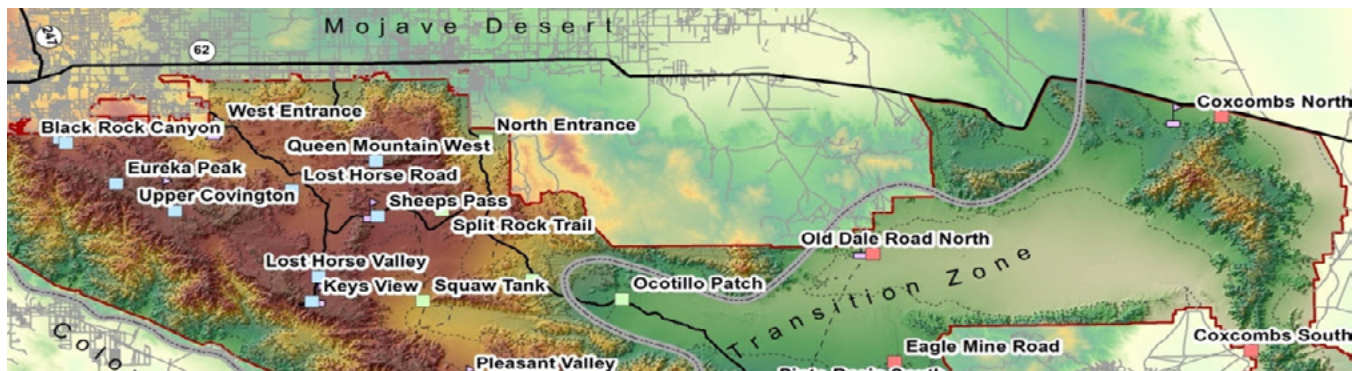




## Satellite Vegetation Analysis and Bird Biodiversity



Sites used in annual avian biodiversity monitoring at Joshua Tree National Park (NPS graphic / Tyler Green)

### Gauging the Effects of Climate Change

Resource managers at Joshua Tree National Park (JTNP) are concerned about changes in biodiversity in the face of climate change. They assess how plants and animals are affected by climate trends and develop management strategies to prevent losses. Traditional monitoring techniques that send highly trained biologists to make field observations of target species are essential for the effort. But this type of data-gathering is time-consuming and expensive, and JTNP is vast.

Remote sensing data may be a useful tool in this effort. A metric called the Normalized Differential Vegetation Index (NDVI), derived from satellite data, is already showing promise in other locations as an efficient way to study biodiversity across large areas. But only a few studies have evaluated this technique in the desert southwest. Could NDVI be a useful tool to assess avian biodiversity at JTNP?

To answer this question, researcher Tyler Green compared seven years of bird population data collected in the field at JTNP to remotely-sensed NDVI data for the same study sites. The bird field data are just one measure in a long-term climate change monitoring project called “Managing Species in Transition Zones” (MSTZ), a collaborative effort of JTNP’s Science and Stewardship Division and the University of California, Riverside.

MSTZ biologists monitor plants, reptiles and amphibians, and birds on 27 nine-hectare plots within the park. These plots are located in Sonoran desert, Mojave desert, and “transition zone” habitats and at a range of elevations, so they sample a variety of plant communities.

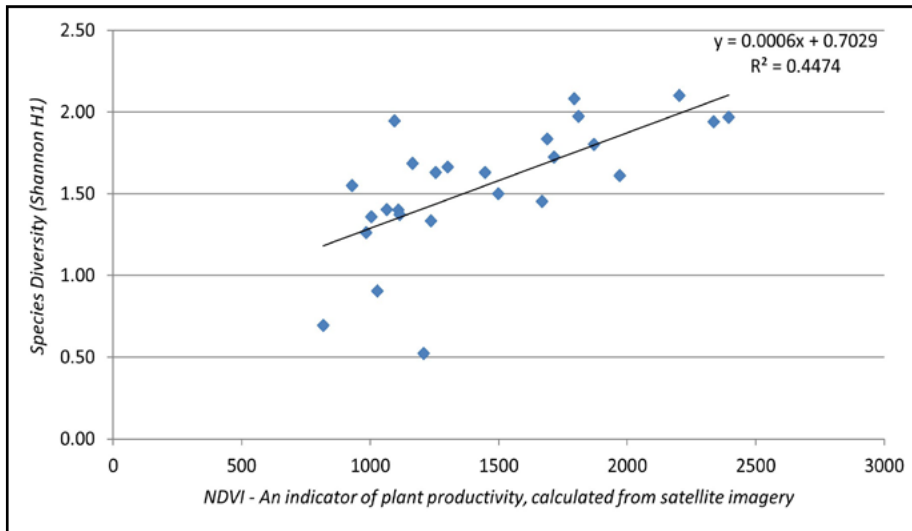
To measure bird population size and diversity, biologists survey each plot in the spring, at the peak of the breeding season for resident birds. They record the species seen or heard during a four-hour period in early morning, when birds are most active.

Green compared bird field data to vegetation measurements obtained by NASA’s Moderate Resolution Imaging Spectrometer (MODIS). This instrument is carried on the Terra and Aqua satellites, which together collect images from the entire Earth’s surface every 1 to 2 days.

NDVI is an index of the amount of near-infrared and red light reflected from the surface of plants; this value is linked to such metrics as net primary productivity (how much energy from plants is available to animal consumers). According to the “species-energy theory,” energy availability can explain much of the variation in “species richness”—a key component of biodiversity—in an ecosystem.



Black-throated sparrow, one of the most commonly observed species in this study (NPS Photo / Jane Gamble).



Scatterplot of bird diversity as a function of plant productivity (NPS / Tyler Green)

**Species Diversity** (“Shannon H1”) is a function of species richness (number of bird species counted) and abundance (number of individual birds counted for each species).

**NDVI** (Normalized Differential Vegetation Index) is a commonly used measure of photosynthetic productivity, calculated using satellite data.

The graph at left shows that NDVI is a good predictor of avian biodiversity at Joshua Tree monitoring sites.

## Results

Overall, Green found a statistically significant linear relationship between NDVI values and bird diversity at JTNP. That relationship is readily visible by looking at specific sites. For example, the study site with the highest average bird diversity (Queen Mountain West) was also the site with the highest NDVI in six out of seven years; meanwhile the Old Dale South site had the lowest NDVI value all seven years and also the lowest average bird diversity.

Averaging all 27 plots across the seven years of the study, mean bird diversity was the highest in the years with highest mean NDVI. And both sets of data showed that avian diversity generally increased with elevation—supporting an observation often noted by park biologists.

Desert precipitation is extremely patchy, meaning that capture and direct measurement of rainfall at a limited number of sites may paint an incomplete picture of climate at the landscape scale. Measures like NDVI provide a gauge of the availability of water over time in the vegetation of leaves, and can be assessed over large areas, including remote and wilderness locations where regular direct observation may be difficult or inadvisable.

## Why This Research Matters

Healthy, biodiverse ecosystems clean the air we breathe, protect supplies of fresh water, and ensure that soils are stable and fertile. But around the globe, scientists are documenting losses of biodiversity. In the Mojave Desert, bird communities have declined dramatically over the past 100 years. Desert birds are particularly threatened by warming climate trends. While they’re already adapted to hot, dry conditions, they may be physiologically unable to cope with even more extreme environments.

To protect biodiversity, biologists need to know what species are present and how species composition changes over time. Resource managers at Joshua Tree and other parks are charged with tracking ecological change across sweeping landscapes and in challenging desert terrain. Metrics like NDVI are promising tools for accurately monitoring changes in habitat and bird species diversity.

And remote sensing of biodiversity is cost-effective. Data are available from a number of sources, often at no charge. Viewed alongside bird population data, NDVI appears to be a relatively fast and cost-effective way to expand monitoring efforts and to inform work that impacts biodiversity, such as fire management and invasive species removal.

## More Information:

For general information about scientific research at the Park: <https://www.nps.gov/jotr/learn/nature/research.htm>

To learn more about this specific project and other climate change research at Joshua Tree National Park, please contact Michael Vamstad, Wildlife Ecologist, Joshua Tree National Park, 74485 National Park Dr. Twentynine Palms, CA 92277.