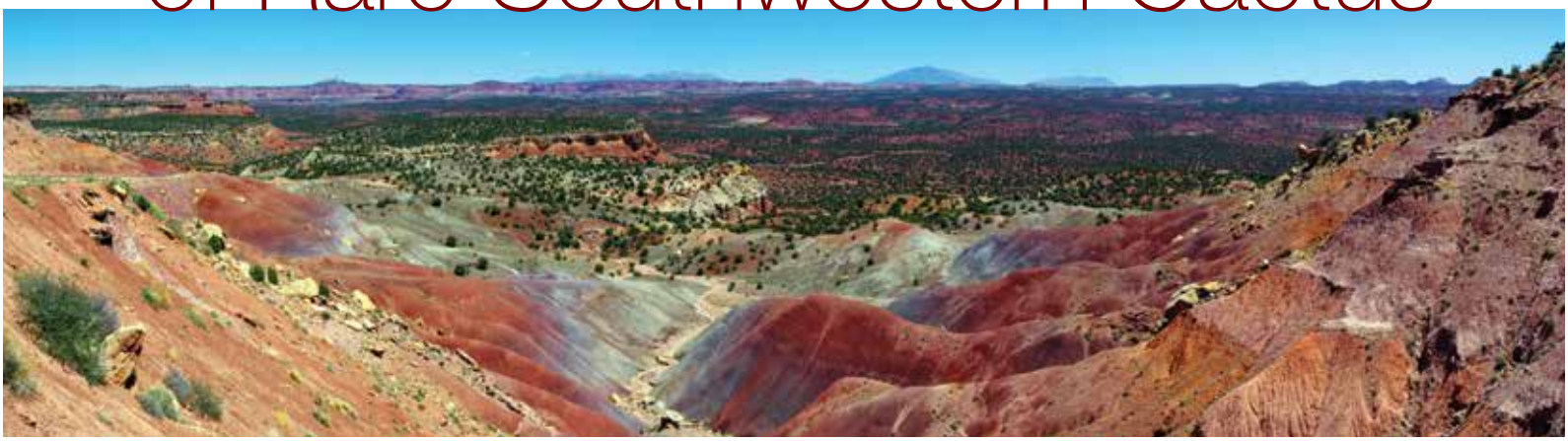
Garden Scientist Maps Future of Rare Southwestern Cactus



Driving through the deserts of the American southwest in a dusty pickup truck, Chicago Botanic Garden post-doctoral research associate Shannon Still is on a quest to predict the future. He is not reading tarot cards, nor does he claim to be the next Nostradamus. He does, however, have a fairly good idea of where *Pediocactus sileri,* commonly known as Siler pincushion cactus, will live in 2050. That place is about five miles east of where it lives now.

Garden scientist Shannon Still photographs a species of cactus. (Top, left to right): Escalante National Monument, west of Capitol Reef National Park, south-central Utah; Jones catseye (Cryptantha jonesiana)*; Siler pincushion cactus* (Pediocactus sileri)*; at the San Raphael Swell, south-central Utah.*

The prickly 1½-foot-tall, pincushion-shaped cactus is extremely rare—just 30 known occurrences totaling approximately 10,500 plants are known in the world. It grows in the hot, dry gypsum habitat of the Arizona Strip, just north of the Grand Canyon, and if Still's bioclimatic models are correct, it will drift steadily east over the next century, following the path of its shifting ecologic niche. In other words, it will migrate to a habitat where it can survive.

Recently, inside the Garden's Daniel F. and Ada L. Rice Plant Conservation Science Center, Dr. Still unfolded plant population maps of the western United States and gestured to known species locations. Arrows on the maps aimed in dizzying directions—the route he predicts plants will travel over the next ten, 40, and 70 years. A popular theory among scientists is that as the planet warms, plant populations will migrate north and to higher elevations. Yet, Still is finding a more bewildering pattern. "What I'm seeing is that distribution goes every which way. We're not seeing a consistent migration direction, and the majority of distributions are getting smaller," he said.

For many plants, warming trends will amount to only a modest shift in the distribution of their suitable habitat—a species niche may move five or ten kilometers north over a period of 50 years. Nevertheless, the change is significant. Many of the cacti Still studies, vulnerable to illegal harvest and threatened by the potential for overharvest and regional development, could lose up to 95 to 100 percent of suitable habitat by 2080. And, if carbon dioxide emissions continue according to widely used global climate change scenarios, 75 percent of those plants would lose suitable habitat by 2050. That means that the native habitat for commercially viable plant commodities—Arabica coffee beans in Ethiopia, for example—may become extinct as once-fertile habitat becomes unsuitable for growth.

The son of a horticulture professor emeritus at Ohio State University, Still has seen evidence of climate change cohere over the past decade. With support from a three-year grant from the U.S. Department of the Interior Bureau of Land Management, he is working to create species distribution models for more than 400 rare sensitive species, including cacti, penstemon, yellow-flowered desert poppy *(Arctomecon californica)*, and nakedstem sunray *(Enceliopis nudicaulis)*. Much of his work takes place in the Garden's GIS (Geographic Information System) Laboratory, where he uses sophisticated computer algorithms and global climate change scenarios to show where plants are likely to live now and to predict where they may live in the future.

The real fun, however, takes place on the ground. Since 2012, Still has spent eight weeks with research assistant Nick Jensen on field validation trips to the Mojave Desert, the eastern Sierra Nevadas, and portions of Nevada, Utah, and Arizona. In areas his distribution models predict are suitable for a species—approximately one-square-kilometer parcels—he searches for the target plant and notes other rare and common plants in the area. He records the geographic location and notes the number of plants, their flowering stage, other plant species, soil and vegetation types, and anything remarkable about the location.

This important part of Still's research, "ground truthing," is used to determine whether plants actually live in the locations computer-based models have determined to be their suitable habitat. Presence locations, or known locations where a plant is found, provide the suite of environmental conditions that a species currently inhabits. Absence locations, or areas where the species is known not to occur, are also important. Having both can improve distribution models by increasing understanding of a plant's ecological niche. In some cases, a plant may not have a virtual species record, but Still will discover it while combing the earth. His fortuitous encounter with a population of 300 *Pediocactus sileri*, a three percent increase in all known individuals, happened through ground truthing.

Continued on next page