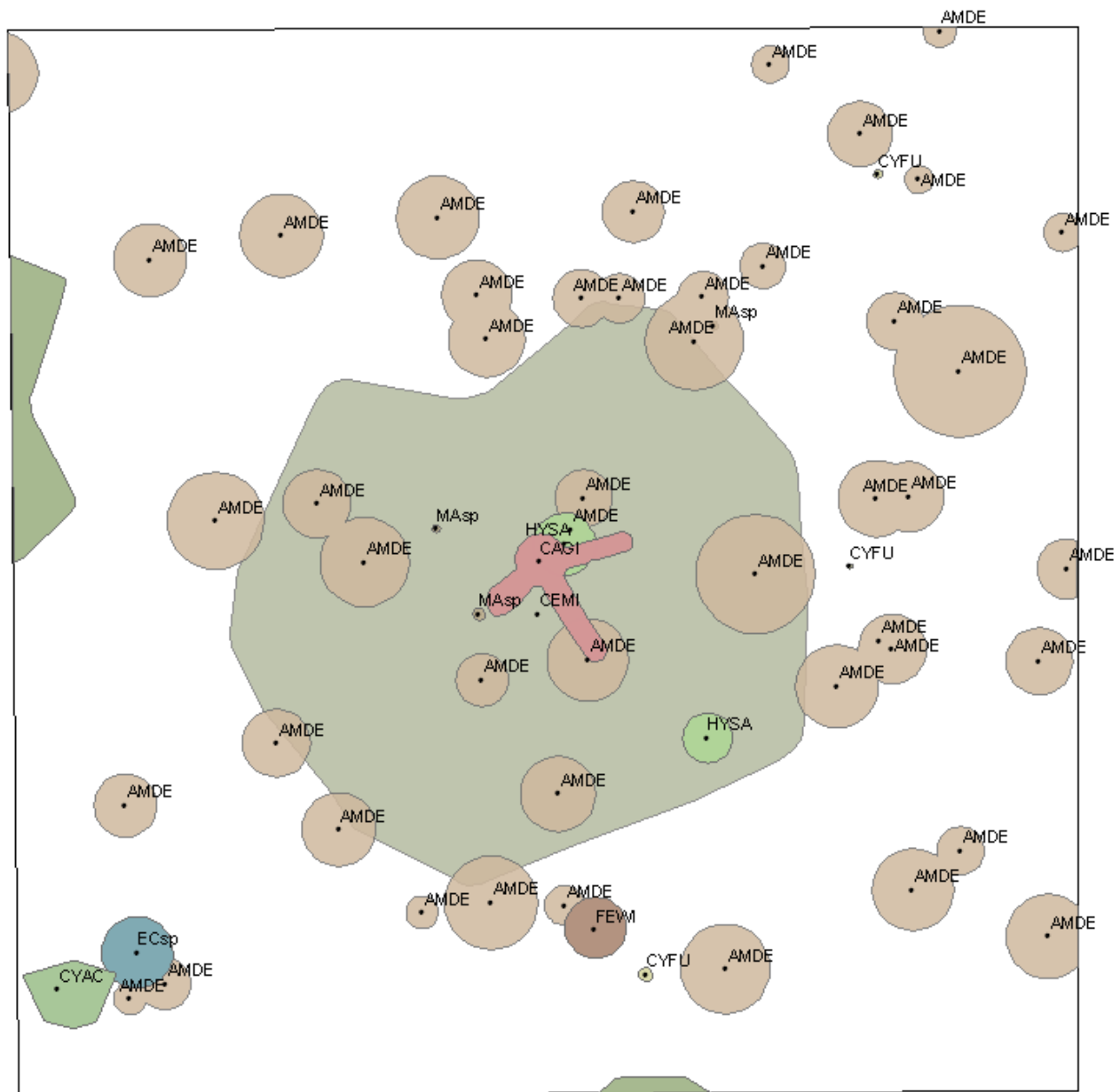


Plot 34: Tucson Mountain District



Label	Species	Density 2010	Cover2010 (m2)
ACCO	<i>Acacia constricta</i>	8	18.96
BRCO	<i>Brickellia coulteri</i>	1	0.02
CAER	<i>Calliandra eriophylla</i>	1	0.03
CAGI	<i>Carnegiea gigantea</i>	1	0.78
CEMI	<i>Cercidium microphyllum</i>	5	12.87
CYAC	<i>Cylindropuntia acanthocarpa</i>	1	0.49
ENFA	<i>Encelia farinosa</i>	36	3.69
FOSP	<i>Fouquieria splendens</i>	3	6.13
HICO	<i>Hibiscus coulteri</i>	2	0.11
JAGR	<i>Janusia gracilis</i>	21	2.38
KRGR	<i>Krameria grayi</i>	6	2.39
LATR	<i>Larrea tridentata</i>	1	0.63
LYBE	<i>Lycium berlandieri</i>	4	4.62
POGR	<i>Porophyllum gracile</i>	1	0.05
SECO	<i>Senna covesii</i>	2	0.08
TRCA	<i>Trixis californica</i>	4	0.68
	Grasses		0%
	Ferns & Allies		0%
Total		97	53.91

Plot 35: Tucson Mountain District



0 0.45 0.9 1.8 2.7 3.6 Meters

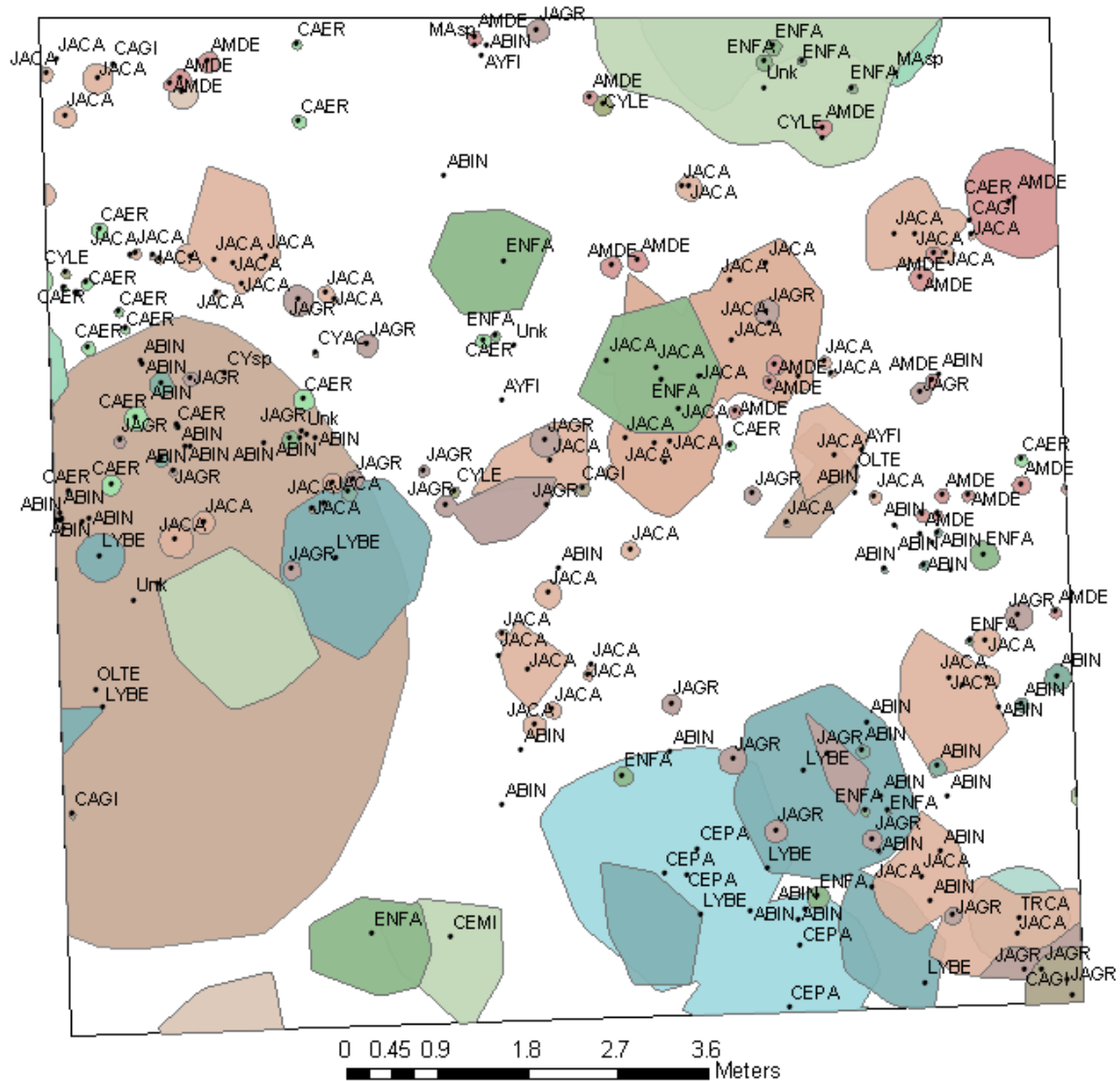
Label	Species	Density 2010	Cover 2010 (m ²)
AMDE	<i>Ambracia deltoidea</i>	47	14.92
CAGI	<i>Carnegiea gigantea</i>	1	0.60
CEMI	<i>Cercidium microphyllum</i>	1	21.44
CYAC	<i>Cylindropuntia acanthocarpa</i>	1	0.38
CYFU	<i>Cylindropuntia fulgida</i>	3	0.02
ECsp	<i>Echinocereus species</i>	1	0.35
FEWI	<i>Ferocactus wislizenii</i>	1	0.26
HYSa	<i>Hymenoclea salsola</i>	2	0.44
LATR	<i>Larrea tridentata</i>	2	1.13
MAsp	<i>Mammillaria species</i>	3	0.02
	Grasses		0%
	Ferns & Allies		0%
Total		62	39.57



Label	Species	Density 2010	Cover 2010 (m ²)
ABIN	<i>Abutilon incanum</i>	19	0.61
ACCO	<i>Acacia constricta</i>	3	1.04
ALIN	<i>Allionia incanata</i>	9	2.58
AYFI	<i>Ayenia filiformis</i>	1	0.00
BAAB	<i>Bahia abanthifolia</i>	16	0.06
CAER	<i>Callandrea eriophylla</i>	7	0.77
CAAR	<i>Carlownrightia arizonica</i>	7	0.47
CAGI	<i>Carnegiea gigantea</i>	15	1.33
CEMI	<i>Cercidium microphyllum</i>	6	3.46
CYAC	<i>Cylindropuntia acanthocarpa</i>	6	3.43
DILA	<i>Dittaxia lanceolata</i>	14	0.50
ECsp	<i>Echinocereus species</i>	1	0.00
ENFA	<i>Encelia farinosa</i>	262	8.96
FOSP	<i>Fouquieria splendens</i>	4	17.31
HECR	<i>Herreraia crispata</i>	5	0.68
HIDE	<i>Hibiscus denudatus</i>	12	0.82
JAGR	<i>Janusia gracilis</i>	60	7.13
JACA	<i>Jatropha cardiophylla</i>	11	3.36
JULO	<i>Justicia longii</i>	2	0.05
LYBE	<i>Lycium berlandieri</i>	4	1.70
MAsp	<i>Mammillaria species</i>	17	0.02
OPPH	<i>Opuntia phaeacantha</i>	2	1.23
SICH	<i>Sinningia chinensis</i>	16	11.44
TRCA	<i>Trichocereus californicus</i>	2	0.42
ZIAC	<i>Zinnia acerosa</i>	1	0.07
	Grasses		3%
	Ferns & Allies		<1%
	Total	502	67.44

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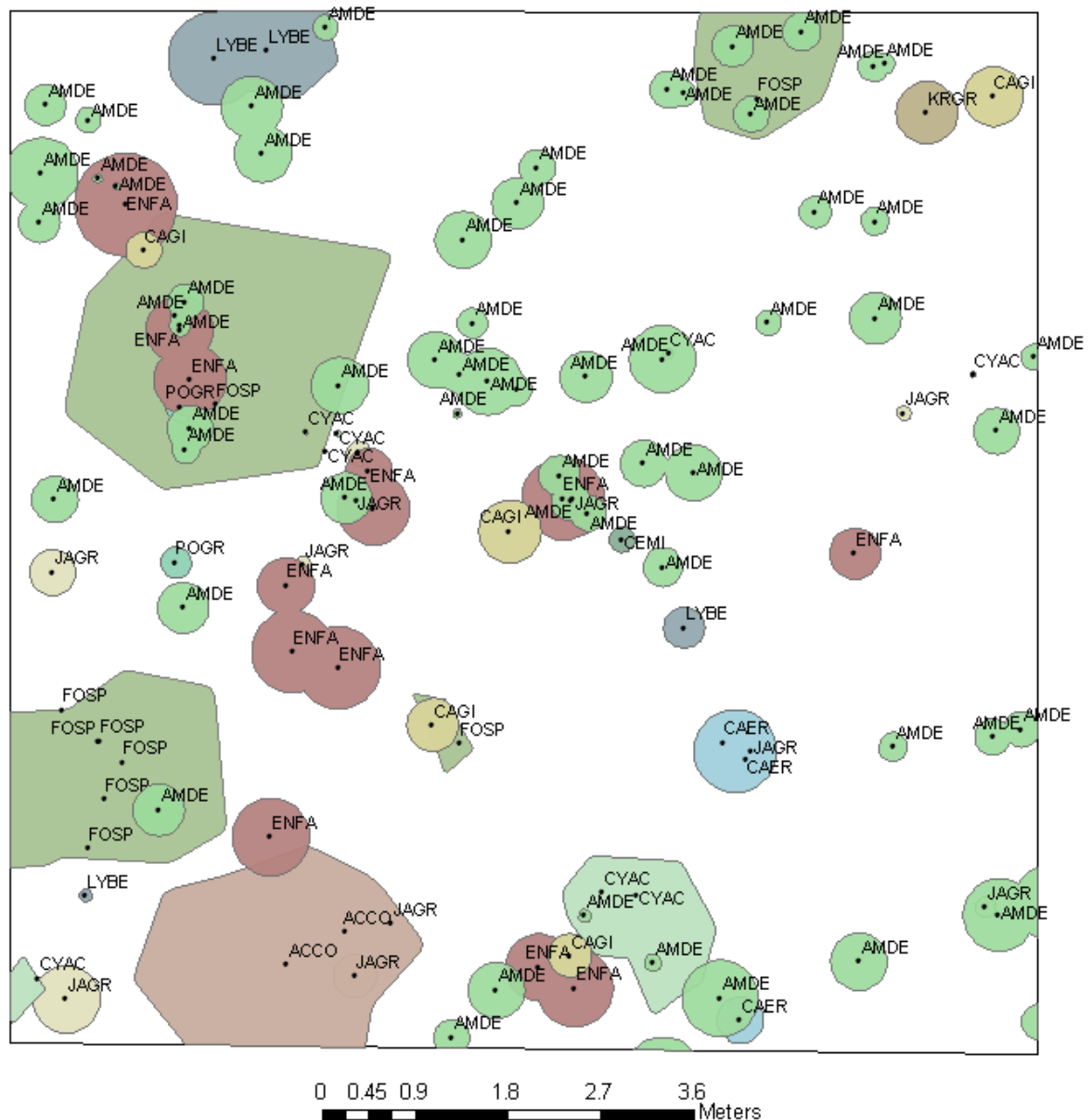
Plot 37: Tucson Mountain District



Label	Species	Density 2010	Cover 2010 (m ²)
ABIN	<i>Abutilon incanum</i>	47	0.20
AMDE	<i>Ambrosia deltoidea</i>	22	1.24
AYFI	<i>Ayenia filiformis</i>	4	0.00
CAER	<i>Calliandra eriophylla</i>	20	0.26
CAGI	<i>Carnegiea gigantea</i>	5	0.29
CEPA	<i>Celtis pallida</i>	5	5.80
CEMI	<i>Cercidion microphyllum</i>	3	6.11
CYAC	<i>Cylindropuntia acanthocarpa</i>	3	0.56
CYLE	<i>Cylindropuntia leptocaulis</i>	4	0.05
CYsp	<i>Cylindropuntia species</i>	1	0.00
ENFA	<i>Ereselia farinosa</i>	15	3.45
FOSP	<i>Fouquieria splendens</i>	2	1.71
JAGR	<i>Janusia gracilis</i>	26	1.74
JACA	<i>Jatropha car diochrylla</i>	64	9.91
KRGR	<i>Krameria grayi</i>	1	0.01
LYBE	<i>Lycium berlandieri</i>	7	6.78
MAsp	<i>Mammillaria species</i>	2	0.00
OLTE	<i>Olneya tesota</i>	2	18.35
TRCA	<i>Trixis californica</i>	1	0.87
	Grasses		0%
	Ferns & Allies		0%
Total		234	57.31



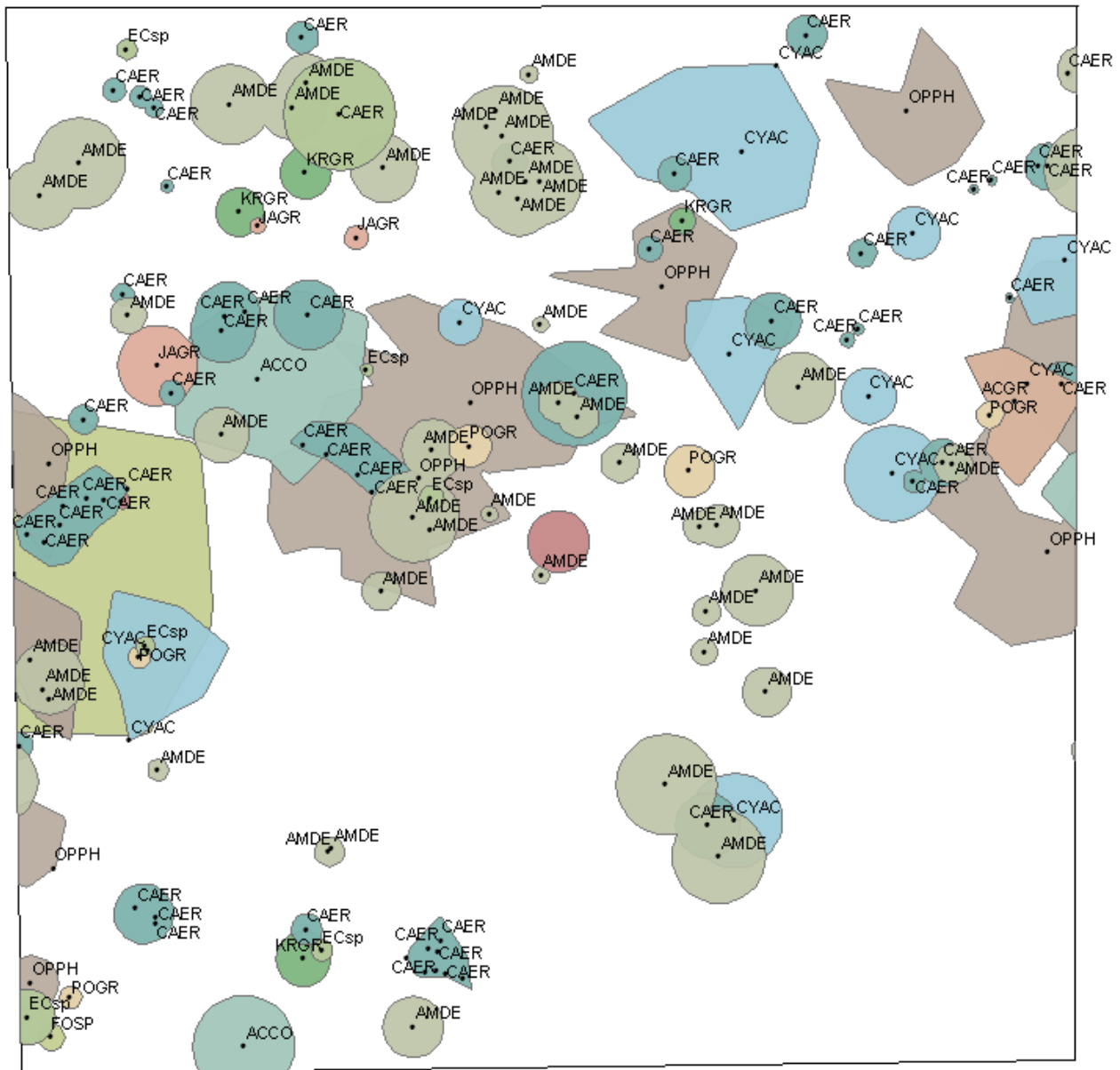
Plot 38: Tucson Mountain District



Label	Species	Density 2010	Cover 2010 (m2)
ACCO	<i>Acacia constricta</i>	3	3.96
AMDE	<i>Ambrosia deltoidea</i>	63	7.89
CAER	<i>Calliandra eriophylla</i>	3	0.66
CAGI	<i>Carnegiea gigantea</i>	5	0.99
CEMI	<i>Cercidium microphyllum</i>	1	0.05
CYAC	<i>Cylindropuntia acanthocarpa</i>	8	1.58
ENFA	<i>Encelia farinosa</i>	13	4.80
FOSP	<i>Fouquieria splendens</i>	9	11.03
JAGR	<i>Janusia gracilis</i>	11	0.97
KRGR	<i>Krameria grayi</i>	1	0.28
LYBE	<i>Lycium berlandieri</i>	4	1.36
POGR	<i>Porophyllum gracile</i>	2	0.14
	Grasses		0%
	Ferns & Allies		0%
Total		123	33.70



Plot 39: Tucson Mountain District

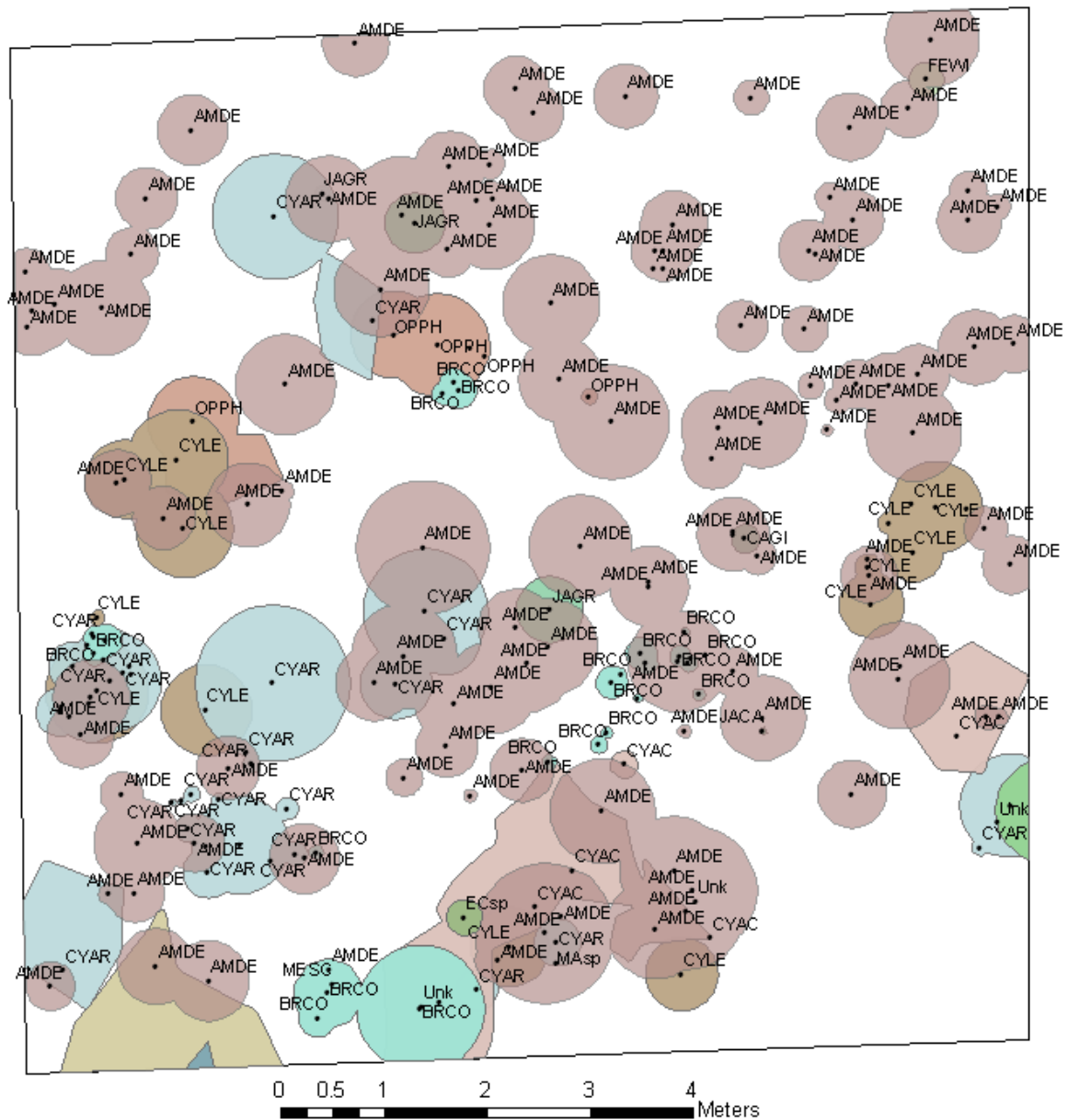


0 0.45 0.9 1.8 2.7 3.6 Meters

Label	Species	Density 2010	Cover 2010 (m ²)
ACCO	<i>Acacia constricta</i>	3	3.05
ACGR	<i>Acacia greggii</i>	1	0.78
AMDE	<i>Ambrosia deltoidea</i>	47	8.23
CAER	<i>Calliandra eriophylla</i>	56	4.65
CAGI	<i>Carnegiea gigantea</i>	1	0.28
CYAC	<i>Cylindropuntia acanthocarpa</i>	12	6.12
ECsp	<i>Echinocereus species</i>	6	1.14
FOSP	<i>Fouquieria splendens</i>	10	4.99
JAGR	<i>Janusia gracilis</i>	3	0.49
KRGR	<i>Krameria grayi</i>	4	0.59
OPPH	<i>Opuntia phaeacantha</i>	11	11.42
POGR	<i>Porophyllum gracile</i>	5	0.42
Grasses:			<1%
Ferns & Allies:			0%
Total		159	42.17

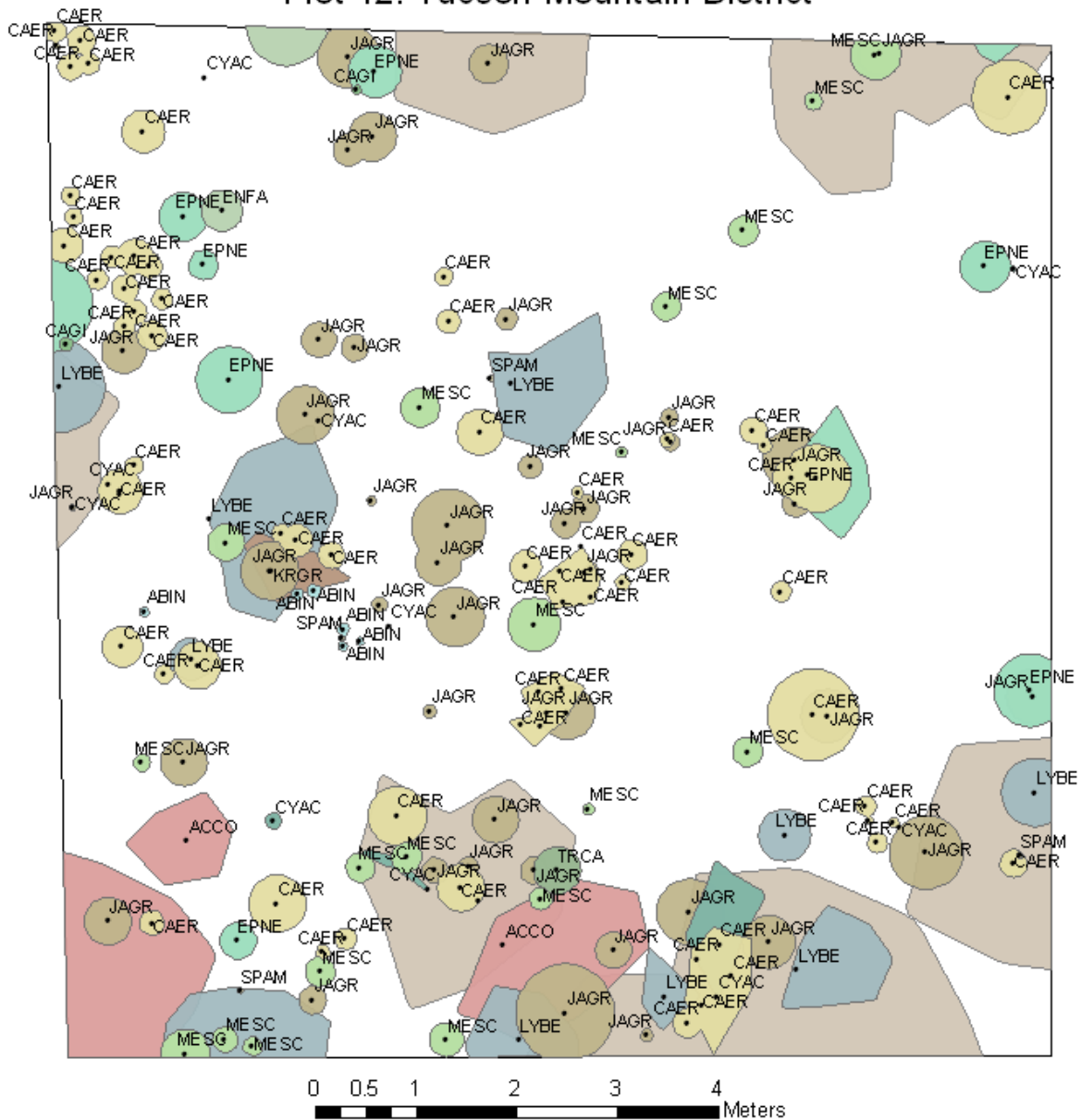


Plot 40: Tucson Mountain District



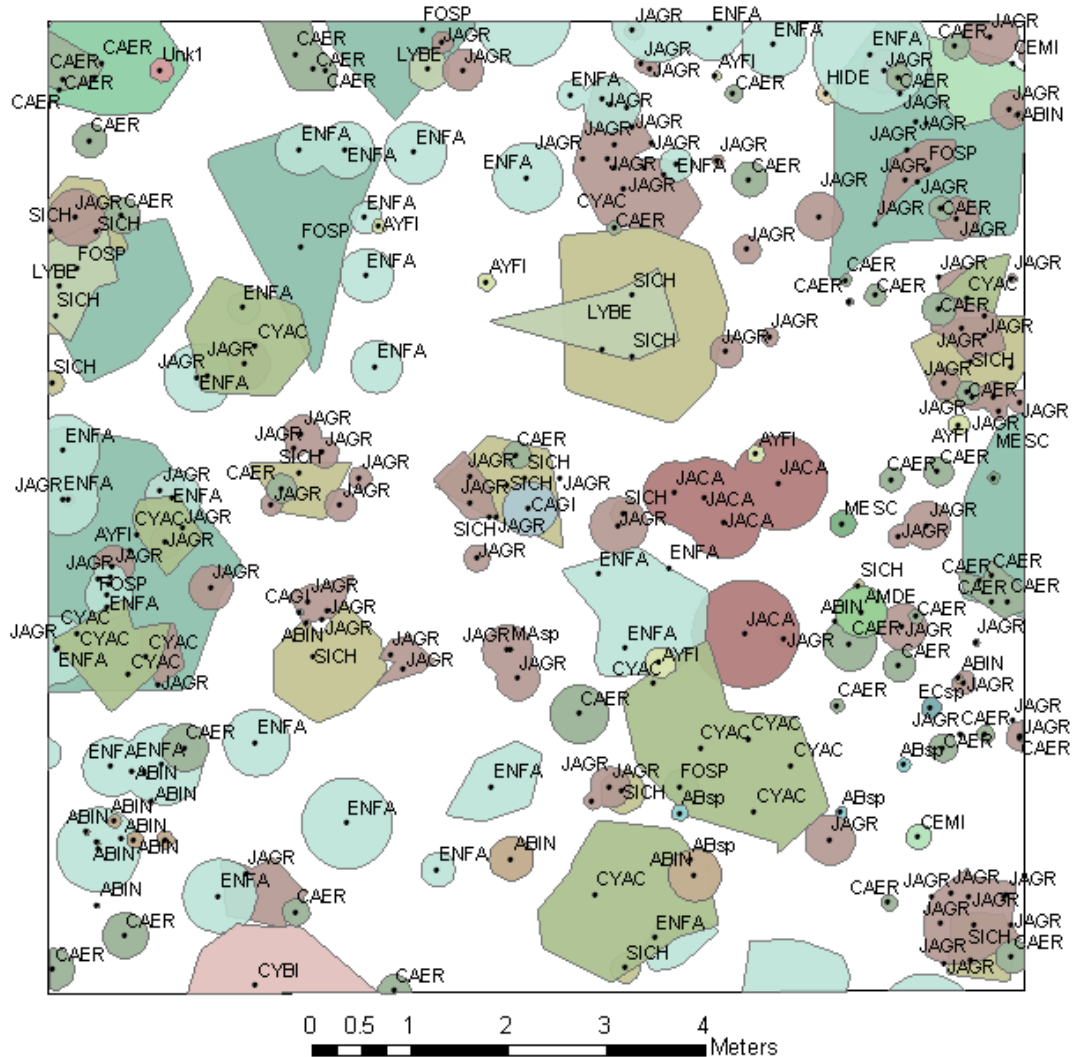
Label	Species	Density 2010	Cover 2010 (m ²)
ACCO	<i>Acacia constricta</i>	1	1.73
AMAM	<i>Ambrosia ambrosioides</i>	112	0.04
AMDE	<i>Ambrosia deltoidea</i>	1	31.85
AMsp	<i>Ambrosia species</i>	1	0.22
BRCO	<i>Brickellia coulteri</i>	25	2.05
CAGI	<i>Carnegiea gigantea</i>	1	0.06
CYAC	<i>Cylindropuntia acanthocarpa</i>	6	4.62
CYAR	<i>Cylindropuntia arbuscula</i>	34	8.80
CYLE	<i>Cylindropuntia leptocaulis</i>	16	5.08
ECsp	<i>Echinocereus species</i>	1	0.10
FEWI	<i>Ferocactus wislizenii</i>	1	0.09
JAGR	<i>Jamusia gracilis</i>	3	0.61
JACA	<i>Jatropha cardiophylla</i>	1	0.00
MAsp	<i>Mammillaria species</i>	1	0.00
OPPH	<i>Opuntia phaeacantha</i>	6	2.13
	Grasses		<1%
	Ferns & Allies		0%
Total		210	57.38

Plot 42: Tucson Mountain District



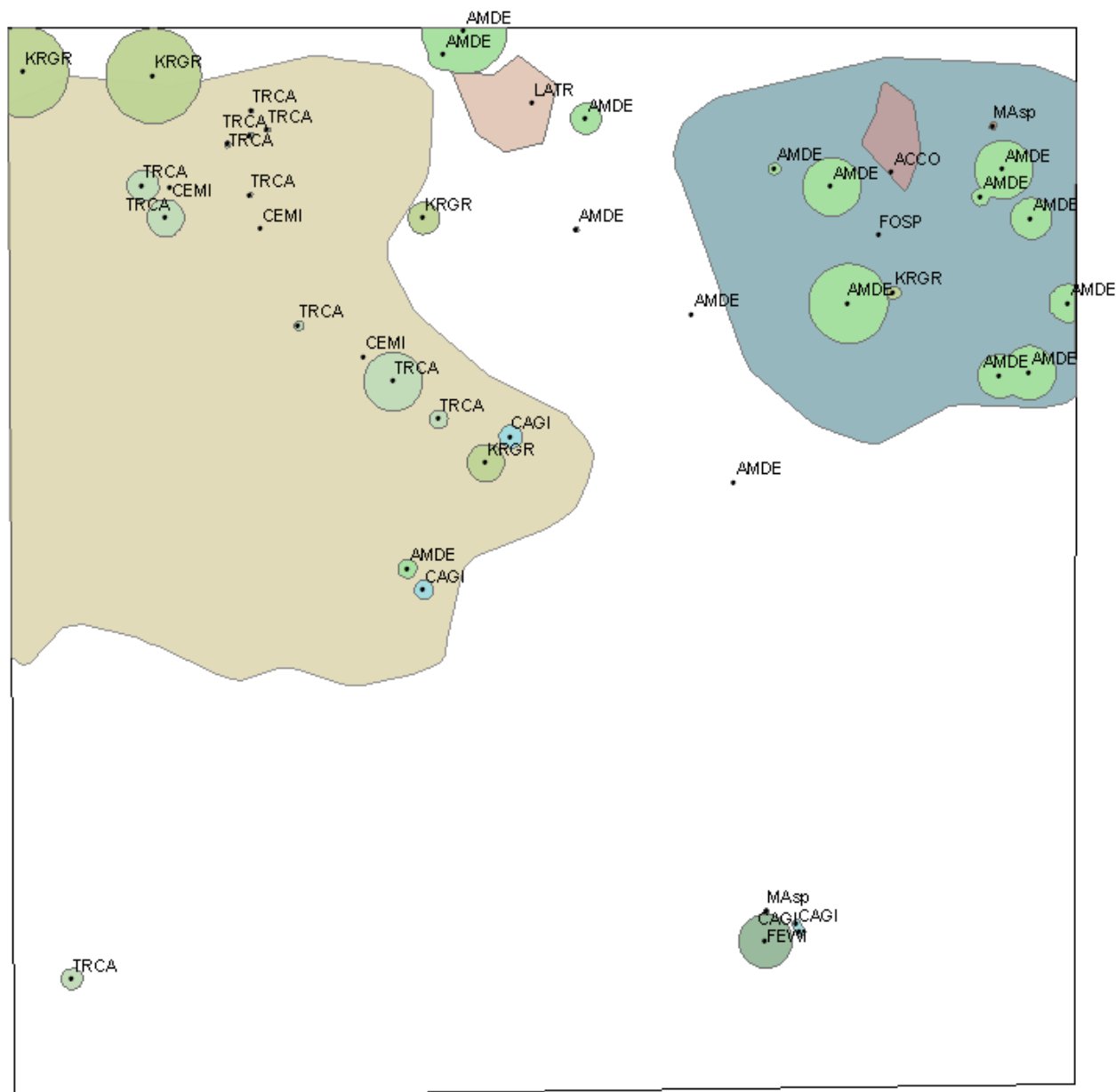
Label	Species	Density 2010	Cover 2010 (m2)
ABIN	<i>Abutilon incanum</i>	6	0.06
ACCO	<i>Acacia constricta</i>	3	4.85
CAER	<i>Calliandra eriophylla</i>	66	5.64
CAGI	<i>Carnegiea gigantea</i>	2	0.02
CEMI	<i>Cercidium microphyllum</i>	5	16.36
CYAC	<i>Cylindropuntia acanthocarpa</i>	10	0.63
ENFA	<i>Encelia farinosa</i>	2	0.37
EPNE	<i>Ephedra nevadensis</i>	10	2.45
JAGR	<i>Janusia gracilis</i>	43	6.28
KRGR	<i>Krameria grayi</i>	1	0.37
LYBE	<i>Lycium berlandieri</i>	10	6.24
MESG	<i>Menodora scabra</i>	19	1.41
SPAM	<i>Sphaeralcea ambigua</i>	4	0.01
TRCA	<i>Trixis californica</i>	1	0.17
	Grasses		<1%
	Ferns & Allies		0%
Total		182	44.85

Plot 43: Tucson Mountain District



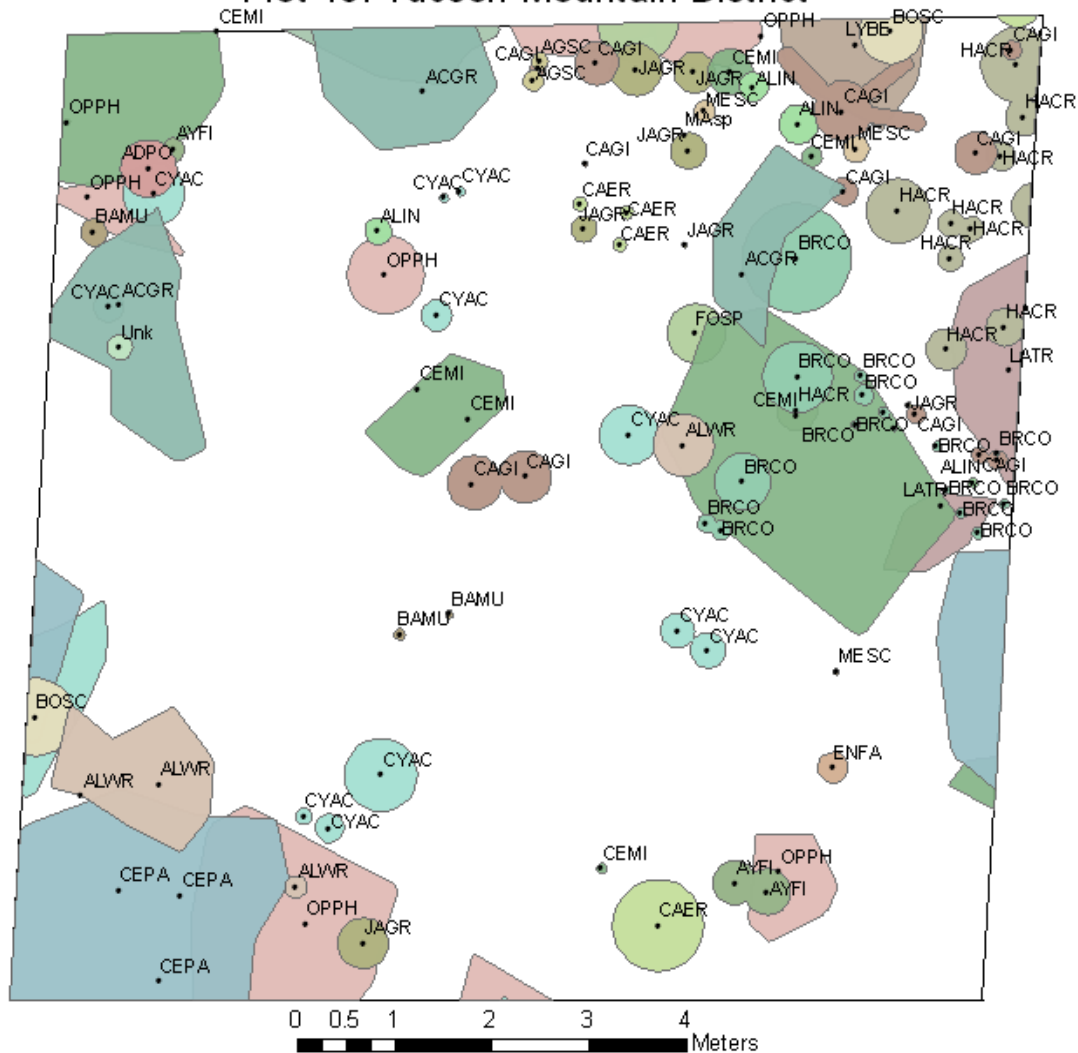
Label	Species	Density 2010	Cover 2010 (m ²)
ABIN	<i>Abutilon incanum</i>	16	0.47
ABsp	<i>Abutilon species</i>	4	0.05
AMDE	<i>Ambrosia deltoidea</i>	1	0.21
AYFI	<i>Ayenia filiformis</i>	7	0.19
CAER	<i>Calliandra eriophylla</i>	43	3.10
CAAR	<i>Carlowrightia arizonica</i>	1	0.04
CAGI	<i>Carnegiea gigantea</i>	2	0.24
CEMI	<i>Cercidium microphyllum</i>	2	0.68
CYAC	<i>Cylindropuntia acanthocarpa</i>	14	6.96
CYBI	<i>Cylindropuntia bigelovii</i>	1	0.96
ECsp	<i>Echinocereus species</i>	1	0.03
ENFA	<i>Eriola farinosa</i>	301	11.79
FOSP	<i>Fouquieria splendens</i>	7	13.79
HIDE	<i>Hibiscus denudatus</i>	1	0.04
JAGR	<i>Janusia gracilis</i>	95	8.32
JACA	<i>Jatropha cardiophylla</i>	5	2.45
LYBE	<i>Lycium berlandieri</i>	3	1.58
MAsp	<i>Mammillaria species</i>	2	0.00
MESC	<i>Menodora scabra</i>	2	0.07
OPPH	<i>Opuntia phaeacantha</i>	1	1.18
SICH	<i>Simmondsia chinensis</i>	17	7.12
	Grasses		2%
	Ferns & Allies		0%
Total		526	59.25

Plot 44: Tucson Mountain District



Label	Species	Density 2010	Cover 2010 (m2)
ACCO	<i>Acacia constricta</i>	1	0.35
AMDE	<i>Ambrosia deltoidea</i>	16	1.81
CAGI	<i>Carnegiea gigantea</i>	4	0.07
CEMI	<i>Cercidium microphyllum</i>	3	23.96
FEWI	<i>Ferocactus wislizenii</i>	1	0.20
FOSP	<i>Fouquieria splendens</i>	1	11.11
KRGR	<i>Krameria grayi</i>	5	1.21
LATR	<i>Larrea tridentata</i>	1	0.57
MAsp	<i>Mammillaria species</i>	2	0.01
TRCA	<i>Trixis californica</i>	11	0.47
	Grasses		0%
	Ferns & Allies		0%
Total		45	39.76

Plot 45: Tucson Mountain District



Label	Species	Density 2010	Cover 2010 (m2)
ACGR	<i>Acacia greggii</i>	3	5.31
ADPO	<i>Adenophyllum porophylloides</i>	1	0.26
AGSC	<i>Agave schottii</i>	2	0.06
ALIN	<i>Allionia tripartita</i>	161	0.84
ALWR	<i>Aloysia wrightii</i>	4	1.93
AYFI	<i>Ayenia filiformis</i>	3	0.35
AYMI	<i>Ayenia microphylla</i>	1	0.05
BAAB	<i>Bahia abscinthifolia</i>	119	0.27
BAMU	<i>Baileya multiradiata</i>	3	0.08
BOSC	<i>Boerhaavia scandens</i>	2	0.57
BRCO	<i>Brietilia coulteri</i>	16	1.82
CAER	<i>Calliandra eriophylla</i>	5	0.77
CAGI	<i>Carnegiea gigantea</i>	12	1.56
CEPA	<i>Celtis pallida</i>	5	6.99
CEMI	<i>Cercidium microphyllum</i>	8	9.31
CYAC	<i>Quindrapuntia acanthocarpa</i>	13	2.47
ENFA	<i>Encelia farinosa</i>	1	0.07
FOSP	<i>Fouquieria splendens</i>	2	0.53
HACR	<i>Haplophyton comocladifolium</i>	11	1.50
JAGR	<i>Jatropha gossypifolia</i>	7	0.73
LATR	<i>Larrea tridentata</i>	2	1.79
LYBE	<i>Lythrum berlandieri</i>	1	1.23
MASp	<i>Mammillaria species</i>	1	0.00
MESC	<i>Menodora scabra</i>	3	0.10
OPPH	<i>Opuntia phaeacantha</i>	9	6.00
PRVE	<i>Prosopis velutina</i>	1	0.78
	Grasses		2%
	<i>Ferrea & Allies</i>		<1%
	Total	396	45.36