



MINERVA: Studying Climate Change and Desert Vegetation

A Park to Protect Desert Plants

Joshua Tree National Park (JTNP) owes its existence to a woman who cared about desert plants. Minerva Hamilton Hoyt (Figure 1) grew up in Mississippi and moved to southern California in the 1890s. Decades later, in 1929, she was devastated when plant collectors dug up and carted away the grove of Joshua trees that had been her favorite desert camping spot. Hoyt became an activist, working to protect the rich diversity of plant life in the Mojave and Colorado deserts. Her efforts led to the creation of what is today a national park.

For the more than 730 species of flowering plants found in JTNP, illegal collecting is no longer an existential threat. Yet many plants here still face an uncertain future because of new human-caused threats: climate change, the spread of non-native plants, and unnaturally frequent, severe wildfires.

A recent study from the University of California Riverside predicts that with expected climate change, Joshua trees could almost completely disappear from the park by the end of this century. Other modeling suggests only a fraction of the park's pinyon woodlands will retain their oak trees. At least 17 other Mojave desert plant species are at severe risk from climate change, including rubber rabbitbush, Mojave mound cactus, fragrant sumac, and bigberry manzanita.

A New Research Program

With such losses predicted, can the special plant communities that define the park be preserved? In 2020 a team of scientists designed a new vegetation monitoring program that improves on past efforts with more statistically sophisticated sampling and new fieldwork protocols. Honoring the legacy of Minerva Hoyt, the program is



Figure 1. Minerva Hamilton Hoyt championed the creation of what is now Joshua Tree National Park. (NPS)

called MINERVA (Monitoring Inventory for Native, Exotic, and Rare Vegetation Assemblages).

MINERVA tracks plant species of concern both in the locations where they currently grow **and** in places where these plants might start growing as climate conditions change. JTNP biologists are using “future habitat” models, developed in collaboration with the University of California Riv-

erside Center for Conservation Biology, to detect whether certain target perennials shift their home ranges over time.

Data collected through MINERVA will help park managers decide what management actions are needed to preserve the plant species that are fundamental to the park's purpose—including the iconic Joshua trees.

MINERVA Project Goals

The MINERVA program will do the following:

- Gather baseline knowledge of the plant communities in the Mojave and Colorado Desert sections of the park. What species are present? Where do you find them?
- Figure out whether distinctive plant communities are changing over time. Which plant species are becoming more common? Less common? Are plants being lost from some communities? Are others starting to grow in new places?
- Determine whether known stressors such as climate change are affecting plant biodiversity in the park—and what the impacts are.



Figure 2. Pancake prickly pear (*Opuntia chlorotica*), a severely climate-threatened species and a target species for the project. (NPS / Hannah Schwalbe)

MINERVA Methods

Park scientists used "generalized random tessellation stratified" sampling (GRTS) to establish 120 MINERVA monitoring plots across the park. All the major vegetation types within the park are represented, including Joshua tree woodlands, juniper/pinyon pine woodlands, creosote and yucca shrublands, desert pavement, the park's few riparian (streambank) areas, and burned-over areas (Table 1). GRTS sampling will allow robust generalization of findings to the park as a whole, while also providing a detailed picture of strata of special interest (such as areas that have been accidentally burned).

Within each 100 m x 100 m MINERVA plot, three parallel 50 m transects are established 25 m apart. The transects are surveyed by biologists in spring and fall; observers walk the transects and use Line-Point Intercept (and for a subset of plots, Nested Frequency Frames) surveying techniques to determine what plant species are present and in what abundance. Soil surface and canopy cover information is also collected. 27 target species of shrubs and trees are surveyed on a five-year rotation (24 plots/year). Annual plants are surveyed in the spring.

Multivariate data analysis will be used to estimate the direct and indirect effects of stressors on plant communities (Figure 3). For example, invasive annual plants can sometimes outcompete native species (a relatively "direct" effect), but if areas with invasives burn more often and more intensely, fire damage there may also impact native plant species composition and abundance (an indirect effect of invasive plants).

Climate Study Collaboration

The Joshua Tree Climate Change Response Program includes researchers from Joshua Tree National Park, the University of California Riverside Center for Conservation Biology, the California Desert Interagency Fire Program, USGS Western Ecological Research Center, Mojave Desert Native Plant Program, the Joshua Tree Genome Project, and other organizations.

Vegetation Alliance Category	Key Plant Species	No. of Plots	# hectares in JTNP
Creosote bush-burrobush shrubland	<i>Larrea tridentata</i> , <i>Ambrosia dumosa</i>	10	122371
Creosote bush-brittlebush shrubland	<i>Larrea tridentata</i> , <i>Encelia farinosa</i>	10	70738
Juniper woodland	<i>Juniperus californica</i>	10	17599
Mojave yucca shrubland	<i>Yucca schidigera</i>	10	14746
Joshua tree woodland	<i>Yucca brevifolia</i>	10	14078
Desert pavement with annual wildflowers	<i>Geraea canescens</i> (desert sunflower), <i>Chorizanthe rigida</i> (spiny-herb)	5	11582
Burned areas	Varied species	25	11418
Pinyon pine woodland	<i>Pinus monophylla</i>	10	11148
Catclaw shrubland	<i>Senegalia greggii</i>	10	7893
Palo verde-ironwood woodland	<i>Parkinsonia florida</i> , <i>Olneya tesota</i>	10	5496
Smoketree woodland	<i>Psoralea argophylla</i>	5	2747
Desert lavender shrubland	<i>Condea emoryi</i>	5	1925

Table 1. MINERVA uses stratified random sampling to provide fine-grained analysis of factors such as whether an area has burned in the recent past. (NPS)

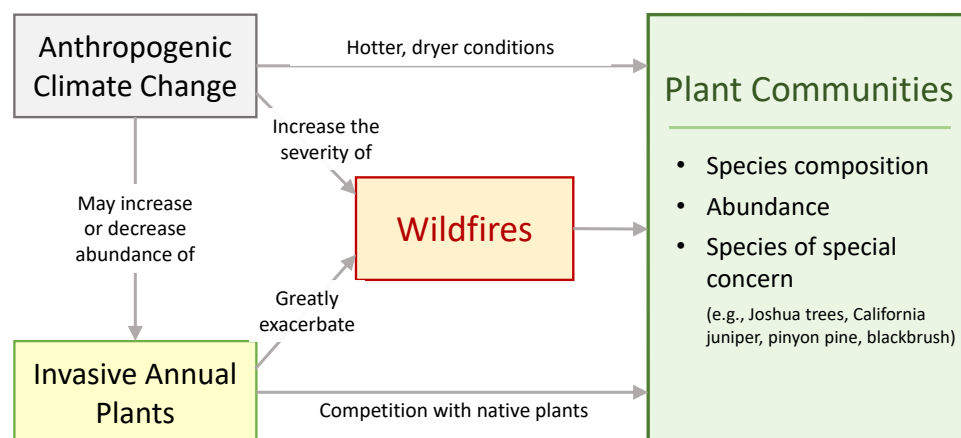


Figure 3. The MINERVA project is studying the effects of three major stressors on plant communities in Joshua Tree National Park. (NPS graphic)

Management Applications

Park resource managers are using the information gathered through MINERVA to devise and put in place strategies to protect threatened plants. For example, JTNP is already protecting "climate refugia" for Joshua trees—high-elevation locations that will remain relatively cool as climate warming progresses—by establishing firebreaks to turn away wildfires. Other actions include controlling invasive plants and restoring areas that have been damaged by fires, invasive plants, or visitor activities.

More Information

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