Welcome to the Anthropocene

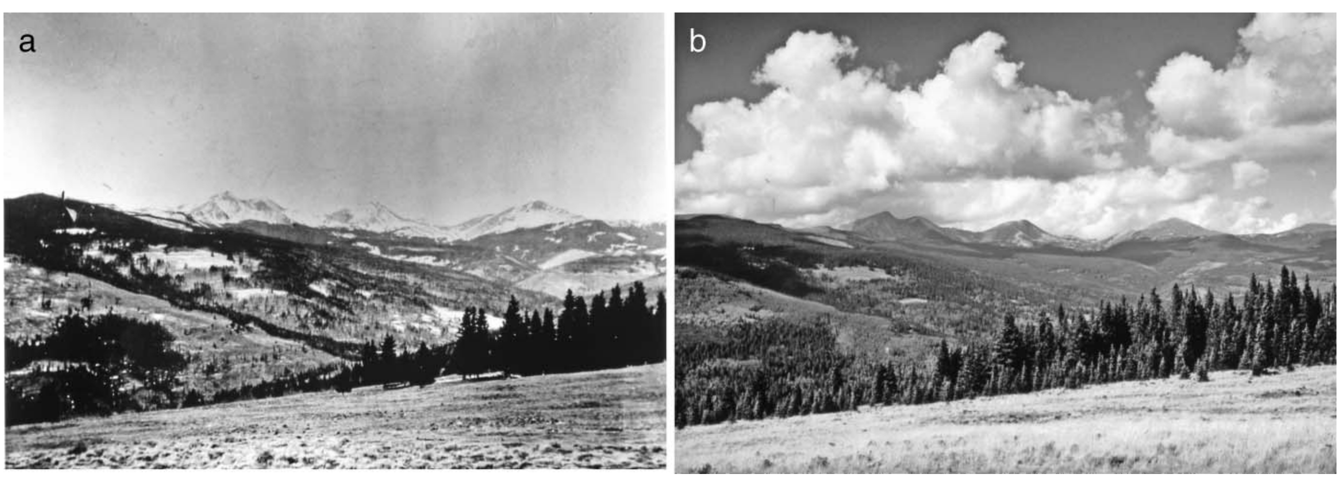
Notes on the Vegetation of the Southwest, Past and Future

By William deBuys, Special Guest Contributor

The land is changing; the land has always changed. But the parameters that limit the working of observable change are also mutable, and they appear to be changing now. As a society, we may be entering a period when the range of changes we experience in the land around us becomes unbounded, and the changes themselves become harder to predict, harder to live with, and, for many of us, harder to accept.

In the summer of 1903 Vernon O. Bailey, a wiry, owlish Midwesterner of 39 years, stood atop 12,529-foot Pecos Baldy in what is today the Pecos Wilderness northeast of Santa Fe, New Mexico. He looked out over a turbulent mountain sea of craggy peaks and high-altitude forest and judged that the forest "has been sadly thinned by burning, fully three fourths of it having been burned over and a large part of the coniferous forest replaced by poplars [aspens] or kept open by repeated burning for grazing land."[1]

He made similar observations in the Taos Mountains: "The greater part of the forest has been burned over one or many times and now stands as a mixed second growth of poplars and spruces or as dense poplar groves or tangled



Left, a view of Truchas Peaks from Hamilton Mesa, 1904, in what was then Pecos River Forest Reserve, northeast of Santa Fe, New Mexico. Photographer unknown. Note extensive evidence of wildfire. **Right,** same view in today's Pecos Wilderness by Steve Tharnstrom, 1997. Both photographs courtesy of the US Geological Survey Jemez Mountains Field Station.

windfalls of bare logs."[1] And near the headwaters of Coyote Creek in the Jemez Mountains:

> *Even the woods are so sheeped out as to present bare ground and bare trunks. The timber has been burnt off as far as possible, but fortunately the yellow pines stand burning pretty well and have not been injured much while much of the higher spruce forest will not burn.*[2]

As chief field naturalist of the US Bureau of Biological Survey, Bailey was an expert observer. Over a span of nearly five decades, he wandered the deserts, mountains, and prairies of North America almost continuously. It was said that years of camp life so ingrained in him the habit of blowing sand off his dinner plate that he persisted in the practice, much to his wife's dismay, even in their fashionable home on Kalorama Road in Washington, DC. Perhaps it was a field man's way of saying grace.[3,4]

If Bailey could come back to Pecos Baldy today he would see a far different landscape. Until recently the percentage of burned land observable from Pecos Baldy was essentially zero. The scars of the Viveash Fire of 2000 (29,000 acres) and the Borrego Fire of 2002 (13,000 acres) may have lifted that number by a digit or two, but Bailey would surely be impressed by the dense uniformity of the spruce and fir forest on the mountain slopes and by the relative decline of grassy parks and young aspen that he viewed in 1903.

Bailey also took note of the degraded condition of the territory's lower elevation rangelands. Of the Llano Estacado near Tucumcari he wrote, "Long drouths [sic] and over stocking have made some of the valleys almost barren."[1] He began a 1908 report entitled "Improvement of Public Range" by writing,

> *The arid valley range in New Mex has long been over stocked with cattle, sheep, and horses: the best grasses have been killed out and fully half the range rendered almost worthless. Mile after mile of bare ground may be found in many of the valleys or of ground bearing only weeds and worthless vegetation that stock cannot eat.*[5]

Bailey was hardly alone in his dire assessment. Other observers like Elmer O. Wooton described New Mexico's ranges in equally negative terms.[6]

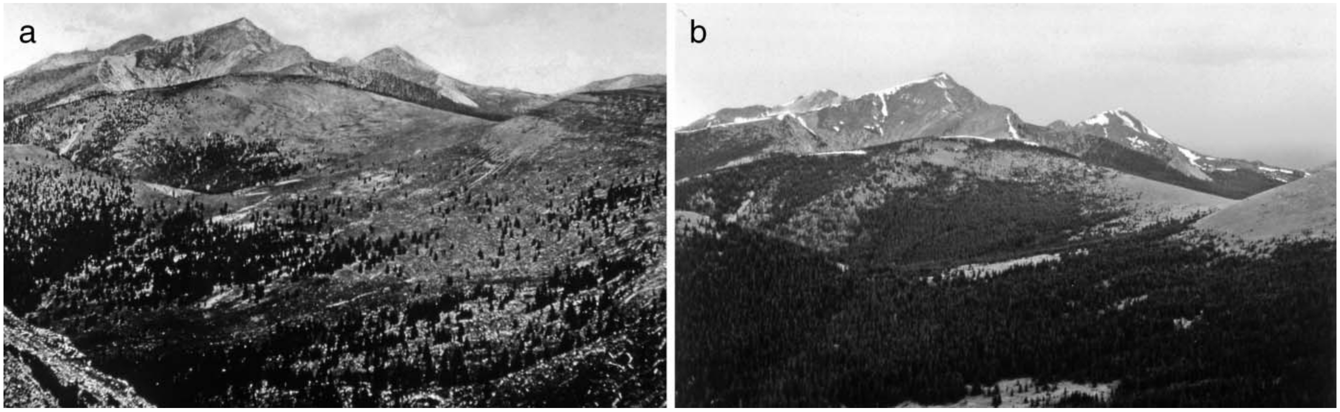
Bailey assessed the lands of the Southwest at a time when they were undergoing rapid, often alarming alteration. The railroad had arrived in the region only two decades earlier (reaching Las Vegas, New Mexico, in 1879), and mining, timbering, agricultural, and grazing operations quickly proliferated in response to new links to distant markets. As economic activity increased, so did human population and settlement, and the resultant impact on the land, unmitigated by any significant government activism, was profound, extensive, and by most standards broadly negative.[7]

If Bailey could come back to the world of the living and retrace his steps, he would be pleased to see that many of the barren ranges he visited in the early years of the twentieth century have much improved their condition. He might be surprised, however, that many other rangelands are no longer recognizable as grasslands. The widespread succession of arid grassland to shrubland dominated by mesquite, tarbush, and creosote was well begun in Bailey's time but still had far to go. In 1915, for instance, a quarter of the Jornada Experimental Range north of Las Cruces remained brush-free, but by 1963 that proportion would be zero.[8] While the phenomenon was hardly unknown in his time, Bailey does not write about "flips" of land from one type of ecosystem to another. Although his familiarity with the region was encyclopedic, his experience in any single area tended to be brief, and the violence of rapid impacts like fire and intense overgrazing easily muted the signal of slower, long-term changes.

Anyone who envies Vernon Bailey for his opportunity to have witnessed the lands of the Southwest in a period of dramatic and extensive change should find the present an excellent time to be alive—so long as he or she does not find the widespread "creative destruction" of landscapes too discouraging. Over the past 12 years, New Mexicans have seen a resurgence of stand-changing, so-called catastrophic fires, especially in the ponderosa pine zone of the Jemez Mountains. The Dome Fire of 1996 burned 16,500 acres, the Oso Complex Fire (1998), 5,185 acres, and the Cerro Grande Fire (2000), 48,000 acres, along with more than 200 residences in the town of Los Alamos. Together with the La Mesa Fire of 1977 (15,000 acres), these fires have largely consumed the pine zone on the east face of the Jemez mountain range. Moreover, they have opened "holes" in pine habitat so large that ponderosa pine is ill adapted to recolonize them. The emerging vegetation of these sites remains a subject of continuing interest and uncertainty.[9]

It is no small irony that the destruction of this resource is an indirect result of the single most consistent strategy undertaken by land managers to protect it, namely, fire suppression. In similar fashion the Rodeo-Chediski Fire redefined many people's idea of "big" for a Southwestern forest fire by burning 462,614 acres of mostly pinelands in central Arizona in 2002. Even the Rodeo-Chediski Fire, however, was small compared to the extensive pine mortality in Arizona and New Mexico caused by Ips bark beetles in 2003. Diebacks in the two states totaled 2,609,475 acres among both ponderosa (26.6% of the total) and piñon pine (73.4%).[10]

Neither extensive fires nor beetle kills, nor certainly drought, which was an underlying cause of both, are new to the Southwest. Long before he was a best-selling author of mystery novels, Tony Hillerman worked as a beat reporter for the Santa Fe *New Mexican.* In 1957, at the height of the twentieth century's worst drought in the Southwest, he filed a story that could easily have been written 46 years later: "Two species of bark beetles, working as a deadly team, are stripping a vast area of Northern New Mexico of its piñon and ponderosa pine. … Approximately a million acres of trees are already dead or currently being killed" (C. D. Allen



Left, South Truchas Peak viewed from East Pecos Baldy, Pecos River Forest Reserve, New Mexico, 1903, by Vernon Bailey. **Right,** same view by Steve Tharnstrom, 1999. Note substantial upslope advance of timberline. Both photographs courtesy of the US Geological Survey Jemez Mountains Field Station.

and D. D. Breshears, unpublished manuscript, 2002, p. 12–14).

The beetle outbreak was only one of the legacies of the 1950s drought. Another effect was the retreat of the lower limit of the ponderosa pine zone. On the Pajarito Plateau, home to both Los Alamos and Bandelier National Monument, the ecotone between the ponderosa pine forest and the piñon-juniper woodland shifted upslope 2 kilometers or more, as pines succumbed to drought, and piñon and juniper occupied the territory of the dieback.[11]

The landscape-scale changes of the drought of the 1950s manifested over the course of nearly five years. The dieback of 2002–2003, in which extensive mortality among other trees, shrubs, and grasses was also noted, seems to have occurred significantly faster, and the apparent cause of the increased velocity of change carries important implications for the future.

The key variable was temperature. Although the 1950s drought was drier than the drought of 2002–2003, the more recent episode was hotter, as determined "by several metrics including mean, maximum, minimum, and summer (June-July) mean temperature."[12] Craig Allen, a research ecologist and station leader of the US Geological Survey Jemez Mountains Field Station at Bandelier National Monument who has studied the ecology of the Jemez Mountains for over 20 years, characterizes the drought of 2002–2003 as a "global-change-type drought," an artifact of a warming planet. Bearing in mind that the temperature increase at play in that drought was 1–1.5°C and it produced changes more extensive than the drier and longer 1950s drought, he asks, what kinds of changes might we expect from a background temperature increase of 2° or 3°C? What happens, if as some climate change models predict, the average temperature of the Southwest increases by as much as 4°C (7.2°F) by the end of the century? Allen adds,

> *Something the climate models don't address well is extreme values, as these increases are projected mean temperature increases; they are not the extremes. But we have good reasons to believe that the extreme values are going to be more extreme—and those are the filters that will determine the life or death of individual plants and possibly whole systems. That's why I believe the climate models may be too conservative in terms of projecting potential ecological effects.*

Nightmarish scenarios follow from these data: multiyear drought punctuated by intense heat waves leading to rapid ecosystem diebacks that in turn trigger other nonlinear processes of erosion and fire.[13] Where might such cycles of change lead?

One of the things that Darwin's critics disliked most about *On the Origin of Species* was that the process of evolution, driven by natural selection, had no destination. It was purposeless. It just happened, perpetually evolving "endless forms most beautiful and most wonderful." The march of species would go on forever, but it would never *arrive* anywhere in particular.

The English philosopher Herbert Spencer (1820–1903) solved this problem by excising the inconvenience from Darwin's inconvenient truth. In applying Darwin's theory to the development of human society, Spencer glossed over the disturbing indefiniteness of natural selection and produced a set of beliefs that came to be known as "Social Darwinism." He argued that if the "survival of the fittest" (his phrase, not Darwin's) were allowed to run its course without the unnecessary coddling of the unfit, the result would be the perfection of civilization, with the fittest in charge and everyone else appropriately in his or her place. Spencer replaced Darwin's infuriatingly open-ended selective process with a utopian vision. He gave the future a locatable address. Happily for Spencer, his vision was also conveniently well tailored to the interests of the moneyed classes, which assured him celebrity and his ideas an enthusiastic audience at the apogee of the Industrial Revolution.

Ecology, as it developed, produced its own brand of teleology. Popular concepts like "the balance of nature" promised the existence of a set of conditions embodying how things were "supposed to be."[14] The theories of Frederick Clements concerning climax states delivered a similar kind of comfort, if in more sophisticated terms. The climax ecology of a given site represented the site's fully realized potential. It was a destination. It did not just happen. It was nature's plan. And if by chance the climax community was disturbed or even destroyed, nature would reassert its intentions by the deployment of one or more seral communities leading back to reestablishment of the climax.[15]

Experience, however, has shown that actual ecological systems are much more variable than Clements' schema allow. Chance, for instance, plays a significant role in determining what species, whether native or introduced, establish themselves after disturbance, and the effects of that particular development in a site's natural history can ramify onward indefinitely. Moreover, seral and climax communities frequently overlap each other, sharing species and responding to successive disturbances according to their (contingently determined) composition at a given time. Other systems can "flip," as in the case of desert grassland succeeding to mesquite shrubland, demonstrating the potential for multiple "climax" states.[16]

As Clementsian climax theory fell out of favor, ecologists increasingly resorted to concepts such as "range of natural variability" to bound their understanding of a system's innate potential. Ideas about "natural variability" that embody the needed virtues of dynamism and inclusiveness also helped shape management goals.[17] But for such an idea to have utility, the range of variation must have reasonably fixed boundaries, which in turn are largely set by climate and edaphic factors. When climate substantially changes, those boundaries weaken and dissolve, and "range of natural variability" wobbles off course like a satellite in unstable orbit.

Earlier this year P. C. D. Milly and a handful of other authors published "Stationarity Is Dead: Whither Water Management?" in *Science.* The paper quickly became a sensation. Stationarity—a one-word synonym for "range of natural variability"—has met its end, they say, "because substantial anthropogenic change of Earth's climate is altering the means and extremes of precipitation, evapotranspiration, and rates of discharge of rivers."[18] The upshot for water managers is that they must develop new "probabilistic models" on which to predict future resource availability, design reservoirs, and defend against floods. Unfortunately, the new models must not depend on expectations that the past will provide a template for the future. But if not the past, then what? For the present, no one seems to know. Like the often-warned individual investor, the water managers addressed in the Milly et al. paper must bear in mind that "past performance is no guarantee of future results."

The problem for the rest of us—ecologists, ranchers, land managers, everybody with a tie to the land—is that we are in the same boat as the water managers.

Darwin's inconclusiveness has pervaded an increasingly broad range of efforts to assess the natural world: we don't know where many of the systems on which we depend are headed. No matter if you put your money on the poleward expansion of Hadley cells[19] or the interactions of the Pacific Decadal Oscillation and the Atlantic Multi-Decadal Oscillation,[20] the biggest bets on the future climate of the North American Southwest are for a hotter and drier environment.[21–23] If these general predictions prove true, the resulting stress on natural systems will likely exceed anything known from recent times, and if the drought of 2002–2003 is any indication, the potential for widespread mortality in multiple vegetation types will be high.

The results that ramify onward from the fires and diebacks of the future will challenge and perhaps defy our skills of prediction, let alone our abilities as "managers" (a term with an increasingly ironic ring). People with attachments to land—a group that includes virtually all of us—may find this new state of affairs distressing, as familiar landscapes metamorphose into new and unanticipated assemblages.

Like ripples in a pond, the waves of ecological change will propagate outward, each from a different point of origin, and each intersecting with countless others, generating a continuously dynamic topography of waves and energy that will exist in any given state only momentarily. Such a prospect goes against our craving for order and our hunger for purpose. It is too random and too arbitrary. It is mapless and trackless. It is wilderness. It is a journey of discovery into the vast uncertainty of the possible. We are likely to find it both disorienting and fascinating.

The Geological Society of London, founded in 1807, is the oldest national learned society for the earth sciences in the world. Last June its "Stratigraphy Commission" reported that the impact of human-induced change on the planet "has so intensified to make our present interval comparable to major global perturbations of the geological past." The commission further suggests "that a new geological epoch, worthy of formalisation, may indeed have commenced."[24] The members of the commission are not merely alluding to the age-old human capacity to alter ecosystems. Rather they seek to draw attention to something new under the sun: a cumulative human effect on core planetary processes, especially climate. The Geological Society bids us to say good-bye to the Holocene, which was the birthplace of civilization and of the turbulent world known by Vernon Bailey.

For better or worse, our time—a new time—has come. Say hello to the Anthropocene. And fasten your seatbelt.

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