

# A Value in Fear

## Some Rivers Remembered

BY LUNA B. LEOPOLD

I stared at the snow-covered peaks of the Brooks Range that seemed to hover over this glaciated valley in Alaska. It would be some hours before the airplane returned with the rest of my research equipment. I laid my rifle across my knees and focused on the local scene. I was completely alone.

A wide gravel bar in the John River stretched away downstream. The rocks were rounded as usual, but what impressed me was the uniformity of size; they were all about the dimensions of a lime. Why were the gravels so uniform, well sorted, and small? This is a big river, and the Brooks Range snowmelt provides plenty of water. But the explanation is more complicated. Across the river was a vertical bank some four meters high against which the water impinged at high flow. The top of the far bank was flat, obviously a terrace, the remnant of a former floodplain. The exposed material underlying that surface was made up of gravel similar to that under my feet. These rocks must have been worked over, rounded and sorted not just by one, but by two or perhaps more glaciations during the Pleistocene.

As I looked across the gravel to the bordering thicket, I wondered how long it would take a grizzly bear to cross that narrow open space. I realized then, but did not want to acknowledge it, that I was afraid.

I remember traveling with my father, Aldo Leopold, in northern Arizona on the way from Heber to Globe. The sky was threatening and the sound of thunder indicated a storm was close by. It had not yet begun to rain, but we looked around for shelter. My father asked, "Are you afraid of lightning?" No, I replied. "Well," he said, "then you have never been on the Mogollon Rim." A few minutes later rain poured out of the sky, and a lightning bolt streaked down the trunk of a ponderosa pine not 30 meters away.

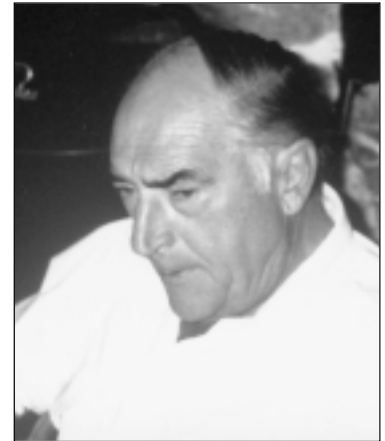
I was too young then to give much thought to the power of rivers, the magnitude of glaciers, or the time required to reduce a large rock to the size of a small fruit. And I was too young to understand how small we human beings are. I am not so young anymore.

Along this river in Alaska I had plenty of time to think—perhaps more time than I wanted. I thought about fear. Fear in the wilderness is different than fear experienced on a dark street where a moving shadow might be a depraved or irrational *Homo sapien* after my wallet. But a grizzly bear cares nothing for my wallet. Protecting its offspring is everything.

### Fear Then and Now

As I waited for the plane, my mind wandered again, this time to the ancient people whose tools and rock flakes I have been studying near my home in Wyoming. Their crude hand axes were used to skin animals, cut flesh, and break bones. I visualized a man standing on the hillside near where my house now stands, looking out over the valley as he methodically picks out just the right kind of yellowish quartzite that will break into sharp flakes. He is alone, as I am now. He must be thinking about antelope, or the flesh obtained during the last communal hunt, and whether he must be content this day with the humdrum roots of wapato baked in the rock-lined depression he constructed near the river.

I imagine this man has little to fear except hunger. So what makes me fearful? I again turn my attention to the far stream bank. It is several meters high, meaning that at some time in the past, very recent in geologic time, this big river flowed over a gravel plain some meters higher than now. The gravel exposed in the far bank was deposited as successive point bars. The rounded rocks under my feet have no doubt been in the outwash plains of at least one and possibly more glaciers.



Article author Luna Leopold. Photo courtesy of the Aldo Leopold Wilderness Research Institute.

This river is wild, and it is the culmination of natural processes that shape alluvial rivers. These interrelated physical processes that influence width, depth, velocity, slope, roughness, and bed material have been well described, but they have not been integrated into an ecological vision of how alluvial rivers work. McBain and Trush (1997) attempted this integration based on their long experience observing and measuring rivers in the field. To integrate these processes into an ecological vision of how alluvial river ecosystems work, they described a set of 10 attributes characterizing healthy alluvial rivers. For example, a healthy river, able to reshape its bed and banks, moves the surface layer of gravel for a few days each year, but once every few years, the riverbed is completely set in motion. Point bars are rearranged and stands of cottonwoods or willows are severely damaged or washed away. By such occasional events, channels form and the riparian borders are reset. A controlled river deprived of these resetting events becomes fixed in form and place by a border of vegetation too firmly established and too large to be moved. The river traps itself by the living border it planted, nurtured, and watered.

Lost alluvial function has extreme ecological consequences. On the Trinity River in northern California dams isolate salmon from most of their upriver spawning grounds, and previously mobile gravel bars, now bordered and anchored by dense alder stands, cannot provide slow-water habitat required for rearing salmon young. Periodic cleansing of sand from spawning gravels is prevented by lack of flows capable of mobilizing the channel bed. The set of alluvial attributes provides a convenient thermostat for gauging river ecosystem health.

A passing raven broke my river reverie, and I realized that my initial spasm

of fear had been ameliorated and transformed into inquiry. Fear had apparently opened my mind to things unrelated to this river, this day, this trip.

### **Studying How Rivers Work**

My plan for a river attribute measurement program was clearer now that I saw the size, form and character of this river and its landscape. No data of any kind were available for this region, so the slate was clean. It was real wilderness. The first job to describe and understand this wild river was to make a sketch map, then survey a cross section, measure the velocity distribution, compute the discharge, run lines of level to establish the slope, and make a pebble count to record the size distribution of gravel. This same procedure will be carried out near the mouth of every tributary, and at successive points along the master stream. These data provide the basis for understanding the hydraulic geometry of channels of different size and changes in the downstream direction. From these measurements, many quantities can be estimated. But how accurate are these estimates? To answer that I decided then to choose one of the few wild rivers in the United States where extensive long-term data had been collected. Before inspecting those data, a single river trip would be organized to take the same measurements on that river and its tributaries as we would later on this river in Alaska. Estimates would be made of various quantities and compared with analyses of the extensive record.

I contemplated the relationship between this planning and my initial

fear. It seems that a modicum of fear in the gut sets off a train of mental processes that might be not only healing but perhaps innovative.

The airplane arrived in the rain, and there was a flurry of activity. We set up camp, sorted equipment, and prepared for work. By mid-afternoon we were organized. We stretched a tape across the river with the help of Smuss, who ran the boat. The drizzle had stopped, so I brought out the plane table, surveyed the cross section, and began the longitudinal profile.

In the morning we counted rocks. The gravel was so well sorted that there was a scarcity of both large and small pebbles. We packed the boat and proceeded downstream to the first tributary, where the process was repeated. And so it went day after day in cold cloudy weather punctuated by rain. We had one night of a damn cold freeze. It was a typical fall season in the Brooks Range.

The uniformity of gravel size was such that at one place the river bed was so level laterally that the water depth was uniformly shallow, too shallow for our heavily loaded boat to pass. We got out to lighten the load and pull the craft. When at last it finally scraped by, the bow came over me and I emerged from the river wet and cursing; the next several days were miserable.

When we finally reached the Koyukuk River, the only large enough gravel bar for the plane to land on consisted of large rounded rocks the size of watermelons. It was the roughest landing strip I have ever seen an airplane negotiate. When the airplane was loaded and Chappie gunned the engine, fear

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The Middle and Main Forks of the Salmon River stretch for nearly 180 miles through the Frank Church River of No Return Wilderness in Idaho. Photo courtesy of the Aldo Leopold Wilderness Research Institute.

again hit me as I realized that the laboring plane might not make it. It did.

I often think back on those uncomfortable days, the big moose in the muskeg, and the morning I stepped out of the tent to find footprints of both a wolf and a bear in the mud of camp. I was young, but old enough to appreciate a wilderness with clear water, unbroken soil, spruce edged muskeg, and animals present, though unseen. Aldo Leopold once wrote, "Is my share in Alaska worthless to me because I shall never go there?" I was luckier than he.

## More Wilderness Rivers

The plan of investigation formulated that cloudy day on the gravel bar materialized. I chose the Middle Fork of the Salmon in Idaho, on which very good stream-flow data were available. A trip on the Middle Fork in 1965 was well before the crush of commercial rafting in the final decades of the 20th century. The measurements made were identical to those we took in previously unmeasured Alaska.

Data on the Middle Fork came from six gauging stations, records of which

totaled 140 station years, each station being equipped with continuous recording equipment that operated 24 hours a day. Our trip down the Middle Fork consisted of taking measurements at seven locations along 100 miles of river, measurements at each location consuming one-half to three-quarters of a day. Comparisons were made for a variety of parameters.

Some hydrologic information depends on a continuous record, such as storm hydrographs, but many crucial parameters can be obtained quickly and inexpensively by direct measurements made in a few weeks. The values of bank-full discharge are more consistent and extend over a larger range of flows for the river-trip data than in the published record. The hydraulic geometry, values of width, depth, and velocity as a function of discharge, are comparable in the two sets of data. With regard to mean annual discharge, the river-trip data failed to discern that in the Salmon River, average flow per square mile decreases with increased drainage area. For this reason the estimates of mean discharge from river-trip data are very good for large drainage areas, but too low for small areas. In summary, estimates of significant flow parameters useful for geomorphic description are more complete than long records at instrument stations (Leopold and Skibitzke 1967).

The last scientific expedition in the Grand Canyon of the Colorado before the gates of Glen Canyon dam were closed, was my trip in the middle 1960s. The water was brown and warm, not the frigid benthic green deprived of the sediment a river needs to function as a river. The great sandbars seemed limitless and welcoming, driftwood was everywhere, tamarisk nonexistent. It was a different world from the overused and less-appreciated world of commercial rafting. Over the course of our trips, we plotted and

measured water depth in about 6,000 places. We floated the Green from Vernal to the mouth, the San Juan, the Colorado, Moab to Lake Mead.

## Fear Remembered

The main stem of the Colorado was running fairly high, 50,000 c.f.s., higher than all the releases from Glen Canyon can now muster—and there were enough tough spots to curl your toes. Each big rapid required scouting and careful choices. The most memorable one was Lava Falls. Our little crew gazed with trepidation at the giant hole, the spray rising 25 feet above the churning surface. At long last, Smuss spoke. "I want a volunteer," he said slowly. "If we make it we can pick up the people from the second boat. If we don't, it's only two of us." I was the leader.

The experience of fear in a wild landscape, even of short duration, leads to a reorientation of mind. It can clear out the clutter of the modern scene and allow one to see life and land in a new context. These moments will be long remembered. My time in Alaska, on the Colorado River and its tributaries, on the Middle Fork of the Salmon, and on the Mogollon Rim with my father, was a coming of age. **IJW**

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