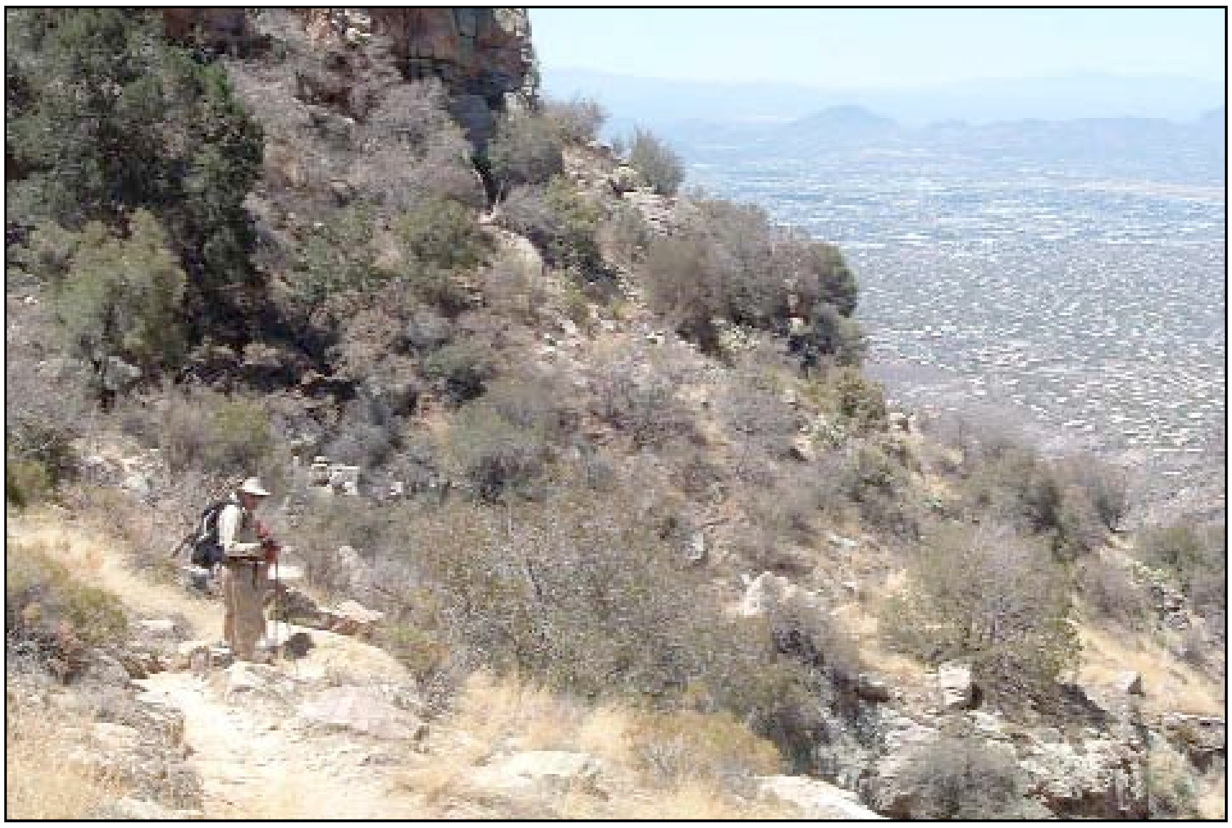
Five Miles & Twenty Years Later… Dave Bertelsen's Amazing Data Set

by Theresa M. Crimmins, from data collected by Dave Bertelsen



Plants observed in bloom in mile 5 of the Finger Rock/Mt. Kimball trail, Santa Catalina Mountains *courtesy Ben Wilder.*

Week after week, month after month, for the past twenty-some-odd years, Dave Bertelsen has quietly and doggedly hiked the same trail in the Santa Catalina Mountains. The trail is a butt-kicker — the Finger Rock trail climbs over 4,000' in its five mile traverse from the north terminus of Alvernon Way to the peak of Mt. Kimball. But making this hike over 1,000 times in a 20-year stretch isn't Dave's only feat — every time he's hiked the trail since 1984, he's kept track of every single grass, cactus, shrub, flowering plant, and tree that he's seen in bloom within each of five, mile-long trail segments.

Unknowingly, Dave has collected an extremely valuable phenological record. Phenology refers to the seasonal timing of life cycle events such as leafing and flowering in plants and migration and egg-laying in animals. Phenological records of plant and animal life cycle events are strong indicators of ecosystem response to environmental change. Dave's meticulous documentation, resulting in more than 111,000 records of nearly 600 taxa of blooming plants over a 20-year period along an elevation gradient, is an incredibly rare and rich dataset. Typically, long-term studies focus on a few target species. Conversely, comprehensive studies such as floras aim to document all species in one location, but are generally short-term (1-2 years) in scope. Dave took the best of both approaches, documenting all species in bloom for an uncommonly long duration. The fact that Dave attributed his observations to mile-long segments, which roughly correlate to the different biotic communities found along the gradient, adds yet another welcome dimension to this dataset. The elevation gradient captured in this study is roughly equivalent to a latitudinal transect ranging from southern Arizona (desert communities) to southern Canada (conifer forests).

I was very lucky to have met Dave a few years ago at a meeting of local environmental organizations and to learn of his efforts. At the time, he was unsure that his meticulous recordkeeping held scientific merit. I have since had the pleasure and honor of working with Mike Crimmins, a climatologist with the University of Arizona, and Jeff Balmat, a geographer and physical science technician with the National Park Service to explore Dave's dataset and to demonstrate to him just what a gold mine his observations are!

Dave's remarkably rich Finger Rock record has allowed us to explore relationships between the plants observed in bloom and climatic variables as well as spatial and temporal shifts in flowering patterns. In initial analyses, we found that the number of plant species observed in bloom in the low elevations, primarily desert scrub and scrub grassland communities, was influenced mainly by the amount of precipitation in concurrent and preceding seasons. Wet winters yielded more species in flower in spring; wet summers encouraged more summer plants to bloom. In contrast, the number of species observed in bloom in the higher elevation communities was much more a function of temperature. In the woodland and conifer forest communities of the highest miles, the great majority of plants observed in bloom occurred in summer months. Warmer summer temperatures prompted more species to flower than cooler temperatures; this is a pattern that is consistent with plant communities in temperate and montane plant communities found at higher latitudes.

Because Dave recorded every plant species in bloom rather than just a few target species, we are also able to explore patterns and look for changes in the composition of the plant communities observed in the five miles. One pattern that stood out to us was that the list of plants Dave observed in flower in exceptionally dry years was very low, but that even moderately wet years yielded similar species lists to very wet years. Many recall the springs of 1993 and 1998, reported as "good" and "great" wildflower years in the Sonoran Desert, respectively; the carpets of poppies and lupines seen in bloom in these years were the result of wet winters. Within Finger Rock canyon, Dave observed many of the species in bloom in these outstanding years in a lot of "mediocre" (average rainfall) years too. The upshot: winters with only moderate precipitation can still induce flowering of many of the same species as very wet winters, just not in the same abundances as these notable years.

Another pattern observed at the highest elevations really jumped out. Over the 20-year study period, average summer (defined as July, August, and September) temperatures steadily increased. Interestingly, the number of plant species observed in bloom in the highest mile in the summer also steadily increased. In addition, a gradual shift in the composition of species was observed over the course of the study. Together, these findings suggest that increasingly warmer average temperatures are producing conditions favorable for greater numbers of plants to flower in summer in forested communities. Dave's dataset is not alone in demonstrating what may be the effects of a warming trend. Many other long-term phenological records collected around the globe have documented changes in the timing of key events, suggesting increasing global temperatures as the driving force.

One key reason the Finger Rock dataset holds such value is that we have it *now*.
Dave's dataset is providing us with a window into changes already taking place in the Catalina Mountains, changes we would not be able to detect probably for several more years, if monitoring was just getting started. However, there is a great need to have this kind of information in-hand *today*, to inform policy, planning, and legislation. Existing datasets can provide the basis for understanding the changes that may already be occurring.

This story is a premier example of a valuable but increasingly more common partnership between a dedicated volunteer collecting data and scientists analyzing it. Unpaid individuals contributing to scientific knowledge in this capacity fall under the general heading of "citizen scientist", which runs the gamut from individuals participating in organized efforts such as Master Gardeners and Watershed Stewards to devoted, solitary data collectors such as Dave. The efforts of these committed individuals are a key contribution to furthering the scientific understanding of our ecological systems. Dave's Finger Rock dataset is far beyond what many scientists could dream of collecting; we have only scratched the surface of how it can be analyzed. We will continue to glean valuable information from this phenological gradient study for many years to come.

Theresa M. Crimmins is adjunct faculty with the Office of Arid Lands Studies at the University of Arizona.