

—NATURAL RESOURCES—



Feature Park— Valles Caldera National Preserve

Valles Caldera National Preserve: Integrating Science with Resource Management

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New Mexico's "Super Volcano"

The Valles Caldera National Preserve in the Jemez Mountains of northern New Mexico is one of the newest units in the national park system. Located at the intersection of two major fault systems, the Rio Grande Rift Valley and the Jemez Lineament, the Jemez Mountains overlie a weak point in the Earth's crust that has spawned volcanoes for the last 14 million years. The preserve contains the remnant caldera of a massive eruption 1.25 million years ago (figure 1). Since that time, more than 15 major eruptions have created numerous volcanic domes

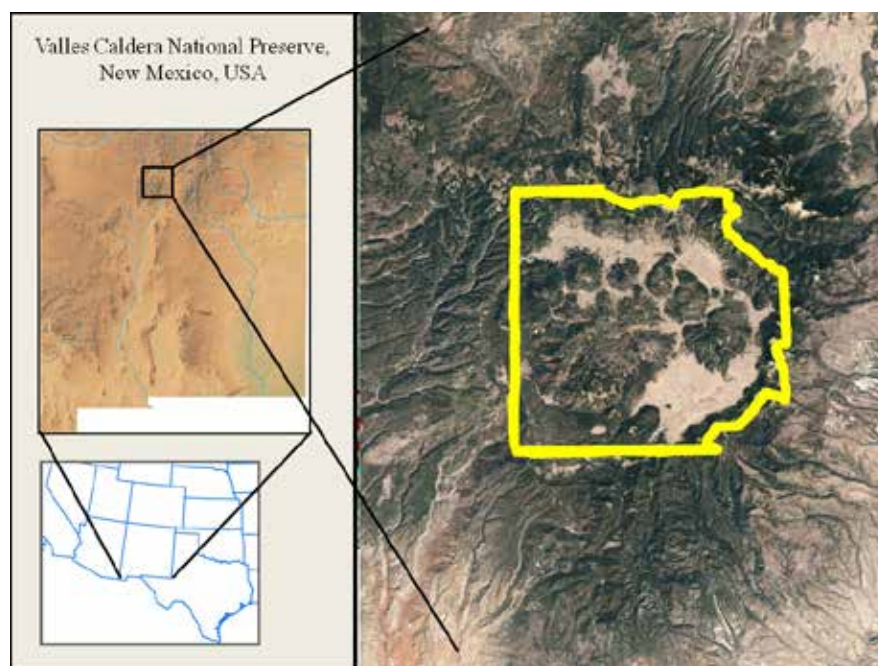


Figure 1. Landsat image of the Jemez Mountains with the Valles Caldera National Preserve (Source: Robert Parmenter)

within the caldera, including the major resurgent dome, Redondo Peak (elevation 11,254 ft.). The 12–15 mile diameter caldera is presently dormant (but not extinct) and still displays signs of volcanic activity, with hot springs and sulfuric acid fumaroles (Goff 2009).

The current landscape is covered with high-elevation coniferous forests and meadows. The iconic features of the preserve are the large, grassy valleys (*valles* in Spanish) that today cover the rich soils of ancient lakebeds. The numerous volcanic domes support extensive forests, with the lower slopes dominated by ponderosa pine, the middle slopes composed of mixed-conifer species of white fir, Douglas fir, Colorado blue spruce, and Southwestern white pine, and the upper peaks cloaked in Engelmann spruce and corkbark fir; extensive aspen stands are sprinkled throughout (Muldavin et al. 2005; figure 2). Overall, the preserve is home to more than 750 species of vascular plants, mosses, and algae, along with a rich assemblage of vertebrate and invertebrate wildlife. The preserve's caldera is also the top of the watershed for the Jemez River, a tributary to the Rio Grande. More than 76 miles of perennial streams drain the preserve's watersheds, supporting rich communities of



Figure 2. View of the Valle Grande from Redondo Peak (Source: Robert Parmenter)

aquatic invertebrates and trout fisheries.

Human History

While prehistoric use of the preserve by American Indians included the usual activities of hunting game and gathering native plants for food, medicine, and ceremonies, the signature resources for the indigenous peoples were the extensive volcanic deposits of obsidian for the manufacture of tools and weapons. The high quality, weapons-grade obsidian quarries on and near the preserve yielded critical materials for spear points, arrowheads, knives, and other tools. Obsidian artifacts dating back nearly 12,000 years have been found in the caldera, with prehistoric use increasing steadily throughout the Archaic

period (10,000–1,500 years ago). Evidence of ancient human use is found in prehistoric quarries, reduction sites, temporary campsites, and seasonal villages. Obsidian artifacts from around the world can be analyzed for site-specific chemical constituents, which allows the original geologic source of each piece of obsidian to be identified, and many obsidian tools and other artifacts found across the United States have their origins in the Jemez Mountains (figure 3), illustrating extensive transport of these artifacts and providing a testament to the high value placed on Jemez Mountains obsidian.

In the 12th century, Pueblo tribes began immigrating to the Rio Grande Valley from

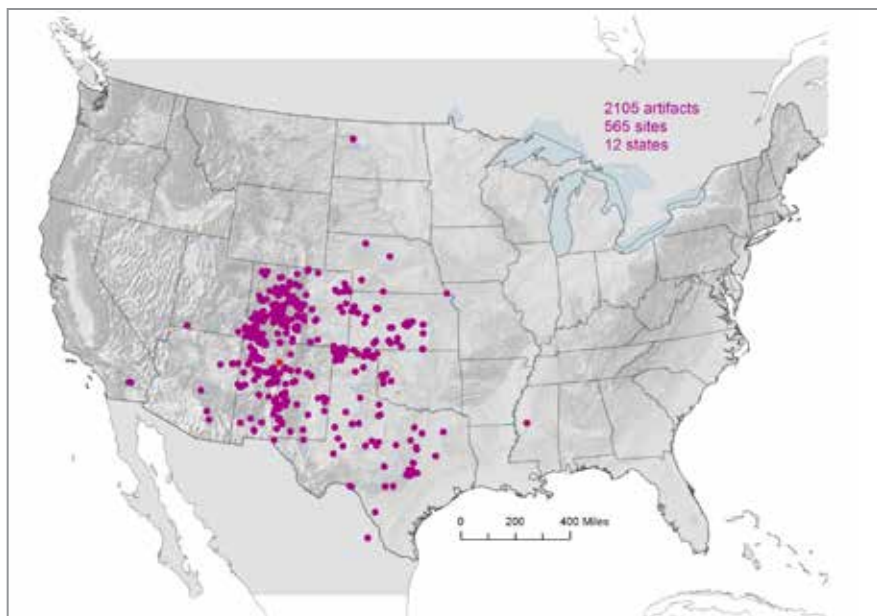


Figure 3. Locations of Jemez Mountains obsidian artifacts; red dot indicates Valles Caldera National Preserve, New Mexico (Source: Anastasia Steffen)

the Colorado Plateau, and several successfully established extensive networks of villages and farm fields in the Jemez Mountains (Anschuetz and Merlan 2007). A small corner of the preserve, below 8,400 feet today, contains the remains of the uppermost-elevation field houses and agricultural sites, delineating the altitudinal maximum for farming limited by the short growing season. The Jemez Mountains also are important for spiritual, cultural, and ceremonial reasons. The preserve continues to host American Indian religious and ceremonial sites and contains numerous areas considered sacred by several tribes.

Hispanic and Anglo use of the preserve during the 19th and 20th centuries was

predominantly sheep and cattle ranching and timber harvest (Martin 2003). These activities had profound impacts on the landscape, with high stocking rates of livestock influencing stream channels, grassland productivity, forest structure, and fuel loads (figure 4). Fire regimes were dramatically altered by the livestock's removal of grasses (fine fuels) on the forest floor, preventing the spread of low-intensity ground fires (Allen 2002). Young sapling trees, previously killed by frequent ground fires, quickly filled in the forest and increased both fuel loads and ladder fuels. Forest clear-cutting in the latter 20th



Figure 4. Top: Sheep herd crossing Jaramillo Creek in Valle Grande, circa 1935 (Source: T. Harmon Parkhurst; Museum of New Mexico image #51457); Bottom: Same location, present day (Source: Steve Tharnstrom and John Hogan; USGS Jemez Mountains Field Station image #JMFS 306)

century created dense, second-growth pine and fir forests, exacerbating the landscape fuel patterns and amounts (Balmat and Kupfer 2004). In recent years, large-scale uncharacteristic wildfires, such as the 2011 Las Conchas fire and the 2013 Thompson Ridge fire, have burned more than 60% of the preserve to varying severities.

Today, most human activities on the preserve are recreational—hiking, mountain biking, equestrian, snowshoeing, cross-country skiing, hunting, fishing, and night-sky events. The preserve is also a popular venue for filming TV shows and movies. In 2014, the preserve hosted nearly 120,000 visitors, and annual visitation has consistently increased since 2003.

Landscape Restoration

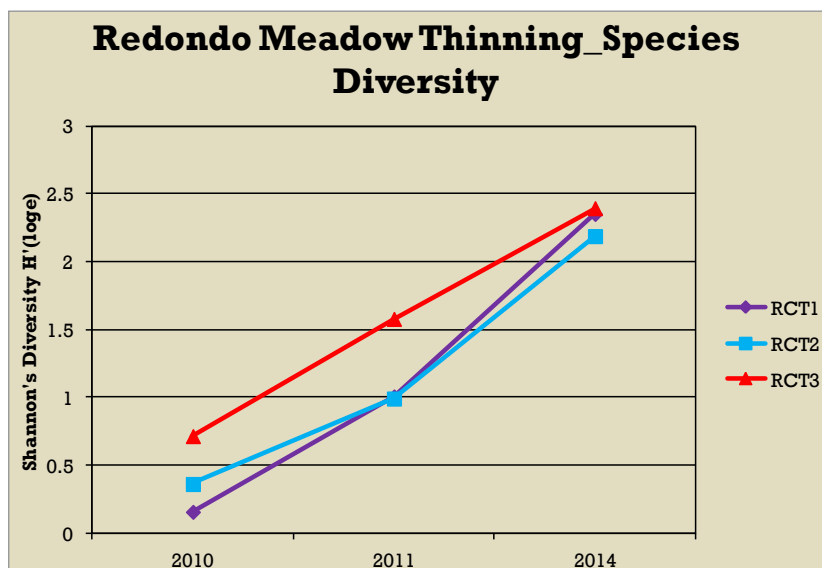
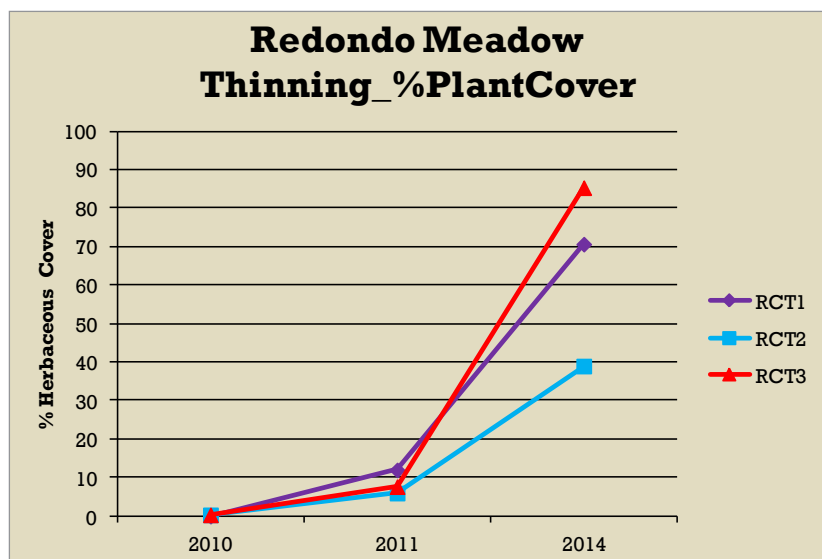
As a result of the existing ecosystem conditions at the time of federal acquisition, a major effort was initiated to restore the landscape to a more resilient condition and reinstate natural fire regimes. The preserve formed a partnership with the Santa Fe National Forest, The Nature Conservancy, the Pueblo of Jemez, Bandelier National Monument, and more than 30 other agencies and organizations to develop and implement a landscape restoration strategy. Projects

undertaken by the collaborative included forest thinning and prescribed burning, management of natural fires, riparian restoration, species reintroductions, and road closures (figure 5). Upon completion in 2019, the preserve's ecosystems will be on the long-term successional trajectory to once again become a mosaic of old-growth forests, lower-density second-growth

forests, and montane meadows and grasslands with natural fire-return intervals.

Science-Informed Management

With the wide range of public activities, the preserve has tasked the Scientific Services Division to acquire the necessary information to ensure that science-based adaptive management is realized in



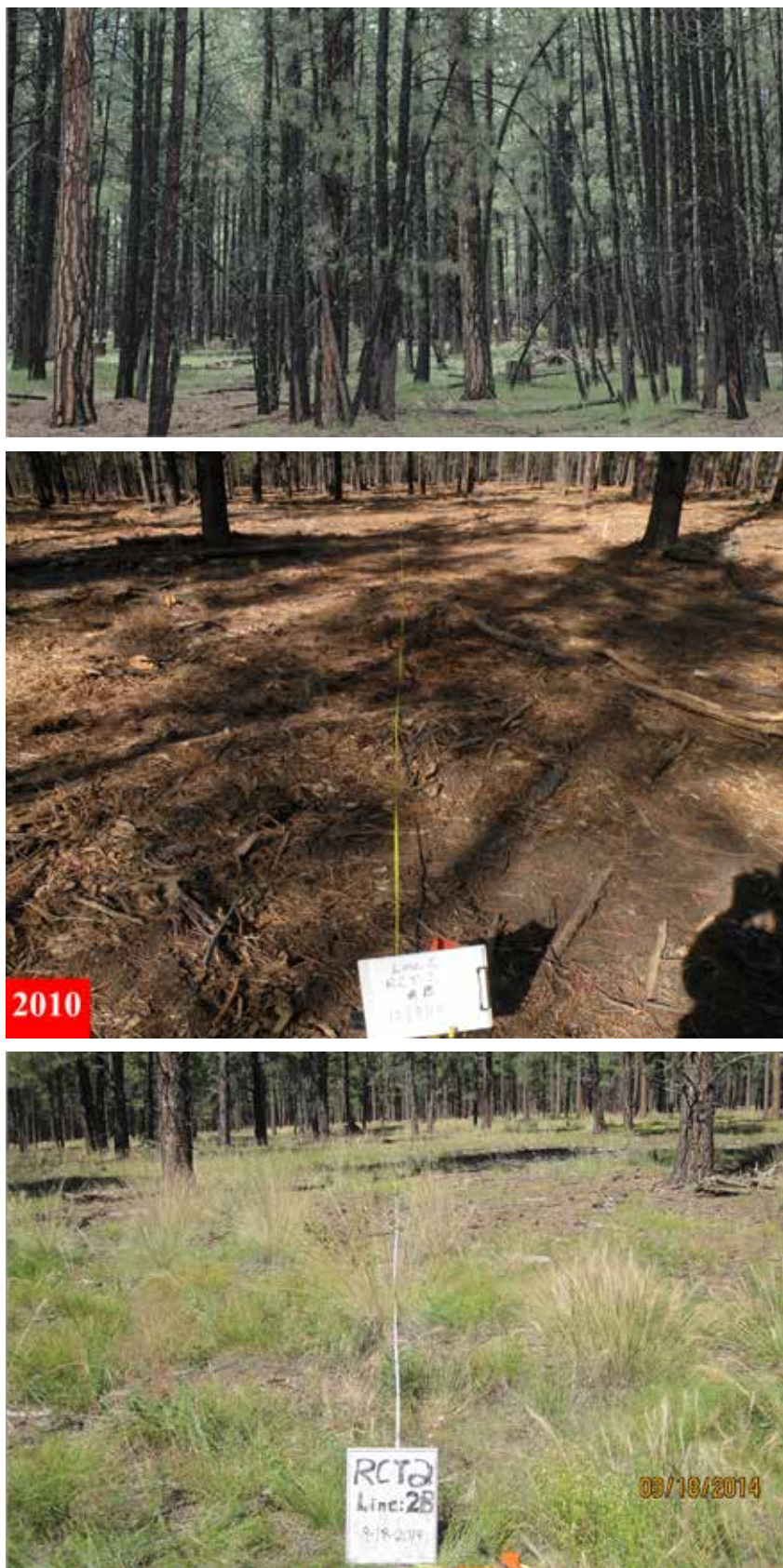


Figure 5 (pages 4-5). Ponderosa pine thinning and burning activity, showing increase in herbaceous vegetation (Source: Robert Parmenter, Rebecca Oertel, Martina Suazo)

management decisions (figure 6). Early efforts were devoted to inventories of natural and cultural resources, and an extensive geographic information system (GIS) was developed; data layers include a high-resolution (2m-pixel) vegetation map, a new level-2 soils map (from the Natural Resources Conservation Service and the Forest Service), a new geology map, and data layers for topography, roads, streams, archaeological sites, and historic features. To date, nearly 20,000 acres have been inventoried for cultural resources—with documentation of 680 prehistoric and historic sites, and GIS data points for 65,800 artifacts.

A major component of the preserve inventories was compiling species lists and distributions of the fauna and flora. Intensive field sampling campaigns, often coupled with ongoing monitoring programs, have led to the near-completion of species lists for vascular plants, mosses, algae, fungi and lichens, mammals, birds, reptiles, amphibians and fish, and many taxa of aquatic and terrestrial invertebrates (thanks to the efforts of scientists from the Systematic Entomology Laboratory / Smithsonian Institution). Many archived

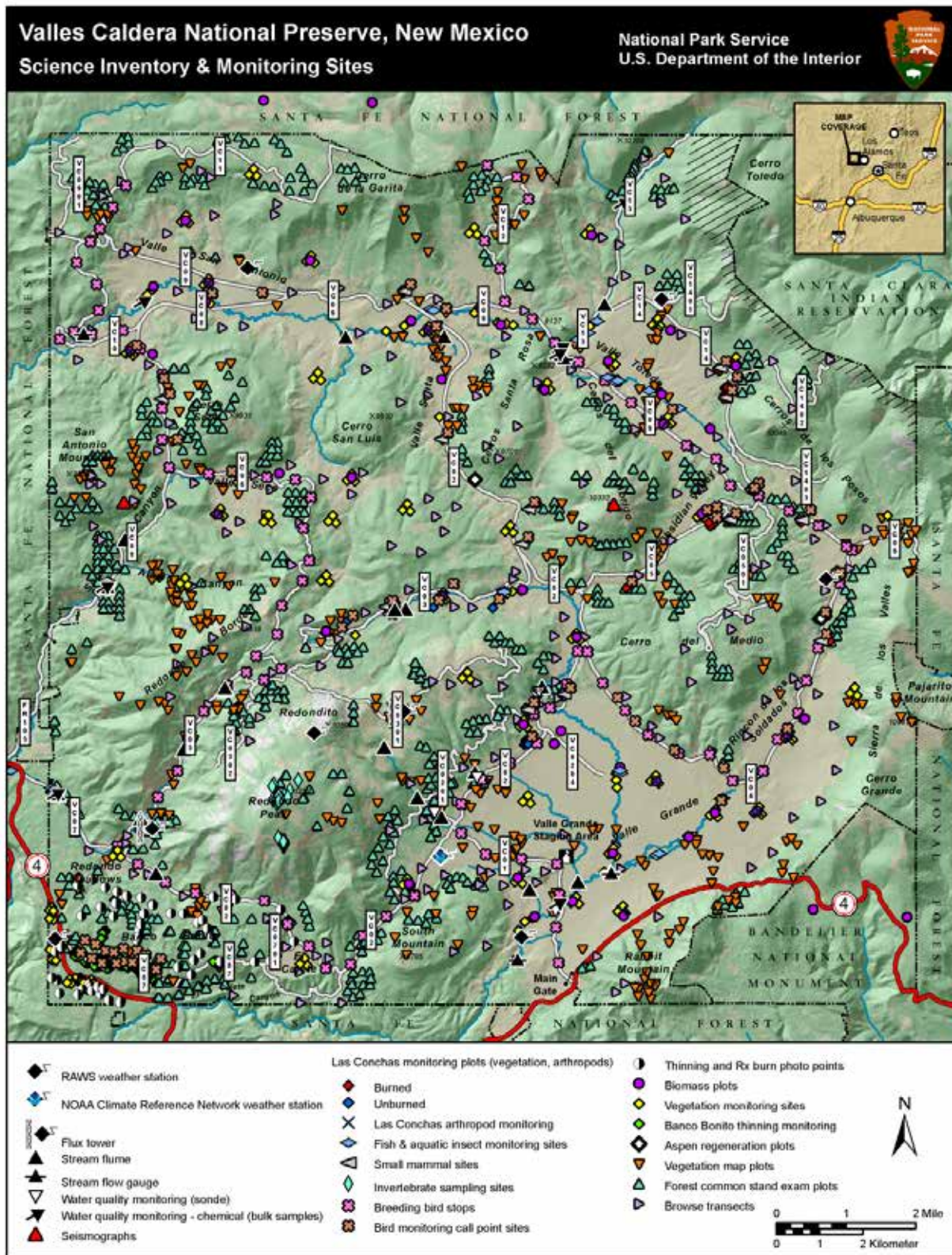


Figure 6. Map of Science Inventory and Monitoring Sites on the Valles Caldera National Preserve (Source: John Swigart)

voucher specimens have been placed in the national collection at the Smithsonian Institution, the University of Wyoming's herbarium, and the University of New Mexico's Museum of Southwestern Biology. Inventories of remaining taxa continue, with the goal of completing an all taxa biological inventory mirroring that of the Great Smoky Mountains National Park. Given the documented climate change in the preserve, coupled with anticipated increased regional temperatures and declining precipitation in coming decades, the preserve's present-day inventory will provide a detailed benchmark to which future generations of scientists can compare changes in biodiversity over centuries to come.

Monitoring programs were established in response to a number of issues. With ongoing climate change, the preserve set up a network of weather stations, including the preserve offices in the town of Jemez Springs. Data from the Jemez Springs station, coupled with comparable data since 1914, show that annual temperatures have risen 1.8° F over the past 101 years, and that the most rapid increases are occurring in the months of March, June, July, and August; this finding is important for anticipating future snowmelt periods and fire seasons (figure 7).

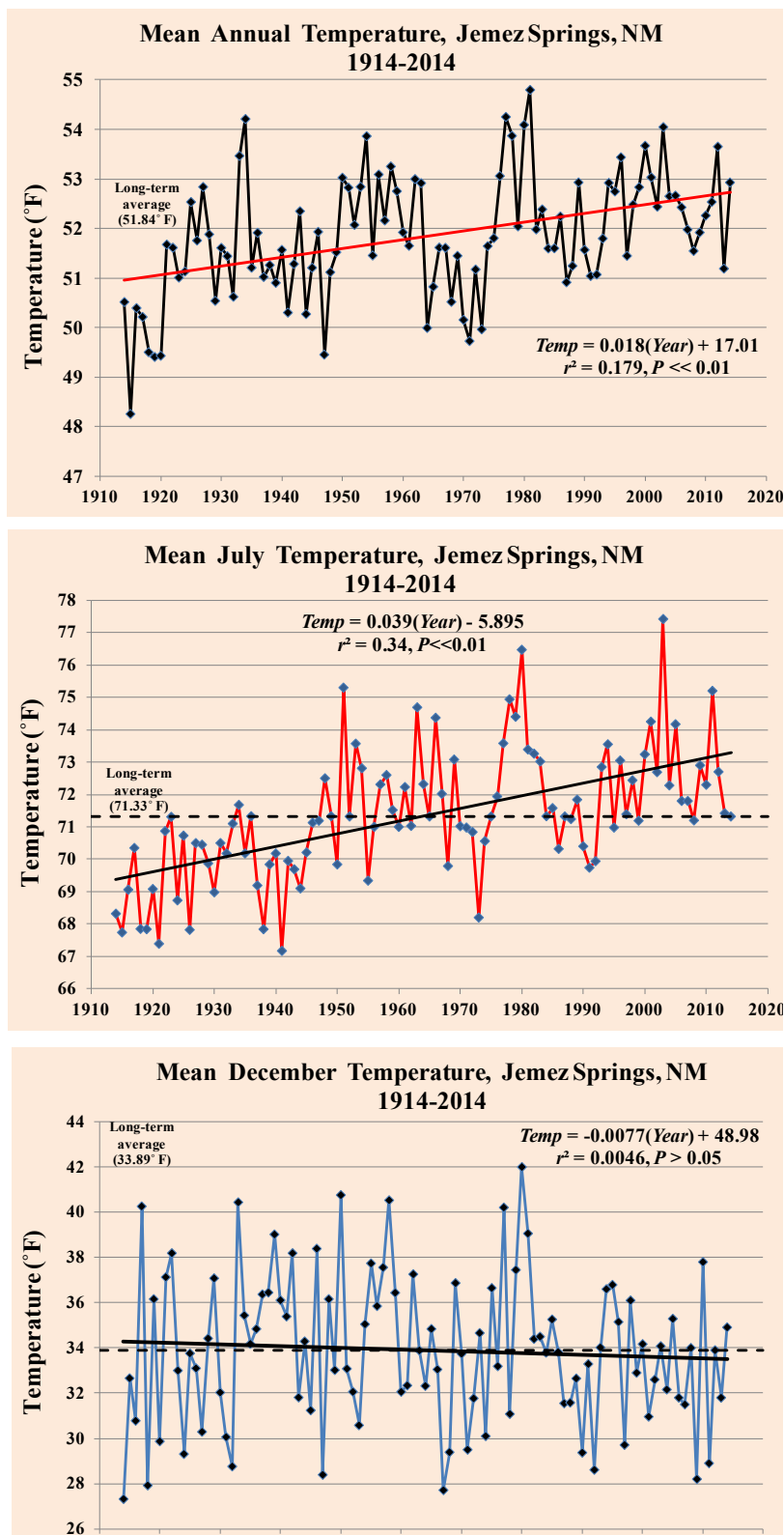


Figure 7. Temperature increases in Jemez Springs, New Mexico, 1914–2014; note that temperatures are increasing in midsummer (July), but not in midwinter (December) (Source: Robert Parmenter)

At the time of acquisition, nearly all the streams on the preserve were impaired for high temperatures and turbidity, a result of prior land-use activities. Preserve streams have been monitored for water quality using automated instruments (sondes) for temperature, dissolved oxygen, pH, conductivity, and turbidity. These data inform management on the success of watershed restoration treatments (e.g., planting willows to shade stream channels and lower

temperatures), as well as document impacts of wildfires upstream. Stream discharge is monitored on all 1st-, 2nd-, and 3rd-order streams on the preserve using flumes and stream gauges; these data will prove critical for determining if forest thinning increases net water yield during spring snowmelt, an important goal of watershed restoration (Parmenter 2009).

By congressional statute, the preserve conducts a livestock

grazing program for regional ranchers. Based on forage production models and a designated light-grazing regime, the preserve supports approximately 750 cow-calf pairs for 4 months/year. Livestock are kept in upland pastures, fenced away from riparian zones. Vegetation monitoring provides forage production and utilization measures, along with plant cover and diversity within and outside of livestock enclosures to ensure compliance with



Figure 8. Forest-floor herbaceous vegetation recovery in a mixed-conifer stand following the 2011 Las Conchas Fire. Top left: Immediately post-fire, July 2011. Top right: 2012. Lower left: 2013. Lower right: 2014 (Source: Rebecca Oertel and Martina Suazo)

National Environmental Policy Act requirements. Livestock owners are charged market rates for pasturage, and as a result, the preserve actually makes a small profit from the program.

Vegetation monitoring also provides estimation of fuel loads for prescribed fires, as well as tracking changes in plant communities following forest restoration and fires (figure 8). During fieldwork, preserve botanists document populations of invasive/nonnative plant species for subsequent removal; they also record locations of sensitive and rare plants for incorporation into future management planning for public access and use.

Wildlife population monitoring data are used in all aspects of preserve management. Information on the preserve's elk herd is critical to monitoring herd condition, demographics, habitat use, migration corridors, and disease so that the preserve can maintain a sustainable population for recreationists and hunters. Preserve biologists and collaborating scientists also monitor other large mammals, including mule deer, black bear, mountain lions, and coyotes, using GPS radio collars for movements and habitat use, scat analyses for diets, teeth collections for age determinations, and blood samples for diseases (figure 9). Small mammal studies (rodents,



Figure 9. New Mexico State University graduate student Sarah Kindschuh administers a "wake-up" injection to anesthetized black bear with iridium GPS collar (Source: Mark Peyton)

shrews, and bats) have been conducted for post-fire successional patterns, along with long-term monitoring of breeding birds. Fisheries across the preserve have been monitored each spring and fall since 2003, allowing evaluation of recreational fishing programs, as well as impacts of post-fire flooding. Biologists also track the distributions of protected species, such as the endemic Jemez Mountains salamander, and have reintroduced other species that were extirpated decades ago, including the northern leopard frog, the Rio Grande chub, and the Rio Grande sucker.

In addition to vertebrate wildlife, preserve entomologists and collaborating biologists have monitored a wide variety of pest and beneficial insects, spiders, and other invertebrates. Ongoing monitoring projects

include post-fire successional patterns of aquatic and terrestrial invertebrates following both wildfires and prescribed fires, in areas with and without ungulate grazing (elk and livestock). These results are continuously contributing to management understanding of the rates of successional changes following restoration of fire regimes on the preserve.

Science Education and Interpretation

Virtually all of the data from the inventory and monitoring programs, and from outside research, are used in interpretive and educational materials for the public and school groups visiting the preserve. Visitors learn the latest information on the geology, biology, archaeology, hydrology, fire history, and climate of the Jemez Mountains from the

preserve's interpretive staff. Preserve education specialists (including volunteer teachers) conduct hands-on field exercises with school classes, measuring vegetation, wildlife, and stream water quality in untreated control sites and areas being restored. Multiple years of education programs' data are being compiled into classroom activities involving not only natural resource ecology, but also mathematics and data analyses.

Future Science

The science program contributes to the baseline

knowledge of the preserve's natural and cultural resources, provides information for management planning and decision-making on all programs and activities, informs restoration efforts during the planning, implementation and post-action evaluation monitoring phases, and transfers synthesized results to public education and interpretive programs. Visiting scientists to the preserve contribute additional knowledge via their research studies; in 2014, the preserve hosted 53 permitted research projects with outside funding

of more than \$5.2 million. This amount exceeded the preserve's FY 2014 appropriated budget and recreational revenues combined. The preserve provides an important outdoor laboratory and classroom; with increasing visitation, climate change, and the expanding programs for public access and use, the science program will continue to provide salient information to fulfill the goal of science-based adaptive management. □

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