



What Will the Cactus Forest Look Like in 2050?

Introduction

Saguaro National Park East (SNPE) was established in 1933 to protect the giant saguaro (*Carnegiea gigantea*) that dominated the landscape in the Rincon Mountains east of Tucson, Arizona. Repeat terrestrial photography of the “Cactus Forest” starting in 1935 shows a landscape nearly devoid of shrubs but with a uniform demographic of the giant saguaros. The decline in the numbers of larger, mature saguaro cacti that dominated the forest was documented beginning in the 1940s. Repeat photography is a simple, inexpensive, and effective way to monitor ecological change over time.

A repeated image from 2010 visually documented the dramatic decline in the number of saguaros in the Cactus Forest (Fig. 1). Scientific studies determined that woodcutting and livestock grazing prior to the establishment of SNPE prevented recruitment of subsequent generations of giant saguaro cacti until the 1960s, when the restored landscape led to an increase in trees, followed by an increase in the survival of very young saguaros. The objective of our 2012 study was to produce an image predicting the view of the cactus forest in 2050. To meet our objective, we utilized a combination of remote sensing techniques, field observations, saguaro growth models, and Adobe® Photoshop®.



Figure 1: Cactus Forest change from 1935 (top left) to 2010 (top right) and the predicted view in 2050 (bottom center). Photos taken from the Park’s Cactus Forest Loop Rd.

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Methods

We followed the field sampling protocols established in 2011 by Saguaro National Park for monitoring saguaros, and we recorded the coordinates and nurse tree species for all saguaros. Measuring each saguaro allowed us to use height-age equations from Steenberg and Lowe (1976) to determine current age and calculate height in 2050. The foreground of the photograph has the best potential for studying ecological change. A survey of the area determined that cacti greater than 350 meters away from the camera point could not be distinguished from the surrounding environment.

We used Photoshop to make the corrections to height and density for the 2050 image. The 2010 image served as the background. Cacti obscured by vegetation are placed relative to known cacti or visible physical features such as the road, parking turn-offs, and landscape features. Aerial photography also assisted with this procedure, resulting in a pseudo-triangulation of saguaro location. 64% of the surveyed saguaro cacti could be placed in the image using this method. The remaining 36% were either obscured by vegetation or could not be visualized with any confidence regarding location.

This project relies on several assumptions. First, we did not account for changes in climate affecting saguaro growth curves or saguaro mortality. Second, we did not account for any vegetation increase or decrease in density or change structure or composition. Third, we did not visualize any saguaros that may germinate between 2012 and 2050. The result is based solely on saguaros found in the field. Fourth, cacti that exceeded 160 years of age in 2050 according to the age-growth curve were removed and presumed dead.

Results

Our survey found 116 saguaro cacti within the photo area. 55.2% of the surveyed saguaro cacti are less than 1.8 meters tall (Fig. 2), indicating that the saguaro population is dominated by juveniles. Three saguaros were taller than 8.2 meters, and all three were assumed to be dead in 2050. Saguaro height ranged from .15 meters to 10.1 meters. This range increased to 3.91 meters to 12.63 meters in 2050 according to the growth curve calculations (Fig. 2).

Discussion

The 2050 image shows a significantly higher number of saguaro cacti will be visible above the shrubs in the foreground compared to the 2010 image. The saguaro cacti population will not return to the 1935 level for some time, but the predicted 2050 image provides some indication of what visitors can expect to see. The aesthetic quality of the Cactus Loop Drive is predicted to increase, ensuring that future visitors to Saguaro National Park will enjoy the view of the cactus forest. The stability of the landscape's physical geography along with the stewardship and conservation provided by the National Park Service adds significant confidence to the result.

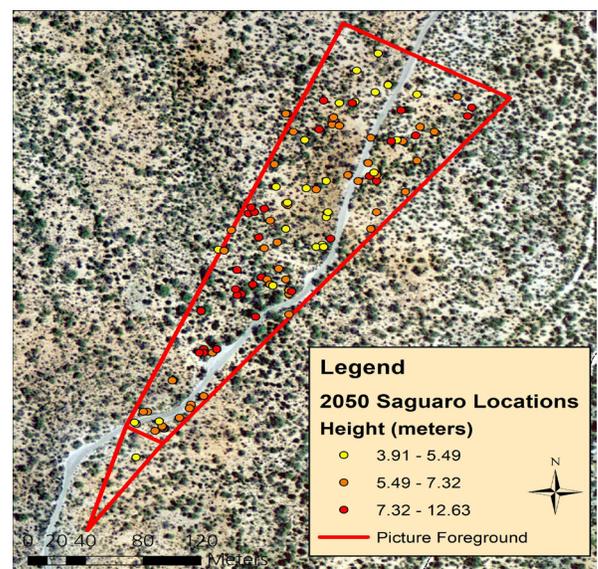
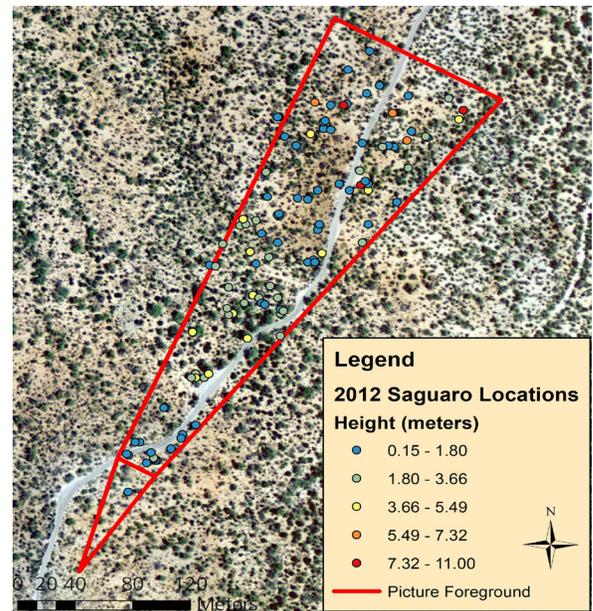


Figure 2: Mapped results of the saguaro survey (top) and the projected 2050 heights (bottom). 36% of the cacti found in 2012 will not be visible in 2050.

Conclusion

Recovery of a long-lived species population requires patience and monitoring over long periods of time. This study shows that recovery of the landscape is continuing. Management of the saguaro population and the disturbances that affect it must continue to mitigate the negatives and maximize the benefits to ensure that future generations of visitors to Saguaro National Park enjoy the cactus forest landscape.

More Information

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