The Sierra Ancha Experimental Forest, Arizona: Long Term Watershed Management Research

By Gerald J. Gottfried and Daniel G. Neary

The U.S. Forest Service’s system of experimental forests and ranges was initiated in 1908 by Raphael Zon whose goal was to conduct experiments leading to a fuller understanding of American silviculture, and economic utilization of forest products. Studies should result in an appreciation of indirect benefits of the forest and dedicated to the study of environmental changes in natural and managed forest and rangeland ecosystems. The research at Sierra Ancha Experimental Forest (SAEF) in central Arizona has contributed to the knowledge of hydrology, watershed management, and basic ecology for almost 80 years, and it continues to contribute. Many concepts that managers and researchers now consider self-evident were first described and analyzed at Sierra Ancha.

Experimental forests and ranges originally were established to solve land management problems. The availability of adequate water supplies has been a critical concern in central Arizona since prehistoric times. The importance of upland watershed management increased after Euro-American settlers in the Salt River Valley, which now includes the Phoenix Metropolitan Area, entered into an agreement with the United States Government in 1903 to build the Theodore Roosevelt Dam on the Salt River to provide consistent streamflow for irrigation and domestic uses. There were concerns that livestock grazing was contributing to soil erosion from upstream watersheds and that this would eventually compromise the longevity of the dam. Initial research was conducted on the Summit Plots in 1925 to study the effects of land management options on streamflow and sedimentation from the chaparral lands above Roosevelt Lake. In 1932, the Forest Service established the Parker Creek Experimental Forest in the Sierra Ancha Mountains east of Roosevelt Lake. The Forest was enlarged in 1938 and renamed the Sierra Ancha Experimental Forest (SAEF).

In 1935, the headquarters complex at Parker Creek was constructed. Weirs, weather stations, lysimeters, and a variety of research facilities also were constructed throughout the SAEF, many by enrollees in the Civilian Conservation Corps or other Depression Era programs.

A view to the northeast to the Sierra Ancha Mountains and the Parker Creek and Pocket Creek drainages. The main area of the Sierra Ancha Experimental Forest is at the higher elevations above the cliffs.

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The National Museum of Forest Service History is loaning the Lane Motor Museum of Nashville, TN a very unique vehicle! The Gyro Stabilized Cargo Carrier, commissioned by the US Forest Service, was built by a man named Tom Summers. Summers was a gyroscope expert with a dream to build gyroscopically-stabilized vehicles. The Cargo Carrier was designed to haul equipment and supplies for trail crews.

In 1965, one of only five prototype was completed and tested by the Missoula Technology and Development Center. This unique item from the Museum's collection will be on loan to the Lane Motor Museum in Nashville, Tennessee and is planned to be on display in 2018 as part of their Unconventional Inventions: Thinking Outside the Box, exhibit.

For this exhibition, they have selected vehicles that embody incomparable automotive creativity. Existing as the result of untethered human imagination, these vehicles represent innovation, yet for many reasons, were not necessarily commercially successful. Through recurring themes of ingenuity and originality.

Unconventional Inventions will inspire curiosity, stretch the boundaries of how one defines the car, and encourage the visitor to think outside the box.
Sierra Ancha (continued)

The Forest was originally administrated by the Forest Service’s Southwestern Forest and Range Experiment Station (now the Rocky Mountain Research Station). The initial research mission was to study the effects of grazed and un-grazed vegetation on water yields and sedimentation and to learn more about hydrologic relationships within the diverse vegetation zones of the Salt River watershed. The mission expanded to examine the impacts of management on multiple resources and to learn about the ecology of these plant communities.

The SAEF includes 13,500 acres with an elevation range from 3,550 to 7,725 feet and contains representative populations of eight plant communities from desert shrub with saguaro (Carnegiea gigantea) and palo verde (Cercidium microphyllum) to southwestern mixed conifer forests of Douglas-fir (Pseudotsuga menziesii var. glauca), white fir (Abies concolor), ponderosa pine (Pinus ponderosa) and quaking aspen (Populus tremuloides). Interior chaparral, dominated by shrub live oak (Quercus turbinella), is the most common vegetation type on the Forest. The average annual precipitation ranges from less than 16 inches to more than 33 inches; approximately two-thirds occurs in winter and the rest falls as summer monsoon rains.

SAEF provides a unique research environment for conducting short-term and long-term studies about basic hydrologic and ecological relationships in many of the important plant and animal communities of the southwestern United States.

Some short-term studies tested erosion control and revegetation techniques, the effects of grazing and wildfires on soil erosion and hydrology, and the hydrology of headwater tributaries of the Salt River. The consumptive use of water by range plants was studied and compared to evaporation from bare soil using small lysimeters.

Above: Ancha Experimental Forest showing the watersheds, hydrologic structures, and research sites. Many of the research plots and sites shown on the map are no longer being monitored.

Above: Crew constructing the Upper Pocket Creek compound weir in 1936 (Photograph by Dr. Elbert L. Little). Pocket Creek contains mixed conifer and chaparral vegetation.

Right: Small lysimeters being weighed at Parker Creek by members of a crew from the ERA (Emergency Relief Administration) in 1937. The photograph was taken by Dr. Elbert L. Little when he was stationed at Sierra Ancha. Dr. Little went on to become the Forest Service’s Chief Dendrologist.
A system was developed to classify watersheds into high, medium, and low potential for water yield augmentation. Some other short-term studies examined the ecology of chaparral, oak woodlands and New Mexico locust (Robinia neomexicana), methods of shrub control, prescribed fire prescriptions for chaparral, pocket gopher (Thomomys bottae) feeding habits, and snowpack-runoff relationships.

The key value of Sierra Ancha is in its long-term hydrologic studies conducted primarily using large lysimeters (a device to measure the amount of actual evapotranspiration released by plants) and on several groups of experimental gauged watersheds. Many of the discoveries related to the importance of winter moisture to the generation of subsurface flows and the impacts of high-intensity summer rains on surface runoff and erosion were developed from research at Sierra Ancha.

The four Natural Drainage Watersheds with a chaparral cover initially were used to study the impacts of livestock grazing. Proper grazing did not result in increased erosion and had no impact on streamflow quantities. The effects of brush control and grass seeding were studied in a subsequent experiment. The results from Natural Drainages and from other chaparral watershed studies elsewhere provide an understanding of the complex mix of natural conditions that influence streamflow from this vegetation zone.

A major project was conducted on the Workman Creek Watersheds to evaluate the hydrology of higher elevation mixed conifer forests and to determine the changes in streamflow and sedimentation from manipulating the forest cover. The studies were planned during the regional drought of the 1940s and 1950s. The three Workman Creek watersheds were instrumented in 1939.

Middle Fork was reserved as the hydrologic control and North and South Forks were treated. Some treatments since 1953 were based on forestry prescriptions and others were designed to evaluate the potential range of water yields from riparian, mixed conifer, and ponderosa pine types. On North Fork, scientists determined that clearing the narrow riparian corridor did not increase water yields but clearing the main mixed conifer and then the ponderosa pine stands did result in statistically significant increases in streamflow of 72 percent (2.65 inches). The forest was replaced by grasses, locust, and Gambel oak (Q. gambelii). It was determined that shallow-rooted replacement vegetation used less water than the original forest and that the surplus contributed to the increased water flows. The North Fork treatments were experimental and not intended as possible management practices.

South Fork was reserved for evaluations of forest management treatments. A single-tree selection harvest resulted in a small but statistically significant increase in streamflow. A subsequent treatment that attempted to convert the watershed to a pure ponderosa pine stand resulted in significant increase of 110 percent (4.20 inches) because much of the area was cleared and new pine seedlings and brush species were using less water than the original mixed conifer forest.

The conclusion was that it was necessary to create clearings or to reduce stand densities if increased streamflow was an objective. None of these treatments resulted in significant increases in sedimentation.
Sierra Ancha (continued)

The challenge is to integrate this information into forest management plans to be able to predict how silvicultural prescriptions affect multiple resource values.

The importance of research at Sierra Ancha are its contributions to the knowledge base of hydrology, watershed management, and basic ecology. The research at SAEF continues to provide useful information to other researchers and land managers. The studies provide: 1) guidance for subsequent research on chaparral, mixed conifer, and ponderosa pine ecosystems; 2) managers and researchers with information about water yield responses to vegetation manipulations; and 3) information that is used in multiple resource ecosystem management treatments.

The Workman Creek studies were mothballed in 1983 but long-term hydrologic, climatic, and vegetation data remain on file at the Forest Service’s Rocky Mountain Research Station. The value of these data became apparent following the Coon Creek Wildfire in 2000. Crews from the Rocky Mountain Research Station and the Tonto National Forest repaired and opened the hydrologic installations and reestablished plant inventory locations to monitor wildfire impacts.

The existing long-term data provided a sound base to compare the impacts of the wildfire to untreated and treated forest watershed conditions. In addition to research related to the Coon Creek Wildfire, two other studies are being conducted on South Fork. One study assesses the effects of air pollution on forests and the other evaluates the role of log decomposition on the carbon cycle. Knowledge gained at Sierra Ancha and other experimental sites can provide managers with information about how proposed treatments and climate change could affect multiple forest and woodland resources.

The SAEF continues to be a location to answer present and future questions. More information and specific references to research at Sierra Ancha can be found in: Gottfried and Neary-The Sierra Ancha Experimental Forest, Arizona: A Brief History. Hydrology and Water Resources in Arizona and the Southwest. 50:72-77. (http:hdl.handle.net/10150/621696).

Above: The Forest Service and its cooperators collect data in Sierra Ancha in the 21st century to study the impacts of wildfire, air pollution and other environmental changes.

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