

RECENT VEGETATION CHANGE AT SAGUARO NATIONAL MONUMENT EAST
PRELIMINARY REPORT

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In 1976 vegetation plots were established in Saguaro National Monument East by W. F. Steenburgh and associates to serve as baseline documentation of vegetation change after cows were removed from the Monument. I resampled plant density and cover on these plots in 1984.

Four 20 x 50 m plots (0.1 hectare) were resampled for density and cover of perennial species. Density was measured by counting all individuals greater than 25 cm tall in each of ten 5 x 20 m subplots. Cover was measured by Canfield's line-intercept method on eleven 20 m transects. Mean density and cover per species for each plot were compared using an ANOVA and Tukey's Honestly Significant Difference Test for a posteriori comparisons between means.

Vegetation has changed dramatically in the intervening eight years since the plots were established. Grass cover and density increase significantly at all sites. Shrub density increased significantly at 3 out of 4 sites while shrub cover showed no change. Cacti and forbs showed no change in either cover or density since 1976 (Tables 1 and 2).

The increase in grass cover between 1976 and 1984 can be attributed to release from grazing and the expansion of previously cropped grasses into large-sized flowering individuals. The increase in grass density reflects some increase in new individuals but also includes many grasses that were previously too small (< 25 cm tall) to be included in the density counts. Palatable shrubs such as Calliandra eriophylla and Eriogonum wrightii also showed increases in density and cover (Tables 4-6).

However, not all observed changes can be attributed to release from livestock grazing; climatic factors have also played a role. A hard freeze in 1979 resulted in a decrease in frost sensitive species such as Encelia farinosa and Eouguieria splendens. In addition, higher than normal rainfall for the last 5 years, especially in 1983, can also account for much of the increase in density and cover for many species. The increase in total shrub density and the density of Aplopappus laricifolius is probably the result of increased rainfall rather than a release from grazing.

These results show that there can be great changes in semi-arid vegetation over a short time period. However, not all the increase in cover and density can be attributed to release from grazing by cows. Higher than normal precipitation also has a strong effect on vegetation growth and seedling established. Recovery from grazing would not be so dramatic if rainfall was less than normal in the intervening years since cows were removed.

Table 1. Summary of mean density per sub-plot (n=10). Plots 3 and 4 are on south-facing slopes and plots 7 and 8 on north-facing slopes. Means are compared with an ANOVA and Tukey's aposteriori test of means.

	Site 3		Site 4		Site 7		Site 8		F
	1976	1984	1976	1984	1976	1984	1976	1984	Value
Shrubs	60.4	64.8	43.8	72.3*	49.8	101.0*	57.6	92.8*	14.0
Cactus	7.0	8.4	15.7	14.0	5.7	8.3	6.7	9.3	7.9
Grasses	0	251.7*	0	123.1*	0	266.7*	0	262.6*	86.0
Forbs	3.0	7.9	0.2	6.0	0.7	4.9	0.2	6.6	6.3

* Means for the two years at a site are significantly different at $p < .05$.

Table 2. Summary of mean percent cover per plot (11 line intercept transects at 20 meters each). Means are compared with an ANOVA and Tukey's aposteriori test of means.

	Site 3		Site 4		Site 7		Site 8		F
	1976	1984	1976	1984	1976	1984	1976	1984	Value
Shrubs	51.8	43.6	38.3	33.9	41.3	51.0	35.0	30.8	2.5
Cactus	3.4	3.1	9.9	9.1	2.6	2.8	4.0	4.1	4.3
Grasses	1.8	27.6*	3.0	21.9*	0.4	20.0*	1.3	24.5*	66.8
Forbs	1.9	2.8	0.2	2.3	1.1	0.8	0.6	2.0	2.7

* Means for the two years at a site are significantly different at $p < .05$.

Table 3. Mean percent cover at sites 3 and 4 (north-facing slopes). Means are compared using an ANOVA and Tukey's aposteriori test of means.

	Site 3		Site 4		F
	1976	1984	1976	1984	Value
Shrubs					
<i>Aplopappus laricifolius</i>	16.9	19.6	9.3	13.4	8.9
<i>Acacia greggii</i>	7.3	9.5	5.6	3.8	2.9
<i>Cercidium microphyllum</i>	4.7	3.6	6.0	2.6	2.7
<i>Prosopis velutina</i>	1.7	3.0	9.0	6.4	1.5ns
<i>Fouquieria splendens</i>	16.3	4.8*	5.0	0.9	7.2
<i>Calliandra eriophylla</i>	0.3	0	0.2	0.3	6.3
<i>Jatropha cardiophylla</i>	1.9	0.2	1.1	0.3	1.4ns
<i>Eriogonum wrightii</i>	0.2	1.6	0.2	2.0*	3.7
<i>Janusia gracilis</i>	0.1	0.1	0.6	1.1	5.4
<i>Encelia farinosa</i>	0	0	0	0	9.8
<i>Abutilon</i> sp.	0	0	0.2	1.5*	3.9
<i>Forophyllum gracile</i>	0	0	0.3	0.3	1.8ns
<i>Celtis pallida</i>	0	0	0.5	0.4	0.8ns
<i>Lycium</i> sp.	0.6	0.1	0	0	1.4ns
<i>Brickellia</i> sp.	0	0	0.3	0.4	0.9ns
Other shrubs	1.9	1.1	0	0.3	1.0ns
Cacti					
<i>Opuntia phaeacantha</i>	2.7	2.1	8.8	8.0	4.6
<i>Opuntia versicolor</i>	1.1	0.5	1.0	1.1	0.4ns
<i>Ferocactus wislizenii</i>	0.1	0	0.2	0	0.6ns
<i>Carnegiea gigantea</i>	0	0	0	0	1.0ns
Grasses					
<i>Bouteloua filiformis</i>	0.7	9.2*	1.2	8.9*	29.3
<i>Bouteloua curtipendula</i>	0.6	8.6*	0.7	2.3	10.4
<i>Muhlenbergia porteri</i>	0.4	3.5*	0.2	1.0	5.7
<i>Aristida divaricata</i>	0.1	2.3	0	3.0*	5.2
<i>Aristida purpurea</i>	0	2.0	0.2	0.9	7.8
<i>Tricachne californica</i>	0.1	1.2	0.1	2.3*	4.8
<i>Heteropogon contortum</i>	0	0.3	0.3	1.4	3.6
<i>Eragrostis intermedia</i>	0	0	0.3	0.1	2.8
<i>Erioneuron pulchellum</i>	0	0.6	0	0.5	1.4ns
Other grasses	0	0	0.1	1.4*	4.0
Forbs					
<i>Evolvulus arizonicus</i>	0.1	0	0	1.0*	11.1
<i>Dalea parryi</i>	0	0	0	0.3	2.4
<i>Dalea greggii</i>	0.1	2.4*	0	0.3	3.6
<i>Avena pusilla</i>	0.6	0.1	0	0	1.0ns
<i>Euphorbia melanadenia</i>	0.2	0.1	0.1	0.3	0.8ns
Other forbs	0.4	0.2	0.1	0.4	0.8ns

* Means for the two years at a site are significantly different at $p < .05$.
ns - no significant variation between sites or years.

Table 4. Mean percent cover at sites 7 and 8 (south-facing slopes). Means are compared using an ANOVA and Tukey's aposteriori test of means.

	Site 7		Site 8		F
	1976	1984	1976	1984	Value
Shrubs					
<i>Aplopappus laricifolius</i>	9.4	22.3*	4.8	11.2	8.9
<i>Acacia greggii</i>	2.5	2.4	2.5	1.4	2.9
<i>Cercidium microphyllum</i>	14.2	8.4	10.6	5.0	2.7
<i>Prosopis velutina</i>	6.3	10.2	2.3	1.9	1.5ns
<i>Eouguiera splendens</i>	3.4	2.6	5.3	1.8	7.2
<i>Calliandra eriophylla</i>	1.0	2.8	1.2	3.4	6.3
<i>Jatropha cardiophylla</i>	1.0	0.1	2.2	1.0	1.4ns
<i>Eriogonum wrightii</i>	0	0	0.1	0.9	3.7
<i>Janusia gracilis</i>	0	0	0	0.1	5.4
<i>Encelia farinosa</i>	2.4	2.0	6.0	3.6	9.8
<i>Abutilon</i> sp.	0	0	0.1	0.1	3.9
<i>Porcophyllum gracile</i>	0.2	0	0	0	1.8ns
<i>Celtis pallida</i>	0.5	0.3	0	0	0.8ns
<i>Lycium</i> sp.	0.3	0	0	0	1.4ns
<i>Brickellia</i> sp.	0.2	0	0	0	0.9ns
Other shrubs	0	0	0.1	0.3	1.0ns
Cacti					
<i>Opuntia phaeacantha</i>	1.6	1.5	3.9	3.7	4.6
<i>Opuntia versicolor</i>	1.0	1.3	0	0.3	0.4ns
<i>Ferocactus wislizenii</i>	0	0	0	0.1	0.6ns
<i>Carnegiea gigantea</i>	0.1	0	0	0	1.0ns
Grasses					
<i>Bouteloua filiformis</i>	1.3	11.2*	0.9	16.2*	29.3
<i>Bouteloua curtipendula</i>	0	0.9	0.2	0.3	10.4
<i>Muhlenbergia porteri</i>	0.1	3.3*	0	0.9	5.7
<i>Aristida divaricata</i>	0	3.6*	0	1.4*	5.2
<i>Aristida purpurea</i>	0	0.2	0	5.5*	7.8
<i>Tricachne californica</i>	0	0.8	0.2	0	4.8
<i>Heteropogon contortum</i>	0	0	0	0	3.6
<i>Eragrostis intermedia</i>	0	0	0	0	2.8
<i>Erioneuron pulchellum</i>	0	0	0	0	1.4ns
Other grasses	0	0	0	0	4.0
Forbs					
<i>Evolvulus arizonicus</i>	0	0	0	0.1	11.1
<i>Dalea parryi</i>	0.1	0.2	0.1	0.9	2.4
<i>Dalea greggii</i>	0	0	0	0.8	3.6
<i>Avena pusilla</i>	0	0	0	0	1.0ns
<i>Euphorbia melanadenia</i>	0.3	0.1	0.4	0.2	0.8ns
Other forbs	0.1	0.2	0.1	0.1	0.8ns

* Means for the two years at a site are significantly different at $p < .05$.
ns - no significant variation between sites or years.

Table 5. Mean density/100 sq.m. at sites 3 and 4 (north-facing slopes). Means are compared using an ANOVA and Tukey's aposteriori test of means.

	Site 3		Site 4		F
	1976	1984	1976	1984	Value
Shrubs					
<i>Aplopappus laricifolius</i>	31.5	38.2	14.9	34.6*	16.9
<i>Acacia greggii</i>	6.4	6.8	4.7	4.1	4.8
<i>Cercidium microphyllum</i>	0.8	1.0	1.4	1.1	13.4
<i>Prosopis velutina</i>	0.1	0.2	1.5	1.4	2.7
<i>Fouquieria splendens</i>	13.1	9.0	5.3	4.0	9.2
<i>Calliandra eriophylla</i>	0.2	0.6	0.6	1.5	17.5
<i>Jatropha cardiophylla</i>	5.9	3.9	4.4	1.5	2.3
<i>Eriogonum wrightii</i>	0	2.3	0.5	6.1	11.2
<i>Janusia gracilis</i>	0.1	0.1	5.3	5.7	16.9
<i>Encelia farinosa</i>	0.2	0.2	0.1	0	22.1
<i>Abutilon</i> sp.	0.2	0.6	2.3	8.1*	4.4
<i>Paraphyllum gracile</i>	0	0.2	1.4	2.7	5.0
<i>Celtis pallida</i>	0	0	0.4	0.5	1.1ns
<i>Lycium</i> sp.	0.1	0.2	0.3	0.1	0.6ns
<i>Aloysia wrightii</i>	0	0	0.4	0.2	0.9ns
Other shrubs	1.4	1.9	0.3	0.7	1.8ns
Cacti					
<i>Opuntia phaeacantha</i>	4.9	6.1	13.3	11.4	9.7
<i>Opuntia versicolor</i>	1.1	1.3	1.1	1.6	3.5
<i>Ferocactus wislizenii</i>	0.8	0.9	1.2	0.9	2.0ns
<i>Carnegiea gigantea</i>	0.2	0.1	0.1	0.1	1.6ns
Grasses					
<i>Bouteloua filiformis</i>	0	160.1*	0	72.7*	44.8
<i>Bouteloua curtipendula</i>	0	38.2*	0	13.8	12.3
<i>Muhlenbergia porteri</i>	0	6.4*	0	5.0*	12.8
<i>Aristida divaricata</i>	0	18.8*	0	15.1*	10.8
<i>Bothriochloa barbinodis</i>	0	7.4	0	1.3	13.9
<i>Tricachne californica</i>	0	13.6*	0	11.4*	17.5
<i>Heteropogon contortum</i>	0	1.1	0	0	15.0
<i>Eragrostis intermedia</i>	0	3.7*	0	1.8	3.1
Other grasses	0	2.4	0	2.0	2.6
Forbs					
<i>Evolvulus arizonicus</i>	0	0	0	4.3*	13.6
<i>Dalea parryi</i>	0	0	0	0.3	6.2
<i>Dalea greggii</i>	1.5	3.9*	0.1	0.6	7.6
Other forbs	1.5	4.0	0.1	0.3	4.8

* Means for the two years at a site are significantly different at $p < .05$.
ns - no significant variation between sites or years.

Table 6. Mean density/100 sq.m. at sites 7 and 8 (south-facing slopes). Means are compared using an ANOVA and Tukey's aposteriori test of means.

	Site 7		Site 8		F
	1976	1984	1976	1984	Value
Shrubs					
<i>Aplopappus laricifolius</i>	16.0	54.6*	9.8	39.0*	16.9
<i>Acacia greggii</i>	2.3	2.0	4.0	3.0	4.8
<i>Cercidium microphyllum</i>	6.5	5.1	4.7	3.8	13.4
<i>Prosopis velutina</i>	0.9	1.0	0.3	0.3	2.7
<i>Fouquieria splendens</i>	5.0	3.5	9.2	3.7	9.2
<i>Calliandra eriophylla</i>	0.5	20.2*	2.1	11.8*	17.5
<i>Jatropha cardiophylla</i>	1.4	1.3	4.8	2.5	2.3
<i>Eriogonum wrightii</i>	0	2.6	0	5.8*	11.2
<i>Janusia gracilis</i>	0.2	0.1	1.7	3.1	16.9
<i>Encelia farinosa</i>	16.3	8.2*	19.5	16.4	22.1
<i>Abutilon</i> sp.	0	0.6	0.6	1.6	4.4
<i>Eriogonum gracile</i>	0.2	0.5	0	0.5	5.0
<i>Celtis pallida</i>	0.1	0.2	0	0	1.1ns
<i>Lycium</i> sp.	0.3	0.3	0.2	0	0.6ns
<i>Aloysia wrightii</i>	0.1	0.1	0.6	0	0.9ns
Other shrubs	0	0.7	1.3	0.1	1.8ns
Cacti					
<i>Opuntia phaeacantha</i>	2.9	4.4	4.5	6.1	9.7
<i>Opuntia versicolor</i>	2.1	3.3	0.8	1.1	3.5
<i>Eriocactus wislizenii</i>	0.3	0.3	0.9	1.5	2.0ns
<i>Carnegiea gigantea</i>	0.4	0.3	0.5	0.6	1.6ns
Grasses					
<i>Bouteloua filiformis</i>	0	164.4*	0	216.0*	44.8
<i>Bouteloua curtipendula</i>	0	3.8	0	1.7	12.3
<i>Muhlenbergia porteri</i>	0	4.4*	0	2.2	12.8
<i>Aristida divericata</i>	0	13.1*	0	12.7*	10.8
<i>Bothriochloa barbinodis</i>	0	4.9	0	23.4*	13.9
<i>Tricachne californica</i>	0	6.2	0	0	17.5
<i>Heteropogon contortum</i>	0	69.3*	0	6.1	15.0
<i>Eragrostis intermedia</i>	0	0	0	0	3.1
Other grasses	0	0.6	0	0.5	2.6
Forbs					
<i>Evolvulus arizonicus</i>	0	0.7	0	0.5	13.6
<i>Dalea parryi</i>	0	2.9	0	4.5*	6.2
<i>Dalea greggii</i>	0.1	0	0.2	1.2	7.6
Other forbs	0.6	1.3	0	0.2	4.8

* Means for the two years at a site are significantly different at $p < .05$.