Arroyo Formation, Juab County, Utah, 1983

James L. Baer

The 1983 water year in Utah was the wettest since precipitation records have been kept. Storms were not only more frequent than normal but many were also more intense. In some areas, mountain creeks that normally ended on alluvial fans now carried enough water to traverse the alluvial fan into nearby arroyos. These arroyos in normal years have short-lived streams or flash floods in their channels. During wet years, like 1983, they can have sustained flows for several days to a few weeks. These sustained flows can cause rapid headward and channel erosion. Such was the case for Chriss Creek in Juab County, Utah.

Chriss Creek drains a relatively small drainage basin of approximately 12 square miles. In normal years its water seldom reaches more than 1.3 miles beyond the mountain front and is lost into the alluvial fan. The channel beyond this point is poorly defined and in many places overgrown with sagebrush. At a point approximately 1.3 miles southwest of where the channnel character is lost another channel appears. This channel differs in two main ways from its discontinuous upstream channel. It has shallow cross-section with a depth to width ratio of 1:15 and a slope of 26 feet per mile. The upper channel has a depth to width ratio of 1:8 and a slope of 110 feet—over four times greater than the lower segment. Because the lower disconnected segment is so shallow with a low gradient it was inferred that it did not carry significant runoff. In all probability this lower channel carried periodic flows of groundwater during times of high watertable.

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Editor's Note: Readers may wish to see the article "Gully Erosion" by E. Arthur Bettis III and Dean M. Thompson, which was published in *Rangelands* 7(2):70-72.

Prior to June, 1983, this lower channel segment extended for another 2.5 miles where it connected with a steep arroyo with a slope of 130 feet per mile and a depth to width ratio of 1:3. It was from this intersection that the rapid headward erosion began sometime in late May to early June, 1983.

On June 11, 1983, while conducting a field geology class, I happened upon a waterfall in Chriss Creek. The waterfall had developed over a 17- to 20-foot elevation difference and the newly developed arroyo differed markedly in size and shape with the upstream channel. The waterflow, which at that time was flowing approximately 55 cubic feet per second was eroding the streambed at a high rate. After a short observa-

Waterfall as it was at the beginning of first observation, June 11. Fall is nearly 20 feet.

tion period, I decided to mark the erosion progress. In the next four days, June 11 through June 15, 1983, I was able to observe and measure the erosion rate three times for periods up to six hours long. During these periods, I recorded the erosion process by photographs and taking measurement every 30 minutes. Markers were placed at the location of the waterfall at the time of the last observation and again upon return and the distance difference measured by steel tape. I found the rate of erosion to be surprising.

On June 11, the erosion was observed for six hours. The rate of headward erosion was 4.7 feet per hour with a volume of 1450 cubic feet of material being eroded per hour. The process was unvarying. The waterfall developed a 10 to 14 foot wide plunge pool at its base where this whirling water would undercut both banks as well as upstream. The material being eroded was wet, unconsolidated silt with lenses of

Bank erosion occurred by undercutting and gravity fall of blocks. Here a block falls from the left bank during the first day of observation, June 11.

fine sand and occasional thin gravel layers. This material was easily eroded by the moving water. But it was the caving from the banks that was the major contributor to erosion volume. These blocks would fall at a rate as high as one every three minutes. Some blocks were 16 feet long, 13 feet high, and 3 feet deep. The area was covered with sagebrush at a density of one per 30 square feet. There were also small patches of grass that dotted the landscape. The plants offered little impedence to the advancing erosion primarily because the cutting took place 10 to 12 feet below the root systems of the sagebrush. The sagebrush served mostly to hold together the blocks before they fell into the stream. The sagebrush crested blocks would sometimes serve as temporary dams that would block the stream momentarily. Eventually, the water would spill over the debris and within a few minutes there would be no trace of the block as the detached sagebrush plants washed downstream. Occasionally, these sagebrush plants would hangup and create an eddy or small whirlpool in the stream. This would allow the stream to undercut the bank downstream from the waterfall and cause isolated blocks to fall, further widening the new channel. Crude measurements of the water volume indicated approximately 55 cubic feet per second going over the fall. At this time the water was falling between 18 to 20 feet.

During the 48 hours that followed, the channel cut headward nearly 440 feet at a rate of 9.1 feet per hour and a volume of approximately 3100 cubic feet per hour was carried away. By now, the erosion had progressed so far upstream that a

Headward erosion as seen from the spot of figure 1 on June 13. Waterfall has moved 440 feet upstream in 48 hours.

picture taken from the spot of the first day's observation did not show the waterfall. During this period, the erosion had cut into a nearby road, threatening safe passage.

The second period of observation, June 13, was 5.5 hours in length. The erosion scheme was the same, but the rate had increased over four times. Headward erosion was 21 feet per hour, and the eroded volume had increased to 7,100 cubic feet per hour. The fall had decreased slightly to 16 feet, but the average channel width had increased to 21 feet. The approximate rate of water flow had increased to approximately 70 cubic feet per second, and the water level was noticeably higher in the upstream channel.

No observation could be made for the next 52 hours because of other responsibilities. Upon return to the site on June 15, the waterfall was much less (Fig. 4). During the 52

Waterfall at time of last day of observation, June. 15. Fall is now just less than 6 feet. Erosion had taken away part of nearby road.

hours, the headward erosion had progressed another 597 feet at a rate of 11.5 feet per hour, nearly 10 feet per hour less than the previous observation, clearly showing the erosion rate was lessening. During the four hours of observation on June 15, the headward erosion was progressing at 0.7 feet per hour—virtually a snail's pace. The stream was now to where it occupied less than its prescribed channel and was flowing approximately 36 cubic feet per second and the fall was 6 feet and decreasing.

During the 115.5 hours from the first observation to the last, the channel cut headward 1210 feet, or an average of 10.5 feet per hour. Approximately 395,000 cubic feet of material was removed during this time at an average rate of over 3410 cubic feet per hour. Examination downstream showed that an additional 3,300 feet of new channel had been eroded during this erosional phase in late May-early June, 1983, and an estimated 1,580,000 cubic feet of material (total) was washed downstream. The channel was approaching the point of no fall. The new channel has a slope 60 feet per mile.

Chriss Creek is presently dry, but forecasts indicate that runoff in the spring and summer of 1984 for this part of Utah is expected to be equal or greater than 1983. The case of Chriss Creek was only one of several rapid erosion creeks in central Utah during 1983. This erosion could be minimized by upstream diversion of placing hard-to-erode material at the head of the arroyo.

Percent Composition versus Absolute Units of Measurement—A Viewpoint

E. William Anderson

The 1983 report by S.R.M. Range Inventory Standardization Committee (RISC) recommends some worthwhile improvements in concepts and definitions applicable to contemporary rangeland procedures. Of these, the terms range condition, ecological status, and resource value ratings are significant and require attention to several factors, one of which is the procedure used to document the make-up of a plant community.

Historically, the degree to which each species occurs in the plant community has been expressed in terms of percent composition. For example, guides to determining range condition (RISC recommends the use of the term ecological status) have shown the percent composition of each species in the potential natural plant community (PNC). Range condition class has been determined by comparing the percent composition of species, or groups of species, in the present plant community with that of the PNC for the site being rated. Trend in range condition has been judged on the basis of changes in percent composition of species as compared to previous readings. The identification of decreaser and increaser species and their dynamics in the stand has been based on comparison of percent composition of these species in the present plant community with that of the PNC.

While composition is a useful term when used properly, e.g., 40% of the total canopy cover (or other absolute measurement) consists of grasses (or a species), it is not a quantified or absolute measurement. It merely expresses the relative proportion of one species, or a group of species, to the total of all the species in the plant community. The total composition of all species always equals 100%, irrespective of the make-up or density of the stand. As the RISC report states, 'specifying the amount of a species in a plant community implies that an absolute measure is required, rather than a species list or the composition alone'. Quantified or absolute measurements of a species include cover, density, frequency and weight. Non-quantified measurements of a species include cover classes, dominance ratings and percent composition.

Using percent composition as a measurement of a species involves a number of erroneous interpretations. This is illustrated by Figure 1 which depicts three hypothetical plant communities: A, B, and C. For illustration purposes, each plant community consists of the same two major species; one large, the other small.

Plant community A has twice as much total quantity as plant community B for a given area, yet the proportion of the large species to the small species is identical in both plant communities: 70% composition large species and 30% composition small species. This points out that percent composition does not necessarily reflect the density of a species in the plant community.

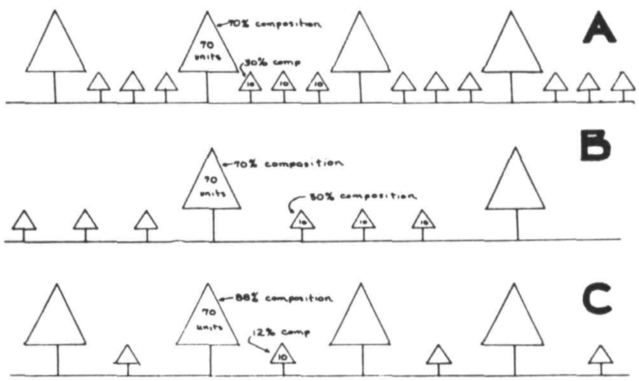

Fig. 1: *Three hypothetical plant communities consisting of the same two major species; one large, the other small.*

Numerous reports cite changes which have occurred in plant communities in terms of percent composition. This is a useful way of describing, in general terms, what has taken place. Nevertheless, the quantitative measurements of such changes should be made available for scrutiny because changes in composition do not necessarily coincide with quantitative or physical changes that take place. A comparison between plant communities A and C in Figure 1 illustrate this point.

Plant community C represents a deteriorated stage of plant community A in that two thirds of the small species has been destroyed, hypothetically, by past grazing. Quantita-

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