

RUCKER LAKE: A HISTORY OF RECENT CONDITIONS AFFECTING A SOUTHEASTERN ARIZONA WATERSHED

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As recently as 1970, there were 12 recreational lakes in southeastern Arizona. Today, due to the high cost of maintaining them, only six remain. One of these is Rucker Lake, which has been a recreation destination in the Chiricahua Mountains of southeastern Arizona since the 1930s (Figure 1). It is located 48 km (30 mi) north of Douglas, Arizona, and 80 km (50 mi) northeast of Bisbee. Even at the height of its popularity, it was only 1.3 ha (3.2 ac) in size, with a small campground on the west end. As is the case with all recreation lakes in southeastern Arizona, it is artificial, created by a small concrete dam. Because of the flashy hydrology and high sediment loads of drainages emanating from the Chiricahua Mountains, Rucker Lake acts as a sediment trap (Baker et al. 1995; Lusby and Hadley 1967; DeBano et al. 1996). Periodic maintenance in the form of dredging every 3 to 4 years has been necessary to keep the lake open.

Recently, Rucker Lake has not been maintained due to changes in the watershed condition and sediment load caused by the 1994 Rattlesnake Fire, and the rising cost of dredging. It is currently full of alluvial deposits and there is no open water. This paper documents the current status of Rucker Lake and will assist managers on the Coronado National Forest in making decisions about future management of the lake.

Rucker Canyon Watershed

The watershed is approximately 1902 ha (4700 ac) in size. Its vegetation consists of 51 percent transition coniferous forest, 3 percent mixed conifer and spruce-fir, 8 percent riparian, and 38 percent oak woodland. These vegetation types are described in the Coronado Land Management Plan (USDA For-

est Service 1986), McLaughlin (1995), and Warshall (1995).

Broadleaf evergreen woodlands are found at elevations of about 1460 to 1645 m (4800–5400 ft). Mean annual air temperatures range from about 11.1° to 14.4°C (52–58°F). Mean annual precipitation ranges about 400–480 mm (16–19 inches). The dominant native vegetation is Emory oak (*Quercus emoryi*), Arizona white oak (*Quercus grisea*), alligator juniper (*Juniperus deppeana*), manzanita (*Arctostaphylos* spp.), and *Juniperus erythrocarpa*.

Transition coniferous forests are found at elevations of about 1980 to 2350 m (6500–7700 ft). Mean annual air temperatures range from about 9.4° to 12.7°C (49–55°F). Mean annual precipitation ranges from about 500 to 660 mm (20–26 inches). The dominant native vegetation is a mix of border pinyon (*Pinus discolor*), Chihuahua pine (*P. leiophylla*), ponderosa pine (*P. ponderosa*), manzanita (*Arctostaphylos* spp.), Arizona white oak (*Quercus grisea*), silver leaf oak (*Quercus hypoleucoides*), and alligator juniper (*Juniperus deppeana*).

Mixed conifer forests are found at higher elevations of about 2075 to 2750 m (6800–9000 ft). At those elevations, mean annual air temperature ranges from about 7.2° to 11.1°C (45–52°F). Mean annual precipitation ranges from about 560 to 660 mm (22–26 inches). The dominant native vegetation is ponderosa pine (*Pinus ponderosa*), alligator juniper (*Juniperus deppeana*), gambel oak (*Quercus gambelii*), and Douglas-fir (*Pseudotsuga menziesii*).

Spruce-fir coniferous forests are found at the highest elevations, about 2440–2990 m (8000–9800 ft). Mean annual air temperature at the mountain summits ranges from about 3.3° to 6.7°C (38–44°F). Mean annual precipitation ranges from about 762 to 890 mm (30–35 inches). The dominant native vegetation is white fir (*Abies concolor*), Douglas-fir (*Pseudotsuga menziesii*), scattered aspen (*Populus tremuloides*), and in a few areas, high densities of Engelmann spruce (*Picea engelmannii*) and corkbark fir (*Abies lasiocarpa* var. *arizonica*).

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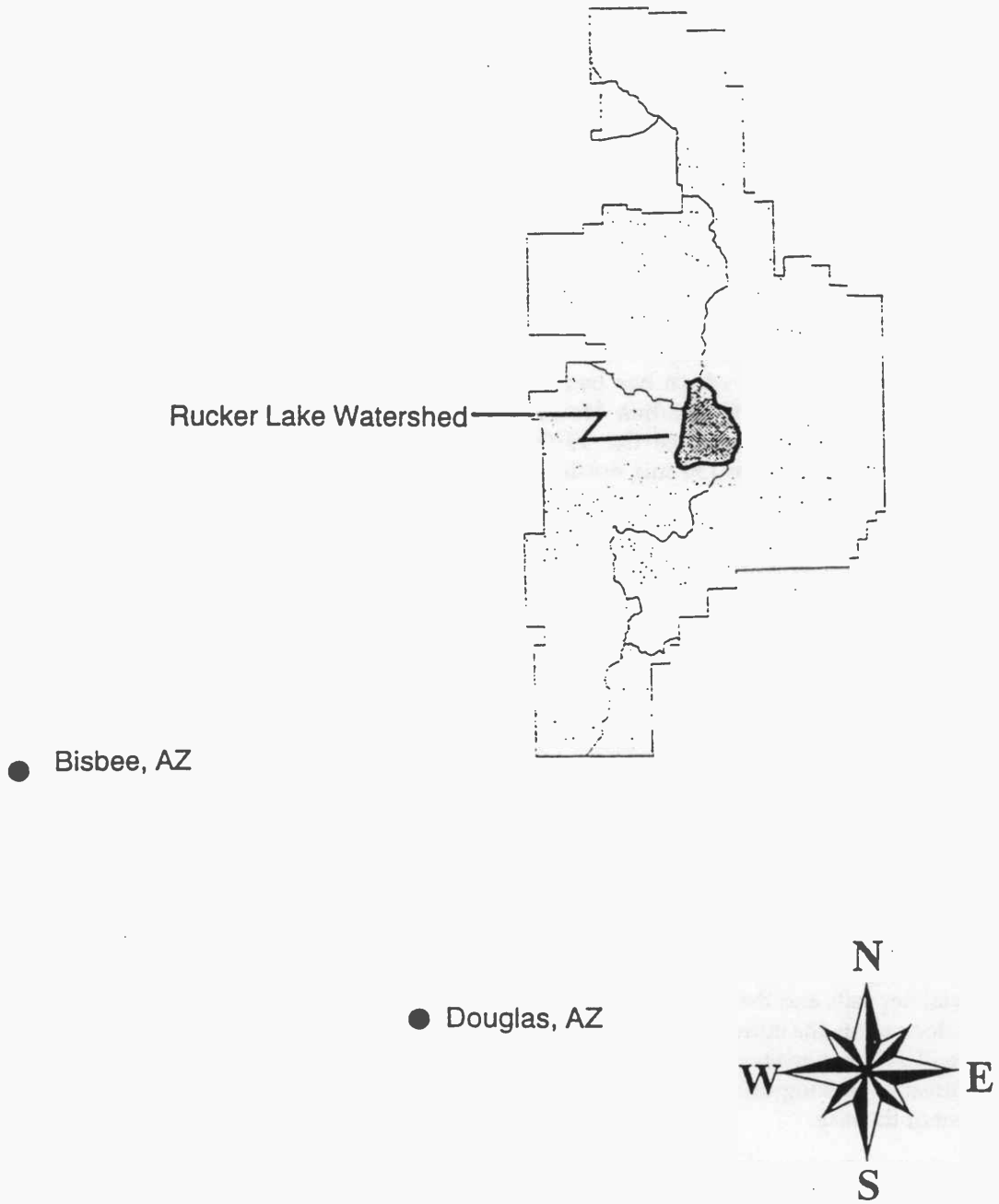


Figure 1. Rucker Lake watershed location, Coronado National Forest, Arizona.

The coniferous riparian forests are combinations of riparian obligate species in ponderosa pine–Douglas-fir forest and pine-oak-juniper woodland communities. They are found at elevations greater than 1585 m (5200 ft). The dominant native vegetation is Arizona sycamore (*Platanus wrightii*), Rocky Mountain maple (*Acer glabrum*), aspen (*Populus tremuloides*), ash (*Fraxinus* spp.), Arizona alder (*Alnus oblongifolia*), and Arizona cyprus (*Cupressus arizonica*).

History

Rucker Lake was originally known as "the Bath-tub" when it was constructed in the 1930s by the CCC Administration (Newbury 1964). In 1947 it was raised to its present height by the sportsmen of Cochise County, and was commonly called Rucker Lake only after it became used for recreational fishing (Newbury 1964). Prominent citizens of Douglas and Bisbee worked to have an improved recreation area around the lake. At one time it was proposed that the lake be named Meisher Lake after W. H. Meischer, who is credited with being responsible for raising the dam to its present height (Newbury 1964).

Throughout the 1940s, 1950s, and early 1960s the Arizona Game and Fish Department stocked Rucker Lake around Easter and a fishing derby was held (personal communication, Medlock 1999 and Velasco 1999). It was a big event for the children of Douglas and Bisbee, who would line up along the bank waiting for the 9:00 a.m. starting whistle (personal communication, Medlock 1999). A prize was awarded for the biggest fish (personal comm., Velasco 1999). The fishing derby has ceased as an organized event, but stocking with catchable trout continued into the 1990s.

Ownership of the lake was turned over to the Forest Service from the Arizona Game and Fish Department by 1968. A water right for the lake was obtained by the USDA Forest Service in 1990.

Apparently sedimentation has been a problem since the early days. Records show that dredging of the lake had become a routine occurrence by 1963. In September, every other year, the gate valve in the dam was opened for about a week. Water and sediment were allowed to pass through the dam. Every third year, the Forest Service road crew brought in heavy equipment and dredged the lake, using the gravel to plate the parking areas and roads in Rucker Canyon (personal communication, Velasco 1999). Approximately 22,935 m³ (30,000 yds³) were removed with each full dredging.

In addition to the sedimentation problem, the lake had a leak. Dick Langford and other Forest Service veterans knew that water flowed through the gravel bench north and west of the lake. The presence of the dam merely provided a more continuous source of water for that flow (personal communication, Velasco 1999). The dam was treated with gunnite in 1964 in hopes of keeping water in the lake longer, but the leak through the gravel to the north remained. In 1966, employees of a mine in Bisbee were hired to pump a jelly substance into the bank along the north and west side of the lake in an attempt to seal the flow of water. It apparently was not successful. In 1970, the Forest Service dug a ditch 3 m (10 ft) deep along the north side of the dam and mixed bentonite into the soil. This was not completely successful either. Water can still be observed coming out of the ground in the middle of the road between Bath-tub Campground and the confluence of Rucker Canyon and the North Fork of Rucker Canyon (personal communication, Velasco 1999).

Changes in dealing with the sedimentation problem began in 1977. The practice of opening the valve every other year ended because of concerns for the effects it had on habitat for the Mexican stoneroller (*Camptostoma ornatum pricei*), a native fish that occupies the stream below the dam. In response to this change in management, six gabion basket retention dams were constructed upstream from the lake in 1979 to trap sediment. These were cleaned in 1980, but it was determined that the retention dams were too small to catch a significant amount of material and cleaning them did not remove all that was caught (Lefevre 1979; personal communication, Velasco 1999). Dredging of the lake was continued on a regular basis by contract and by joint projects with the Arizona Game and Fish Department in 1979, 1986, and about 1990.

The sedimentation problem continued, and became more of a burden each time the lake was dredged because of increasing costs. In 1982 and 1983 a watershed survey was conducted by the Forest Service to determine the source of sediment. The uplands were found to be heavily vegetated with nearly 100 percent ground cover on the forest floor with the exception of a number of rock slides. These rock slides were identified as the source of material to the channel. The channel itself was found to be in stable condition in spite of conducting large amounts of material. Flood-prone areas along the channel supported well-developed

stands of cypress, pine, and various species of oak. These flood-prone areas were assumed to be composed of gravel carried to the site during prehistoric events. In 1983, it was determined that not all those events were prehistoric. The trail in Bear Canyon (a tributary to Rucker Creek) shows evidence that large amounts of material have moved since construction of the trail. Blazes on trees that were put in place about 1.2 m (4 ft) off the ground are now ankle high.

1994—The Rattlesnake Fire

The Rattlesnake Fire burned about half of the 1900 ha (4700 ac) Rucker Canyon watershed during 1994. The fire area was not seeded artificially as part of a burned area emergency rehabilitation. However, the uplands were inspected for evidence of fire severity. Overstory vegetation throughout the transition coniferous forest had been killed by the wildfire. The pre-fire ground cover, which consisted mostly of forest floor litter, was reduced to zero. The pre-fire closed canopy had not allowed for much development of ground vegetation. Unlike most of the rest of the burned area of the Rattlesnake Fire, the Rucker Canyon watershed did not have a good seed source for reestablishment of ground vegetation.

Post-fire runoff was predicted to be dramatically higher than pre-fire conditions (Figure 2). The stream channel was inspected and appeared stable in the reach immediately upstream from the lake. There were no signs of large amounts of deposition except in the campground and lake. It was about time to dredge the lake again based on the history of dredging, but the sediment yield from the burned watershed was much greater than any previously witnessed. The lake filled in quickly and aggraded up the channel, completely covering the campground area with about 76 cm (30 inches) of new material.

1996—Recovery Processes Assessed

Alluvial material found in the channel appeared more angular than that found deposited in the lake. This would indicate that the material in the lake had been in the riparian and channel system a long period of time compared to that now found in the channel. Erosion in the burned area of the headwaters of the watershed obviously has provided a large source of fresh sediment. High streamflows have subsequently carried this material through the channel system and into Rucker Lake. It was estimated that more than enough material was stored in the channel to fill

the lake with sediment again in a short period of time.

The "toe" of a fresh deposit of erosional material was found about 2.4 km (1.5 mi) upstream from the lake. An interpretation of this observation in 1996 was that material was moving through the system in waves. The channel between the point of fresh alluvium and the lake appeared to have few if any signs of newly deposited material, signifying that the worst sedimentation was yet to come.

The uplands were monitored with photographs, and recovery was found to be very slow. Gullying was observed in the upper watershed. Soil movement in the upper watershed was calculated using the Universal Soil Loss Equation. Losses in the burned area were estimated to be four times the amount in unburned areas. Delivery of sediment to the channel was estimated to be about three times that of unburned areas (Lefevre 1996, 1997).

In addition to the observations described above, a more detailed channel investigation was conducted in the vicinity of the Rucker Lake Campground, where new deposits had buried some picnic tables, tent sites, and campfire grills. It had been proposed to construct a dike to protect areas of the campground that had not yet been impacted from future sedimentation or channel encroachment. It was determined that the channel could be steered to the north side of the canyon for storms up to the 25-year event by constructing a dike 1 m (3 ft) tall. This evaluation was made assuming that the new deposits in the campground area were permanent, and that dredging them out would be futile (Lefevre 1996). Due to the cost of such a project, no dike was constructed.

1998—Upland Recovery Finally Begins

Observations in the upper watershed conducted in 1998 noted that ground vegetation had become established from seed blown in from adjacent slopes in the highest portions of the basin, and that trees had begun to fall, providing some protection to the soil surface. Also, the rate of gully formation appeared to be slowing. Midway down the slopes grass stands were becoming established, although fewer trees had fallen. The lowest portions of the burned area had not begun to revegetate significantly (Hocken 1998).

An observation of the channel conditions noted that the "gap" between the lake and newly deposited channel material had disappeared. Newly deposited material was found continuously from the lake upstream to the bend in the creek

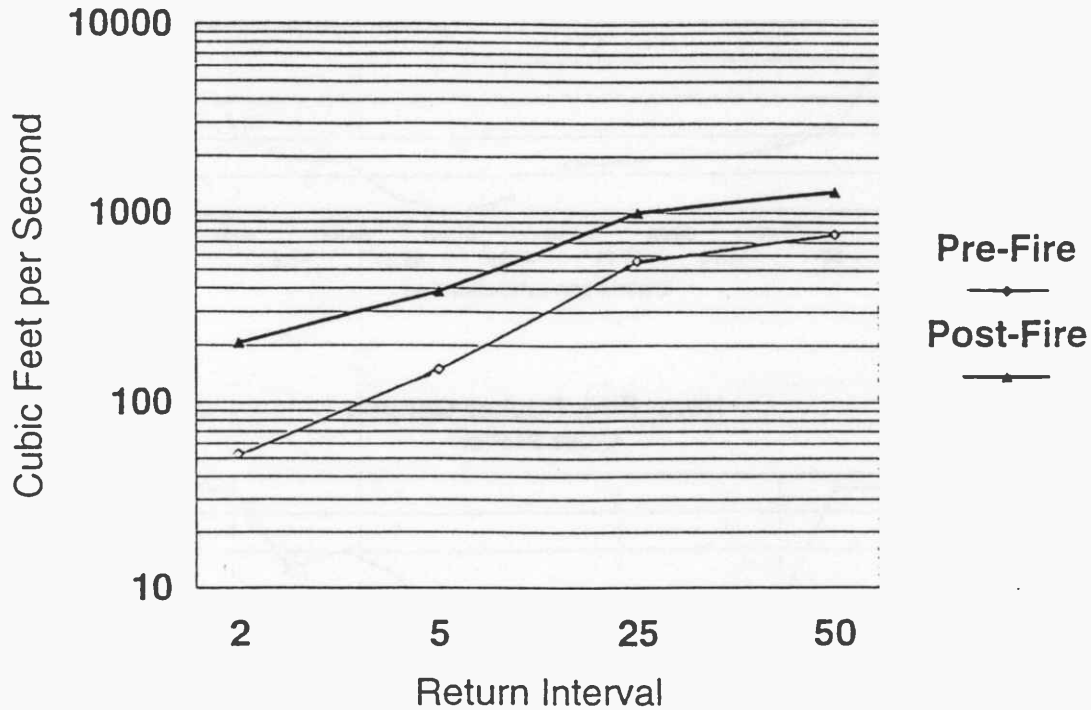


Figure 2. Predicted pre-fire and post-fire peak flows in Rucker Canyon.

and beyond. The significance of this observation was that no new wave of material appeared to be moving through the system.

The Current Situation

Channel cross sections and pebble counts in Rucker Canyon and the North Fork of Rucker Canyon (a nearly unburned tributary to Rucker Canyon) provide some important information about the current sedimentation situation (Figure 3). Cross-section data (Figure 4) indicate that in the burned watershed the entire flood-prone area is covered with water more often than the expected 1.5-year interval (bankfull discharge; Moody et al. 1998). The unburned watershed has the more desirable situation of bankfull flooding outside the channel occurring about every 1.5 years. For the Rucker Canyon Creek channel to stabilize, the banks will have to continue to build with available sediment. This should happen as fresh material is deposited on old terraces, resulting in a deeper channel. Observations of old terraces away from the active channel indicate that any new, post-fire terraces

and freshly capped old terraces will become vegetated and stable.

Channel substrate is dominated by sand and gravel in Rucker Creek, and by cobbles in the North Fork of Rucker Canyon (Figure 4). Most exposed material in Rucker Canyon appears new by its color, but previous observations of more angular material in the channel than in the lake are no longer true. Apparently new material is being transported all the way to the lake and deposited on top of the older material. In addition, small-sized older sediments from the slopes and terraces of the channel are being mixed with new material throughout the channel. Because of the smaller size of the alluvial material currently in the channel of the burned watershed, much more sediment moves with every runoff event compared to the unburned watershed.

The situation of frequent flooding and small-sized material has resulted in terraces along the channel receiving additional sediment since the 1994 Rattlesnake Fire. These terraces have been in place for many years, as evidenced by the old trees

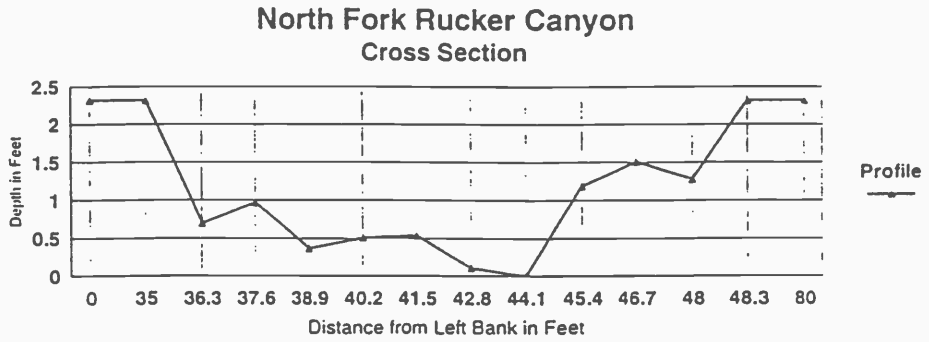
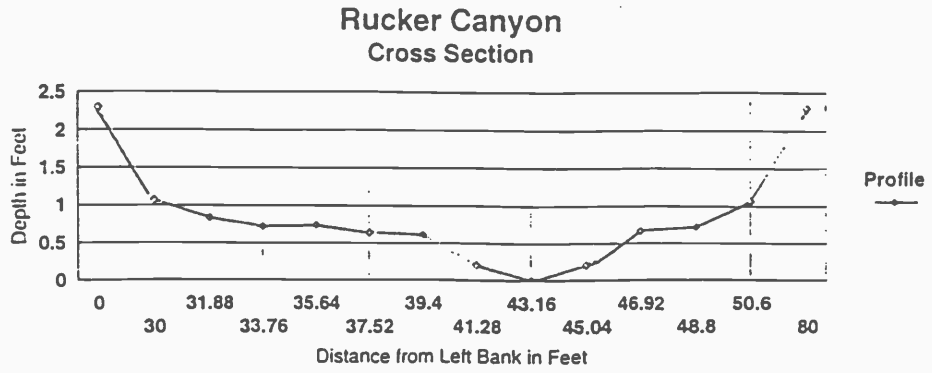


Figure 3. Cross-sections of Rucker Canyon Creek (burned) and the North Fork of Rucker Canyon Creek (unburned).

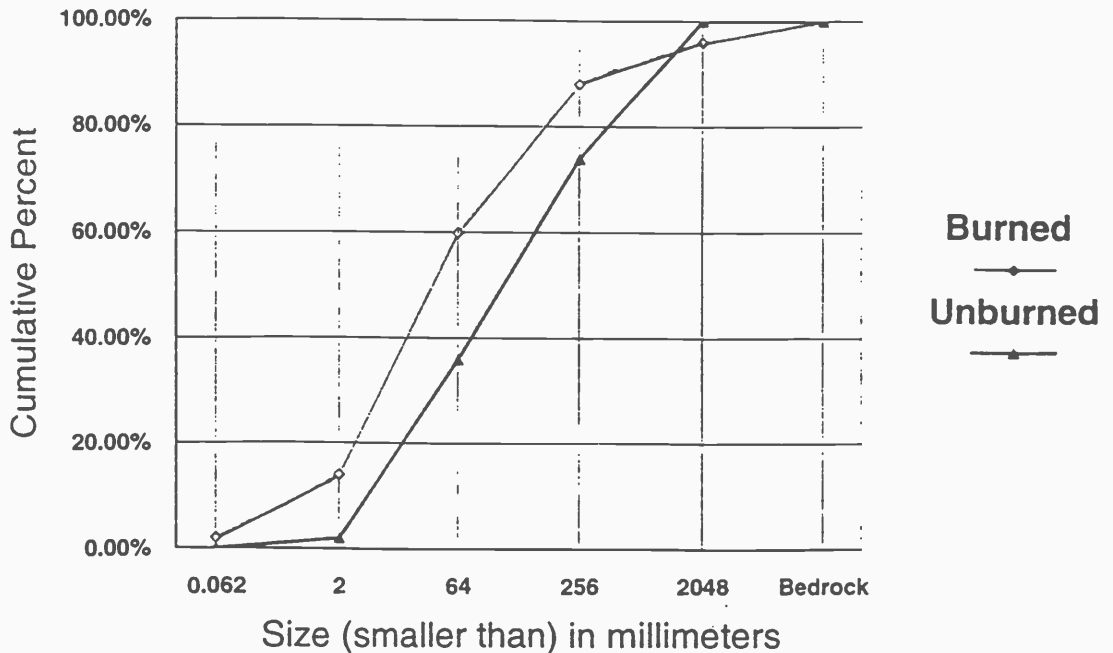


Figure 4. Stream substrate composition of Rucker Canyon Creek (burned) and the North Fork of Rucker Canyon Creek (unburned).

found on them. Future channel development will most likely consist of adjustments in depth and width to carry most flows within the confines of the new terrace situation. New terrace elevations should become stabilized with vegetation.

Observations were made in the winter of 1999 of two major channel reaches upstream from Rucker Lake. The channel conditions and trends are described below.

Rucker Creek Channel from the Campground Upstream to the Bend

The channel is formed on old alluvium similar to that brought in since 1994. Some new terraces have formed, and some old ones have received a veneer of new material. There is ample evidence of fresh erosional material being stored in the channel in lower-gradient reaches. This stored material is smaller and more mobile than the substrate of an adjacent unburned channel. Most of the stored material is behind temporary debris dams. These pockets of stored material may be stable for many years, allowing new vegetation to establish. However, when the material forming the debris dam decays or otherwise breaks down, the creek will downcut through the stored sediment, carrying much of it downstream. This process has apparently been happening for many years and is not something new caused by the Rattlesnake Fire.

Rucker Creek Channel Upstream from the Bend

The creek channel turns abruptly from the point where the trail leaves the canyon bottom. Upstream, the area is characterized as a bedrock-confined channel with vertical canyon walls. There is very little material stored in this reach, as its gradient is steep enough to produce the streamflow velocities needed to process all the sediment transported in from upstream. It stays scoured to bedrock. The channel is acting as a pipe, moving water and sediment debris efficiently from the uplands to the lower reach of the channel. As in the lower reach, there are a few debris dams storing material, but this process is insignificant compared to the role this reach plays in moving material. Observations were made at the mouths of all tributary channels and only two were found with any indications of residual sediment. Most were steep bedrock chutes. Apparently most of the fire-generated sediment material is transported very efficiently from the upland gully systems to

the main channel of Rucker Canyon, and ultimately into Rucker Lake.

Rucker Lake Campground

The alluvium aggrading through the campground should be considered the new base level. Even if the lake is dredged, this new terrace will remain. Trying to dig out areas around the picnic tables and grills will be temporary because they will fill back in. If a campground is desirable here, the facilities must be on the new level. The same goes for a new road crossing to get from the main road to the campground site; the existing level of gravel should be considered a new base level.

Management Opportunities

The channel is quite efficient at transporting material from the upper watershed to the Rucker Lake area; when the upper watershed is stabilized at pre-fire conditions, it is likely that sediment loads will be similar to pre-fire conditions. Such conditions are expected 5 or 6 years after the fire, but may take much longer. The best circumstance expected will be that of a high sediment yield system similar to the situation before the Rattlesnake Fire. Rucker Lake could be dredged and maintained as a recreation facility at a cost similar to that experienced prior to the Rattlesnake Fire. That would mean dredging every 3–6 years.

The campground can be reconstructed at the new terrace level, but it must be recognized that the channel within the new terrace is not yet stabilized. It may continue to move laterally through the new deposits until it reaches an appropriate course for the gradient and sediment load.

Conclusions and Implications for Other Areas

There are other recreation lakes in southeastern Arizona and over the years there have been proposals for more recreation lakes. The observations made in the Rucker Lake case are that such lakes carry high maintenance costs due to the naturally high sediment loads characteristic of the steep mountain watersheds in southeast Arizona. Rucker Lake essentially functions like a debris basin. These structures are very efficient at trapping sediment but they have a high maintenance cost. Changes in upland watershed conditions induced by wildfires will disrupt maintenance schedules and temporarily increase costs.

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