

Hoski Schaafsma, John M. Briggs
Arizona State University, School of Life Sciences, Tempe, Arizona 85287-1601
hoski.schaafsma@asu.edu

Abstract

Anthropogenic disturbances often alter local patch-dynamics and successional processes. These patches may be difficult to determine in areas with species with longevities measured in hundreds and thousands of years as seen in some desert plants. Recent research has shown that prehistoric (~750 years BP) farming has produced measurable legacies in modern Sonoran Desert plant communities. Our study area is a five-mile reach of Cave Creek in Arizona that encompassed the first terrace with a total area of 124 ha; prehistoric fields make up 9% of the area. The differences between the fields and the remainder of the first terrace show that almost 1/10th of the area has been modified by humans and retains legacies of these changes up to 800 years after abandonment. Legacy effects have been measured on the fields in the woody, cacti and herbaceous communities. Changing 9% of the landscape has consequences for the patch-dynamics of the system as a whole by altering plant communities as well as producing differences in habitat. These results show that archaeology coupled with plant biology may provide a way to assess processes of disturbance, succession, and patch dynamics in plant communities with extreme longevity. The results also have serious implications regarding past human interaction with the landscape; the wide distribution of archaeological sites suggests that large areas of the Sonoran Desert have contained numerous anthropogenic patches for at least the last two thousand years. Discovering the scale at which these patches create significant alterations is an on-going aspect of this work.



View of prehistoric field surface showing reduced vegetation within the patch.



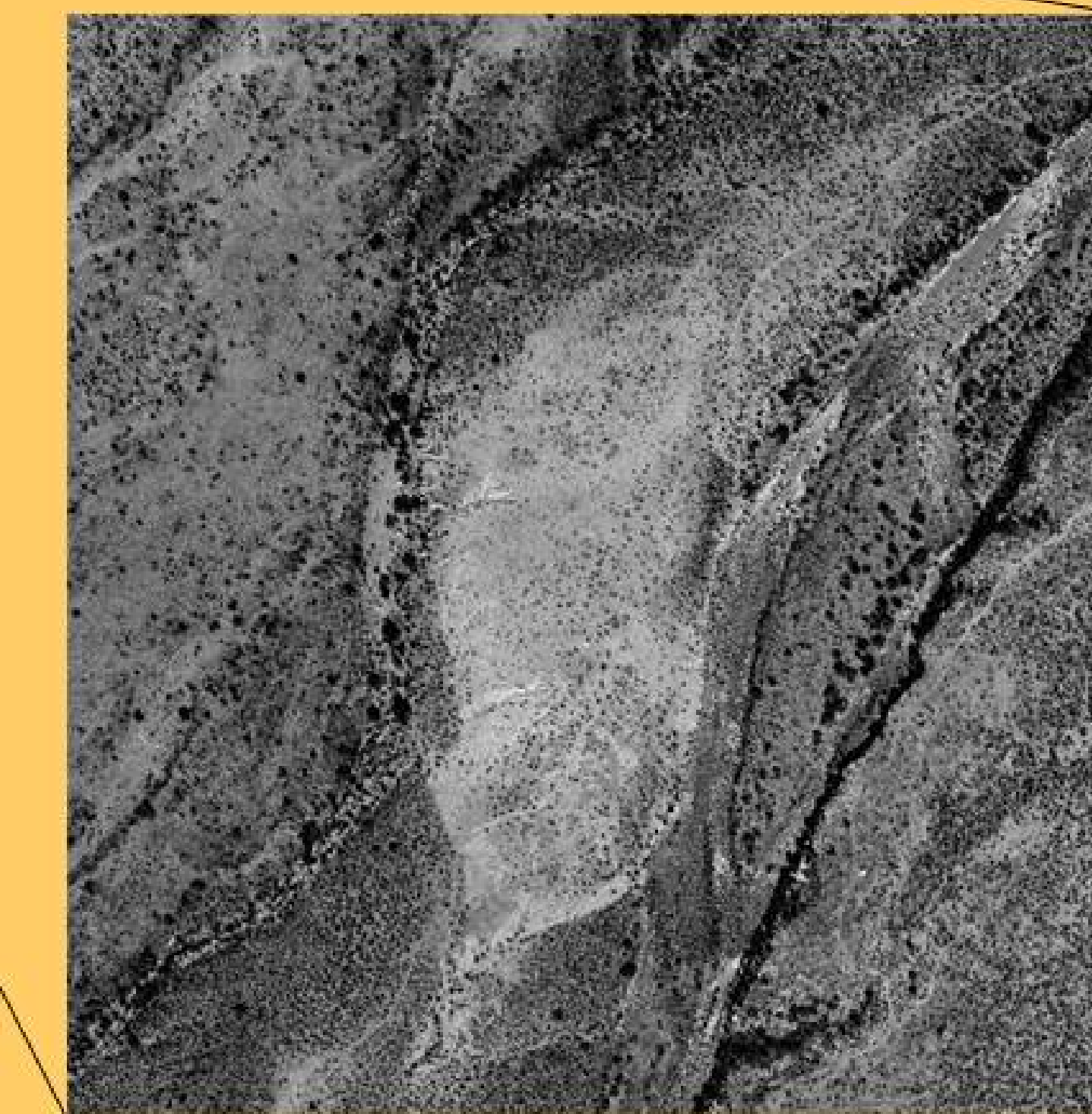
View of prehistoric field surface showing reduced vegetation within the patch.



View of anthropogenic patch (light colored dirt) with single woody species surrounded by diverse population of woody and cacti species.

Anthropogenic patches, landscape fragmentation and altered patch-dynamics along Cave Creek

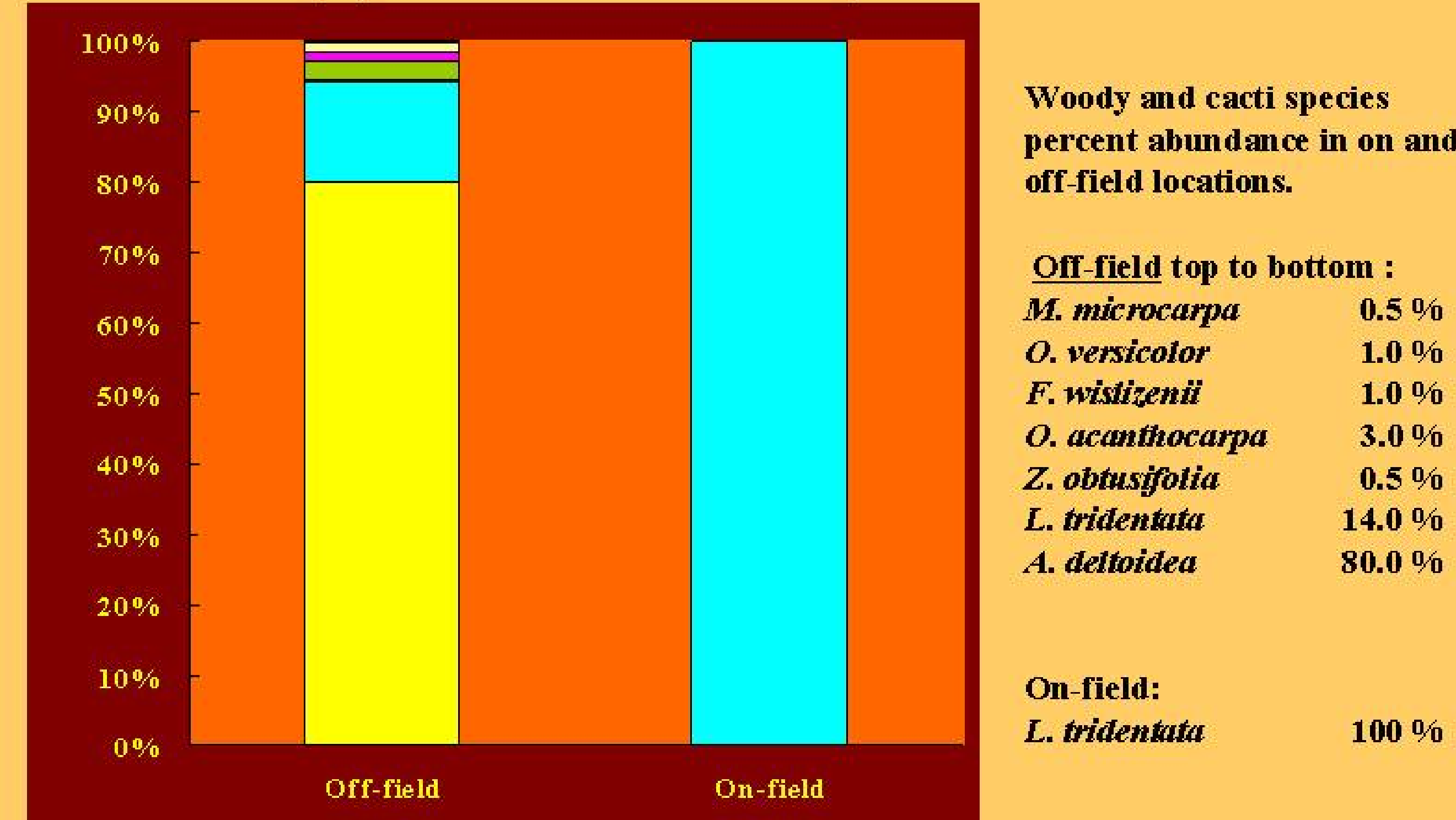
A fragmented landscape: the black outline shows the extent of the first terrace west of Cave Creek extending roughly 3.5 miles north-south. Modern disturbances are outlined in red. Archaeological sites are outlined in blue. First terrace total area = 146.25 ha. Archaeological sites on first terrace total area = 14.27 ha. Roughly ten percent of the land form of the first terrace is made up of anthropogenic patches.



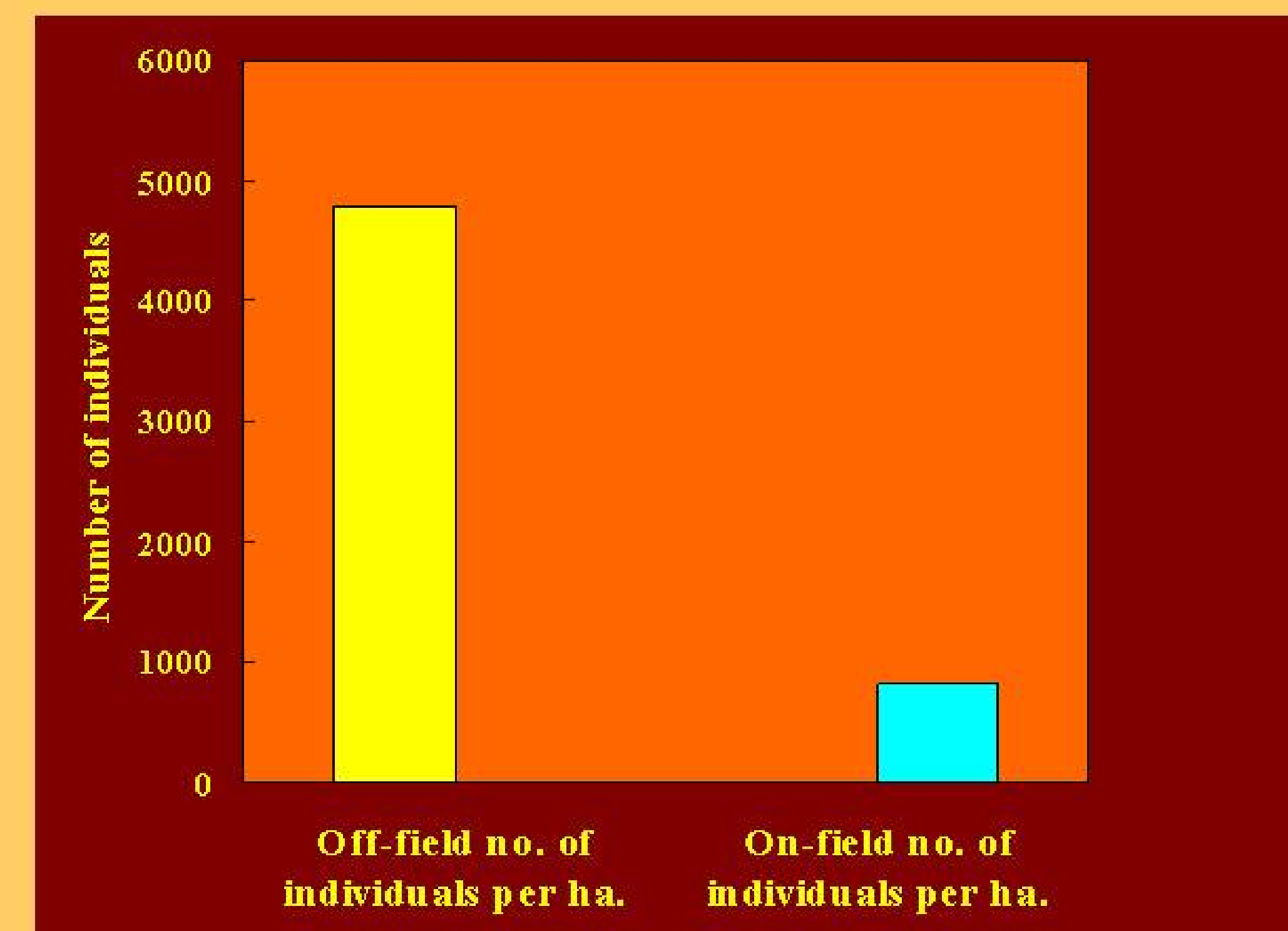
Aerial image of one of the larger field sites showing changes in soil color, from darker to lighter, and lower vegetation density within the field area.

Legacies exist if the current system retains a memory of antecedent conditions. Measures of prehistoric farming legacy in the modern vegetation of Cave Creek are shown below:

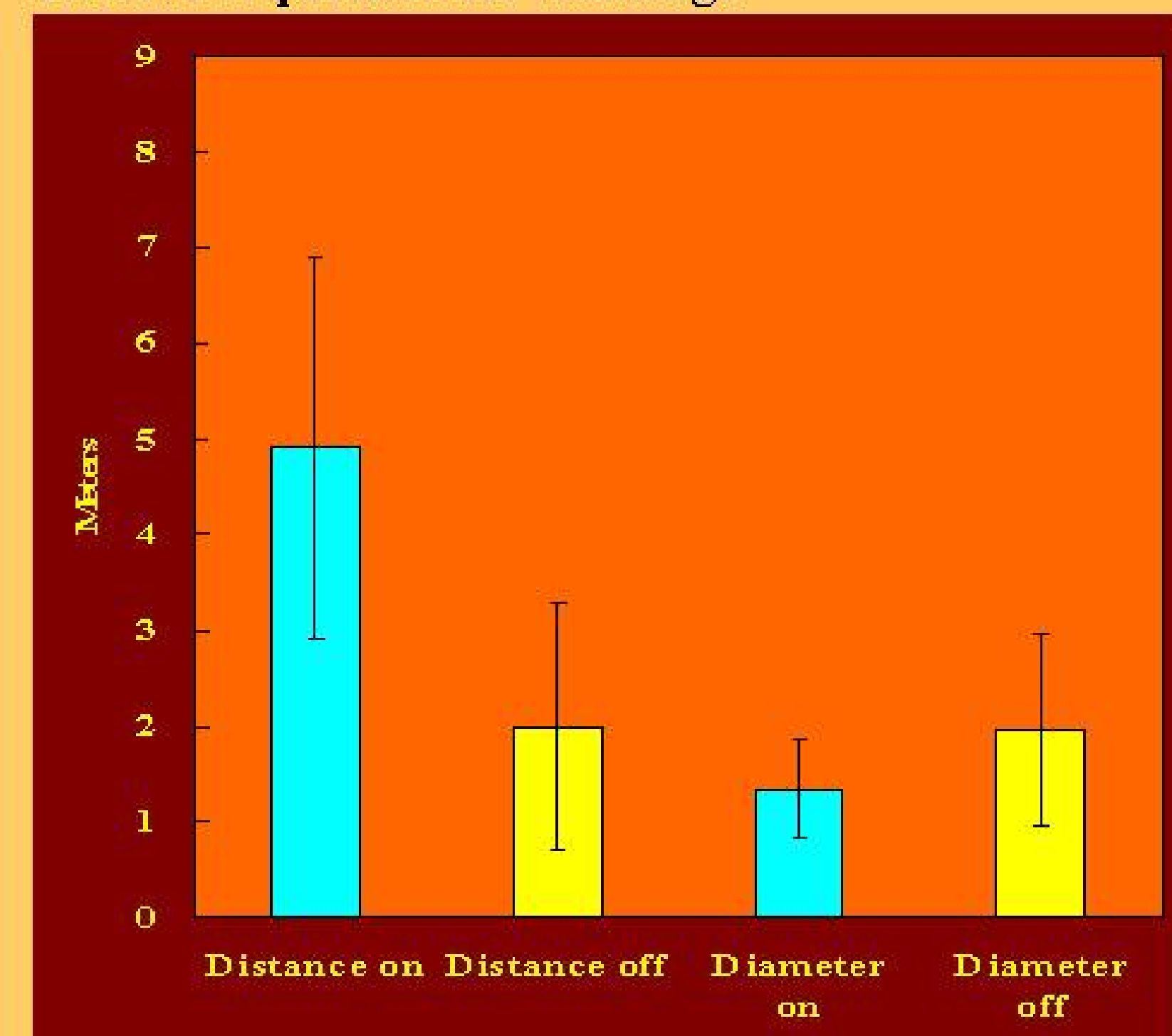
Presence and diversity of modern woody vegetation and cacti species are significantly reduced on prehistoric fields. No cacti were observed on the fields, and woody species were reduced to one species, *Larrea tridentata*:



Over all, woody vegetation density dropped on the fields:

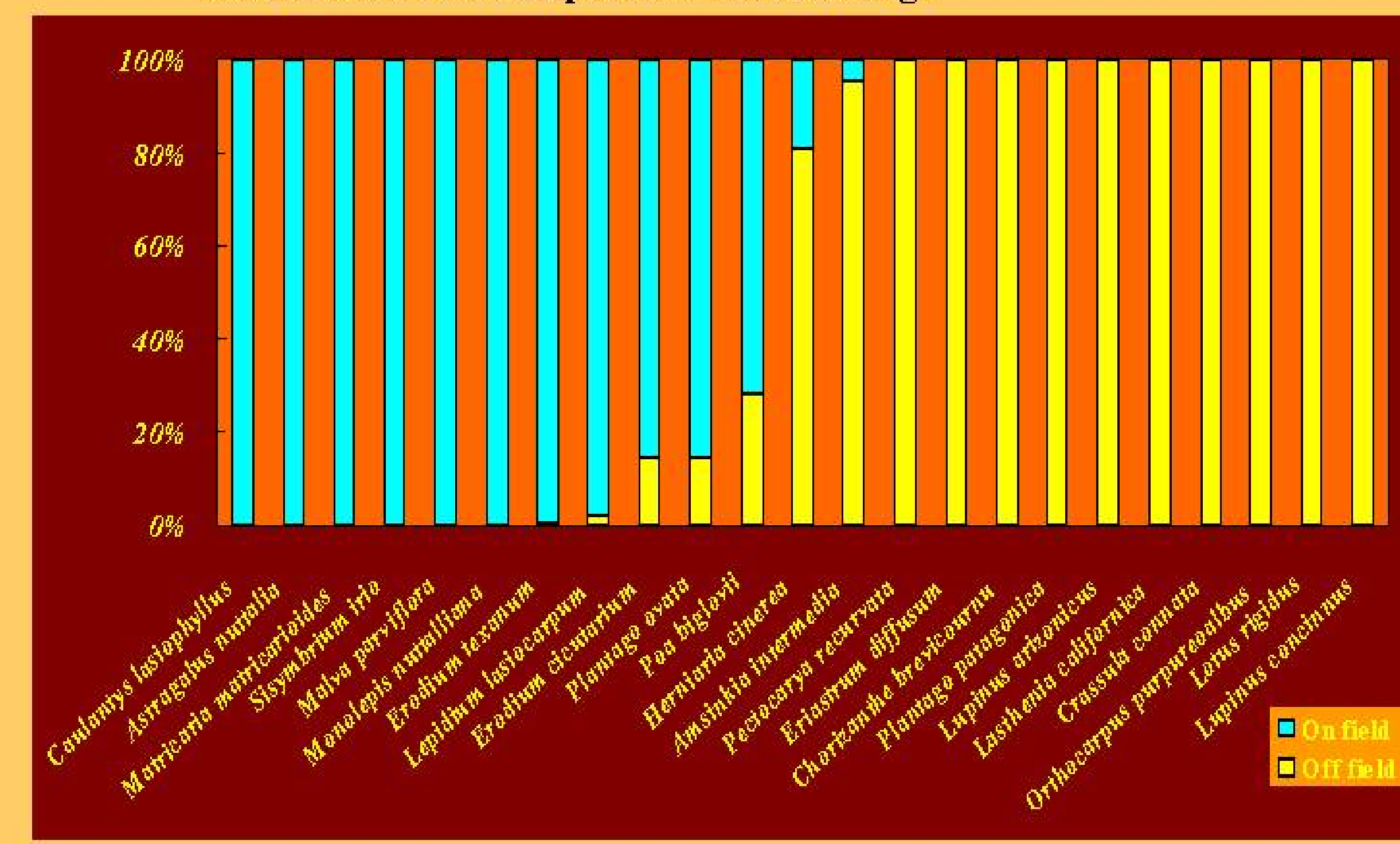


Differences between *L. tridentata* on and off fields shows an effect on growth habit due to location relative to prehistoric farming:

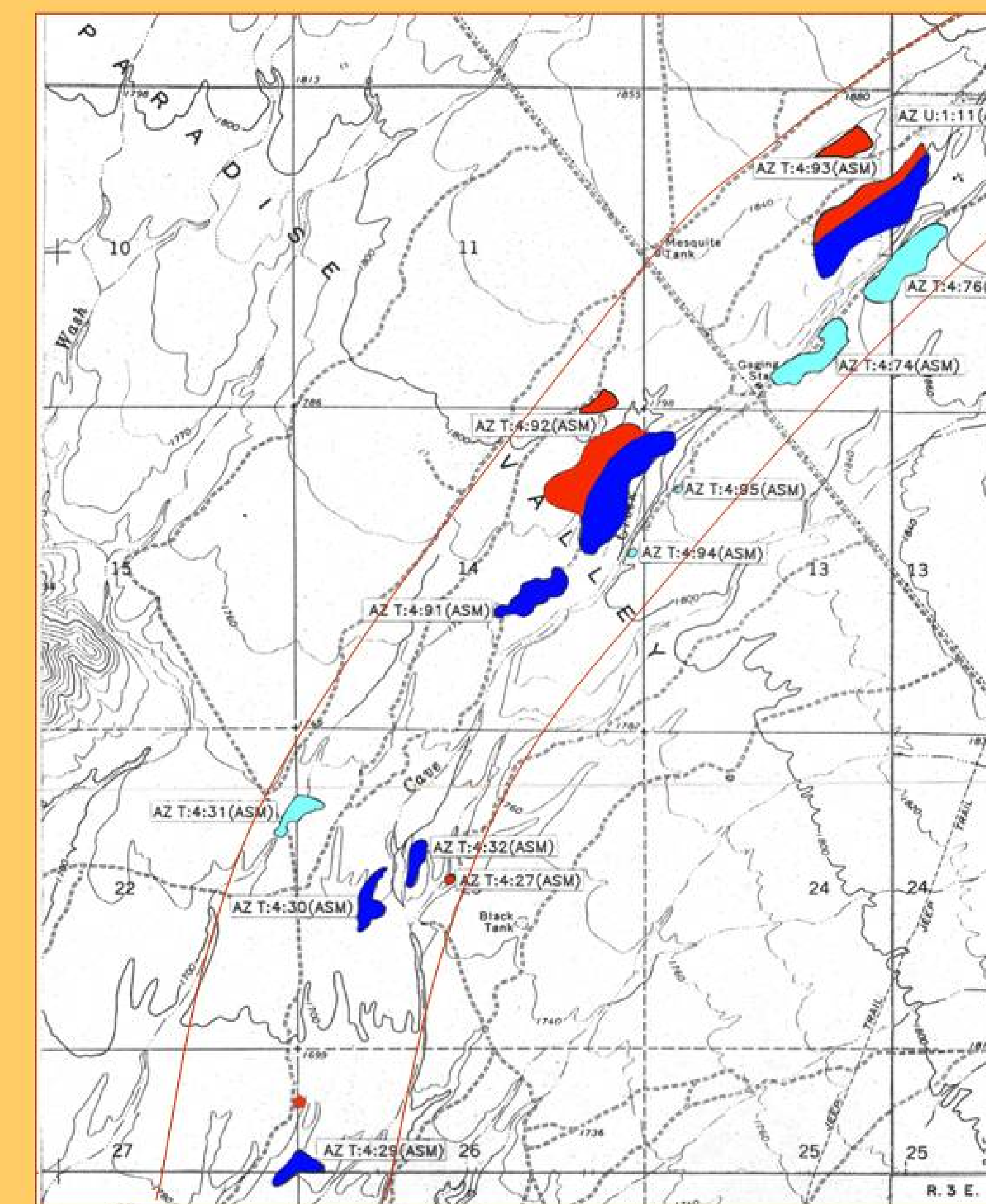


Comparison of the mean diameter and the distance between individual *L. tridentata* on and off fields:
 > Significantly greater mean distance between plants on fields ($4.9m \pm 2.8m$ vs. $2.0m \pm 1.8m$, $t = 5.1$, $P < 0.001$)
 > Significantly larger mean diameters of off-field plants ($1.9 \pm .9m$ vs. $1.3 \pm .5$, $t = 2.8$, $P = 0.005$)
 Error bars show standard error of the mean

Herbaceous species also showed changes in population distributions due to prehistoric farming:



Percentage of each species by location on and off-fields. Note the overlap of only seven species while the remainder are exclusive to location.



Topographic map showing archaeological sites along Cave Creek. Archaeological site areas indicated in blue are on the first terrace, orange are on the second terrace and light blue are on the third terrace. The brown lines represent the approximate boundaries of the study area, more archaeological sites on the larger landscape. The number of sites on each landform suggests an extensively fragmented landscape.

Consequences of anthropogenic fragmentation:

- ❖ Vegetation in anthropogenic patches on the first terrace show a full loss of cacti species and a reduction of the woody community from at least eight to one (only three were encountered in randomly selected transects reported in the graphs to the right).
- ❖ The density of woody individuals is significantly reduced within anthropogenic patches.
- ❖ Herbaceous species have significantly altered populations on and off anthropogenic patches.

Implications for the patch-dynamics in the study area due to landscape fragmentation:

- ❖ Loss of species results in a loss of propagule generation for all species except *L. tridentata* within anthropogenic patches, using the area as a rough approximation of species presence this results in an approximate 10% loss in reproductive opportunity for the woody community of the first terrace.
- ❖ The change includes fewer and smaller *L. tridentata* within the patches, likely further limiting seed production due to smaller sized individuals (this has not yet been verified).
- ❖ Reduced shrub density and structure likely reduces bird nesting and foraging within these patches as the diversity of resources is limited.
- ❖ Similar consequences are anticipated within rodent populations as well.
- ❖ The shift in woody populations and bird foraging habits may have implications for the insect populations as well.
- ❖ The shift in herbaceous populations may also have implications for bird, rodent, and insect populations depending on individual species food sources during periods of herbaceous growth.

In summary:

The fragmentation of the landscape by prehistoric human activities continues to have landscape-wide impacts on multiple species of vegetation, and very likely at different trophic levels. The successional process of long-lived desert species suggests that growth after the fields were abandoned was set on an altered trajectory, forming a new landscape with altered patch dynamics.

Summary

- 1) **Woody community:** The population diversity and density of woody and cacti species on the fields are substantially reduced on the fields compared off-field. Likely due to changes in the soil from prehistoric agriculture.
- 2) **Herbaceous census:** Species known to have been important food crops to the Hohokam showed a five-fold increase in population on the fields. The composition of the two populations was divergent in terms of the numbers of each species type.