Using Monkeyflowers to Understand Adaptation to Climate Change

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Plant and animal populations typically perform best in the particular environments in which they evolved. However, climate change is now disrupting the fit between organisms and their environments, leading to population declines for some species. Natural areas loved by people and required by native species are being drastically and rapidly changed as key species are lost.

Photo: Steve Matson

But, if a species has enough genetic variation in traits allowing survival and reproduction in a changing climate, then natural selection (evolution) may help populations persist. E.g., if there's wide variation in genes controlling flowering time, or drought hardiness, a species may naturally be able to evolve rapidly with climate change. In such cases, a species may be capable of evolutionary rescue without human intervention.

Evolutionary rescue could also be facilitated by humans by actively increasing the amount of genetic variability for a species in a given locality by introducing genotypes from different elevations, latitudes, or habitats to increase the odds the species will persist. The results of this study will provide policy makers and conservation managers tools to evaluate the potential benefits and likelihood of success of evolutionary rescue to help species endure climate change.

The PIs will measure plant performance and the speed of evolutionary response of **scarlet monkeyflower (*Erythranthe cardinalis*)** to the major, multi-year drought that took place between 2011-2016 in the western United States. This project will also provide training in ecological, evolutionary, and statistical concepts and approaches for high school students, undergraduates, graduate students, and postdoctoral researchers, including those from underrepresented groups. In addition, for the Batterson study plot, this is a marvelous opportunity to educate Forest Service employees and the local public about methods of predicting responses of plants to climate change, and to learn about the science behind it.

Although adaptation by natural selection and population growth trends are typically studied separately by biologists, they are fundamentally connected by fitness (e.g., seed production) of individuals in a population. In declining populations, the average individual's fitness is generally low, and individuals do not have enough offspring to replace themselves. However, if individuals differ genetically in critical traits (e.g., how much water they need), this can allow adaptive evolution, boost fitness, and lead to increased population growth or at least sustainable populations.

Adaptive evolution! An important question is whether populations of native species can adapt to a changing climate fast enough to avoid population declines. This study will test the success of scarlet monkeyflower plants grown from seeds collected before and after the mega-drought from across California and Oregon in three common gardens (S. Cal, Central Sierra, S. Oregon) to see if populations are adapting to climate change in different parts of the species' range. The PIs will determine if natural selection during the drought led to increased plant performance, and whether this change was greatest in populations that started with the most genetic variation for drought-related traits and overall fitness.

For more information about the research, or to schedule a field presentation, please contact Joanna Clines, Sierra NF Botanist at 559-760-3618 or Dr. Jason Sexton (UC Merced) at 209-985-5299