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THE NATURAL LANDSCAPE

The main features of the preserve and why they are important and valuable

The Valles Caldera is a land of superlatives. In beauty, productivity, ecological significance, scientific interest, cultural and religious importance, and many other respects, it is a landscape of the first rank. Few first-time visitors, beholding the caldera's largest valle, the Valle Grande, fail to stop and gaze in wonder. What they see is a vast bowl of grass, rippled in myriad subtle greens and tans, split by meandering streams and ringed by dark, timbered mountains. They sense an interplay of light, distance, and spaciousness in the vista before them that is different from what they have experienced in other places. Perhaps what sets the caldera apart is the brilliance of the light that shoots through its thin mountain air, or it may be the sense

of self-containment conveyed by the steep enclosing slopes. Perhaps it is the contrast of dark, dense forests with lighter, sprawling grasslands. Perhaps it is the seeming absence of disturbance or intrusion across so large a space (although past years have seen disturbance and activity aplenty). Perhaps the bugle of an elk suddenly shatters the silence and animates the moment with a flavor of wildness. Perhaps what makes the place so extraordinary is all of these things and more, working in combination and repeating themselves vista by vista, mountain by mountain, and valle by valle throughout the 89,000 splendid acres of the preserve.

GEOLOGY

The singularity of the Valles Caldera begins (but hardly ends) with its geology. The volcanic pile underlying the Jemez Mountains of northern New Mexico has been active for at least the past four million years, and it is by far the largest and most powerful such formation in the region. The events that define the present landscape began approximately 1.22 million years ago, when a previous caldera, known to geologists as the Toledo Caldera, became the scene of renewed volcanic activity. A field of multiple volcanic domes within the caldera erupted, spewing vast quantities of ash and magma and making the area of the present Jemez Mountains a scene of sustained violence far greater than anything that has been recently observed on earth. Many Americans remember the eruption of Washington's Mount St. Helens in 1980, which resulted in the rapid ejection and displacement of about 2.8 cubic kilometers of material, including landslides triggered by the eruption. By comparison, the eruptions that formed the Valles Caldera displaced some 292 cubic kilometers of the earth's crust and produced the titanic flows of superheated, liquid mineral that cooled to form the Pajarito Plateau. Ash that can be traced to the eruptions has been found as far away as Kansas.

The ejection of so much material left the subterranean innards of the former Toledo Caldera hollow and eviscerated. Devoid of structural support, the ravaged landscape fell in on itself, the floor of the land sinking to form the bottom of a giant, roughly circular bowl 13 to 14 miles across and bounded by a knife-edged rim of mountains. This collapsed volcanic field was the Valles Caldera, which remains today one of the best exposed examples of caldera formation known to science. Although by no means the largest of the world's calderas nor the oldest or youngest, the landscape of the preserve is unsurpassed in the perfection of its

expression of the caldera landform. This is one of many reasons for the preserve's great value for study and education.

The Jemez country's volcanism hardly ceased with the formation of the present caldera. The uplift of Redondo Peak, which towers above the center of the caldera, continued long after the eruption of the caldera. About 1.1 million years ago, new eruptions welled up to the northeast of Redondo, forming a mountain 1,200 feet higher than the surrounding caldera floor. This was Cerro del Medio, which separates what is today the Valle Grande from the Valle Toledo. About a hundred thousand years later a second cluster of mountains, Cerros del Abrigo, welled up, after which came a third, a fourth, and more eruptions, each spaced more or less a hundred thousand years apart, as the site of the eruptions moved at first counterclockwise around the northern and western interior of the caldera and later clockwise across the southern interior. Last in the sequence of volcanic events sculpting the interior of the Valles Caldera was the El Cajete eruption of 40,000 to 60,000 years ago, which deposited thick layers of pumice in and near the southern parts of the preserve. Almost certainly there will be more eruptions in the future—the magma underlying the caldera lies only about five kilometers beneath the surface, rather than the 30 kilometers typical throughout most of the world—but such eruptions probably will be far in the future. The presence of geothermal waters in and around the Valles Caldera serves as a reminder that this volcanic field is dormant, not extinct.

Water as well as fire has shaped the present landscape. At various times lakes have filled parts of the caldera, and the soils that formed from the sediments that collected beneath their waters help account for the famous grasslands of the valles. One of the lakes that formed within the caldera also shaped lands beyond its boundaries. About half a million years ago, the waters of a lake filling the Valle Grande breached the southern rim of the caldera, and once the breach began, the escaping waters flowed faster the more they opened the breach, widening and deepening their channel and eventually becoming a violent, sustained, and stupendously erosive flood. The result was the formation of the Cañon de San Diego, the narrow, steep-walled canyon through which the Jemez River flows today.

Aquatic and Riparian Communities

The rivers and streams of the preserve are its lifeblood. Their health is a major indicator of the condition

of the preserve in general. With minor exceptions, the headwaters of the streams that flow out from the preserve are entirely contained within its boundaries, making the VCNP a self-contained watershed unit. With no other lands and no other land managers upstream from the VCNP, any changes in the quality of water leaving the preserve or in the ecological condition of its aquatic and riparian communities are wholly attributable to the interplay of human activities, ecological succession, geology, climate, and other natural processes occurring within the preserve.

The water-collecting basin of the preserve contains a number of unique and uncommon aquatic and wetland features, ranging from warm and extremely acidic geothermal waters to numerous springs, seeps, and boggy wetlands. These water-rich environments, combined with the preserve's many creeks and streams, provide a robust foundation for the ecological diversity and productivity that characterize the preserve.

Approximately 27 miles of streams within the preserve offer habitat suitable for trout, although part of this habitat is in need of rehabilitation. The commonest impairments to these streams are a lack of pools due to sedimentation and stream channels that are wider and shallower than they should be. Other stream segments within the preserve, however, feature habitats that are in excellent condition and that can serve as models for the eventual restoration of the impaired reaches. Moreover, the present trend of ecological change appears to be toward recovery. Certainly trampling and grazing by elk, cattle, and sheep are partly to blame for the condition of damaged stream sections, but the dynamic of that impact is imperfectly understood. The respective contributions of elk and domestic livestock and of historical versus current grazing are difficult to separate.

Substantial uncertainties also exist concerning both the historical species composition and the ecological potential of the caldera's streamside communities. Nonnative Kentucky bluegrass is dominant in many riparian areas, and the potential for reestablishing the dominance of native species remains unclear. In addition, stream banks in the western United States are typically occupied by woody shrubs, especially willow, but relevant historical photographs of the VCNP, the earliest of which date from about 1906, show no such vegetation along its principal streams. Whether or not woody shrubs existed along VCNP stream banks prior to the 1900s is unknown. At present, one rarely finds willow, alder, or other woody

A meander of the Rio San Antonio.

shrubs growing along the banks of the caldera's watercourses, and where these plants are found, they show the effects of heavy browsing by elk. Much of this browsing occurs in late winter and early spring, when the twigs of woody plants prepare for spring growth before the first grasses in the parks and meadows turn green. These woody stems offer rich nutrition at a time of year when other food is scarce, and the large numbers of elk in the caldera appear to exploit fully what woody riparian growth is present. Before elk were present in large numbers (they were reintroduced to the Jemez Mountains in 1947 and 1964), more than half a century of heavy early season grazing by sheep may have had a similar effect. It is possible that these pressures, augmented by decades of cattle grazing, removed woody riparian vegetation from part of its natural range within the caldera, but the limits of that range are by no means well understood. It may be that woody plants should not be expected to grow along certain stretches of stream, such as the East Fork of the Rio Jemez through the Valle Grande, where the gradient is nearly flat and the soils fine textured and water saturated.

To address these uncertainties and other questions, the trust has established an extensive network of

upland range and riparian monitoring sites. The trust has also initiated a long-term field experiment that uses large fenced exclosures to collect data on the response of riparian areas to three levels of use: no grazing, grazing only by elk, and grazing by both elk and cattle. By learning through scientific experimentation and adaptive management, the preserve expects to contribute to improved management of riparian zones here and elsewhere in the Southwest.

GRASSLANDS

No feature of the caldera is more stunning than the sprawling, open grasslands that define its famous valles.* Cumulatively these giant, sun-drenched spaces account for about a quarter of the area of the preserve. Although at first impression these blankets of grass may seem uniform, the ecological communities found within them are actually quite diverse. Under the gentle light of early morning or late afternoon, the summer landscape of the Valle Grande reveals an intricately varied mosaic of countless shades of green, each hue and location reflecting a particular composition of grasses, forbs, rushes, and sedges at a particular stage of annual development. It is also important to note that the diversity of grasslands within the preserve is not solely a phenomenon of the valles. Additional grassland types grace the slopes of the preserve's mountains, even to the summits.

A number of useful approaches exist for evaluating the condition and health of grassland systems. One that is widely used compares existing vegetation to the vegetation that would be present under pristine conditions, uninfluenced by livestock grazing or other significant impacts caused by humans. By this measure, some of the preserve's communities—notably certain of the bunchgrass meadows on the upper slopes of its mountains—are in excellent condition, but most of its valles rate only a grade of "high fair." This is because of the extensive presence of Kentucky bluegrass and other non-native species. These non-natives are pervasive throughout the mountain grasslands of the surrounding region, including wilderness areas.

Another way to appraise the grasslands of the preserve is to evaluate their effectiveness in terms of watershed function: do they absorb and retain precipitation, do they

**A note on terminology: the Spanish word* valle *approximates but is not entirely synonymous with the English word* valley. *Valles are always open and for the most part treeless, while a valley may be heavily wooded. In both cases, the land in question is lower and enclosed in relation to the surrounding land, but a valle may be only slightly depressed or bowl-like, while valleys tend to be pronouncedly so.*

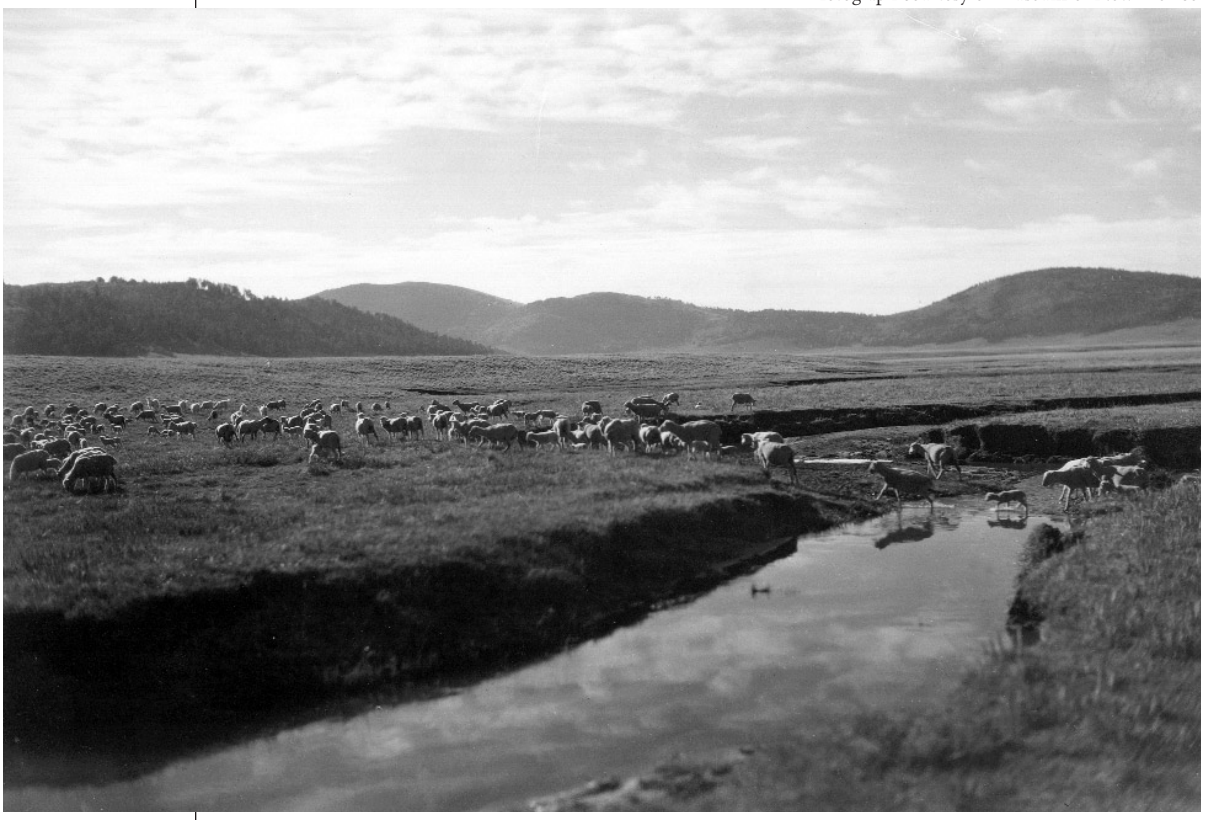
hold soil in place and retain nutrients, and are they productive and diverse? By these criteria, the grasslands of the VCNP are among the finest to be found in the entire Southwest. The soils are by and large superb, and the vegetative cover, in general, is excellent. Nevertheless, significant areas are in need of improvement. The Valle Jaramillo, for instance, receives heavy and sustained impacts from elk, for which it is a key calving and nursery area, and parts of the Rincon de los Soldados are likely less productive than they could potentially be because the area underwent long-term use as a bedding ground for sheep both entering and leaving the caldera through Valle Pass (between Cerro Grande and Pajarito Mountain). Restoration of a more natural fire regime among the grasslands of the preserve may help improve vigor and diversity in the future.

FORESTS

In 1918 the Redondo Development Company, an investment group based in Pennsylvania, sold Baca Location No. 1, including all of today's Valles Caldera National Preserve, to Frank Bond. But the company did not sell Bond all its interest in the property. It held back the rights to the timber of the caldera, in expectation that the lumber resource would become extremely valuable once reliable roads penetrated the area and allowed the efficient transport of logs to mills and markets.

That day came in 1935, when the Civilian Conservation Corps finished construction of an evenly graded and reliably drained road from what is today known as Ponderosa (near Jemez Pueblo) northward into the Valle Grande and thence eastward over the rim of the caldera to the Pajarito Plateau. Changes in state law also spurred logging activity. Immediately the Redondo group sold the timber of the Baca Location to the New Mexico Timber and Lumber Company, which thereafter commenced operation within the caldera. Between 1935 and 1972, when Bond's successor in ownership, Patrick Dunigan, managed at great expense to terminate the timber lease, New Mexico Timber logged more than 36,000 of the caldera's timbered acres, much of it by clear-cutting. Most of the logged lands have since grown back with secondary growth, sometimes in mixes of species different from those that were removed. In the latter part of this period, about a thousand miles of roads were bulldozed into otherwise inaccessible upper-elevation stands. This episode of construction, the results of which account for the ubiquitous sight of roads corkscrewing up the forested

Photograph courtesy of Museum of New Mexico



Sheep grazing on Rito Jaramillo in Valle Grande, T. Harmon Parkhurst, ca. 1935.

Same view, 2001.

Photograph courtesy USGS Jemez Mountains Field Station

slopes of the preserve, no doubt caused widespread erosion, and while most such roads have at least stabilized, erosion within certain problem areas continues.

Although New Mexico Timber harvested most of the preserve's old-growth ponderosa pine, an extremely impressive uncut stand remains in the headquarters area of the preserve. This stand, which runs for about a mile and a half in a narrow strip between the base of Redondo and the grasslands of the Valle Grande, is one of the great natural features of the preserve. Many of the huge old pines exceed 300 years in age, and their majestically tall, straight trunks and high canopies allow for a spacious, sunny, and open understory that features abundant grasses and expansive views. Perhaps no finer example of an open ponderosa pine grove exists elsewhere in the Southwest, at least not in a location easily accessible by road.

Over a century of fire suppression has greatly altered most forests on the preserve, and the old-growth stand in the headquarters area is no exception. Parts of it are heavily stocked with an understory of smaller trees, which in the event of fire entering the stand might serve as ladder fuels carrying flames into the canopies of the oldest, tallest pines and Douglas firs, endangering the stand with crown fire.

Many other forested areas within the preserve are similarly overstocked with young, small-diameter trees and remain vulnerable to high-severity, stand-changing fire. As is the case on much of the surrounding public land, large parts of the forests of the Valles Caldera will require thinning and fuel reduction treatments if they are to return to a more natural level of resistance to fire and drought stress. Restoration of natural, low-severity surface fires will be essential to improving forest conditions on the preserve.

The forests of the preserve possess considerable potential for sustainable sawtimber production. Soils are highly productive, and most sites are fully stocked or overstocked, so that limited thinning operations may produce marketable benefits.

Other noteworthy features of the forests of the preserve include the presence of a variety of natural forest insects and diseases that sometimes flare up and cause the death of many trees; the absence of significant regeneration among aspen, due in large measure to elk browsing and fire suppression; and the historically recent encroachment of trees, especially ponderosa pine and blue spruce, into grassland areas.

VEGETATION AND FLORISTIC DIVERSITY

Initial surveys of the plant life of the VCNP have identified over 550