Priorities for Riparian Management

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All streams and riparian areas are not created equal. Some have potential to provide higher resource values, some dramatically reflect watershed and riparian management, and some are in the midst of long-term geomorphic evolution. The Nevada Riparian Management and Research Task Group, an ad hoc interdisciplinary team, developed a classification for riparian areas that may be useful for all land management disciplines in all land management agencies.

The classification system they initiated was described by Swanson et al. (1988). It is part of the foundation for classification of "riparian community types" throughout National Forest lands in Nevada. The Stream Classification system (Rosgen 1985) that is incorporated into the riparian classification system has been the subject of six week-long short courses. It has also been incorporated into the computerized General Aquatic Wildlife System (GAWS) developed by Region 4 of the Forest Service.

Perhaps the most useful aspect of riparian classification is the education one gets from using it. By trying to understand the management implications of stream types, some lessons in stream mechanics become apparent. Also, knowing the function of riparian vegetation is a natural first step for setting riparian management objectives. Some of the lessons learned have been used to develop an approach for selecting priority stream reaches in order to wisely invest limited riparian management time, effort, and money.

Historical Perspective

The history of use of the American West has left today's land managers with many riparian problem areas. Many streams that were altered by overuse of riparian vegetation, by roads, trails, straightening, dredging, or by an altered watershed, have downcut, and are now becoming gullies. Some streams have been gullies for decades.

Streams suffering from inappropriate grazing management practices may change gradually over a period of many years. At any time during this period of gradual change, riparian vegetation with access to a high water table could respond rapidly to improved management. Riparian vegetation could then help heal these stream banks relatively fast.

However, as change occurs, some streams pass a point of "no return", becoming a gully. When a stream passes this threshold (Van Havern and Jackson 1986), it must progress through a series of steps in its long-term process of recovery. These steps are very different from the previous condition of the stream.

As years pass, additional streams experience big runoff events that trigger important long-term changes in stream morphology. In the Intermountain West this happened to many streams in the early 1980's. Successive heavy-snow winters produced abnormally prolonged periods of high flow.

When stream morphology is approaching a threshold of gully formation, substantial effects can result during a flood if either or both of two conditions occur:

1. Streambank vegetation has been weakened and can no longer hold the streambank well enough to prevent serious bank erosion; or
2. The forces working on streambanks and channel bottoms become too great because the stream has straightened and become too steep or has downcut and lost access to its floodplain.

Function of Riparian Vegetation

It is not uncommon to see stream banks that are stable because of the tough sod produced by plants that thrive with a high water table. Some Nebraska sedge-*Carex nebraskensis,* dominated riparian communities have an average of more than 100 feet of roots and rhizomes per cubic inch of soil near the ground surface (2m/cm3). It is no wonder that this plant and other broad-leaved sedges have gained a reputation for stabilizing sediment and binding streambank soil.

Besides binding soil that would otherwise erode, vegetation provides roughness at the water-land interface. This decreases water velocity and the energy available for transport of sediment. The filtering effect of riparian vegetation is partly responsible for deposits of fine fertile soils on many floodplains such as mountain meadows. Within the active channel, vegetation also traps and stabilizes sediment on point bars. Thus, streams recovering from bank erosion tend to become narrower.

It is natural for low-gradient (<1.5%) streams with floodplains to meander. The process of forming meanders involves a balance between erosion on the outside turns and deposition on the inside turns. In order for meandering streams to remain stable, the rate of these two processes must remain about the same. If the outside erodes faster than the inside captures and stabilizes sediment, a narrow deep stream will become wider and shallower. A stream that provided good habitat for cold-water fish such as trout may become too clogged with sediment, exposed, and warm.

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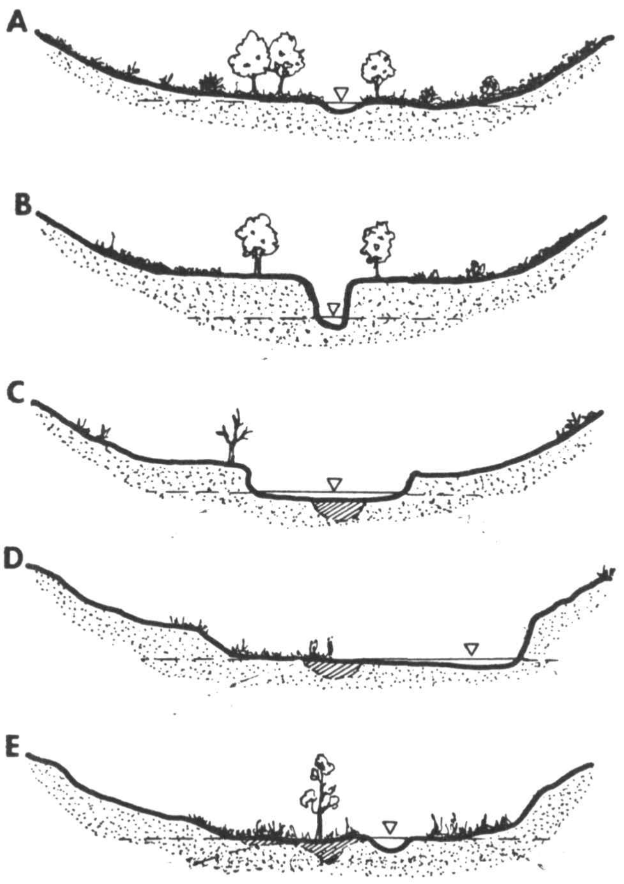

Figure 1. Phases in arroyo (gully) evolution (after Elliott 1979).

As the stream widens, the stream pattern changes accordingly. It may break through meanders and the broad sweeping curves of the new channel decrease stream length. The now-shorter stream must still drop the same elevation. Therefore, as the stream straightens, the slope steepens and velocity increases. Stream energy is thus expended over a shorter length of channel and may accelerate erosion.

Function of Floodplains

Narrow meandering streams commonly flood a broad floodplain, adding to a high water table (Fig. 1 A). A higher water table provides abundant water to vegetation that in turn provides the bank stability upon which stream morphology and the high water table depend. The broad flat floodplain is necessary for dissipation of energy during flood events. It also stores floodwater for future streamflow.

Tractive force, or the ability to detach and carry sediments, is directly related to depth of flow and stream slope. Therefore, as a stream floods it has increased energy available for erosion largely in proportion to the increase in depth. A stream that can spread out over a broad floodplain increases depth only a small amount during a flood; therefore, it can withstand floods of tremendous magnitude with little erosion. Floods on such streams will generally deposit fine sediment on the floodplain and build stream banks.

Gully Erosion

Any net loss of channel material, such as bank erosion, causes a stream to lose some access to its floodplain. As a stream loses its opportunity to dissipate flood energy over a floodplain, the more confined stream begins or accelerates the process of downcutting. Often, one or more headcuts move upstream. Eventually the stream may become totally confined in a deep narrow gully (Fig. 1 B&C). Then the concentrated energy of flowing water causes rapid erosion.

Immediately following gully development, stream width is the same as the gully-bottom width, the old floodplain is a terrace, and there is essentially no floodplain. During this phase erosion is rapid and mostly downward until the stream reaches local base level or an erosion-resistent layer. Thereafter the concentrated energy continues to do work by eroding the gully walls. It also inhibits vegetation from stabilizing the active channel, which becomes wide and shallow (Fig. 1 C).

The water table that previously supported dense vegetation on the old floodplain is lowered as a result of downcutting. Riparian vegetation is then replaced by drier species such as sagebrush and cheatgrass. Over-steepened gully walls typically support little vegetation because they are naturally unstable and dry.

Recovery

As the erodible gully walls spread farther apart, the new floodplain in the bottom grows (Fig. 1 D). As it widens, it grows vegetation, dissipates flood energy and collects sediment. Energy dissipation allows vegetation to grow stronger. It can then shape the active channel forming meanders and overhanging banks (Fig. 1 E). Eventually the gully may fill and the terraces become floodplain again.

Prioritizing Streams for Management

Land managers must accept the history of land use that has preceded them. By understanding that history they can better appreciate the trend of their landscapes and the potential of those landscapes to respond to management.

In an evolving landscape, it is not useful to compare what could be with what is. One must instead compare the future assuming management option A with the future assuming management option B. This must be done in individual settings to determine if possible or proposed actions will be worthwile. It almost must be done in many settings at once to determine where and how limited resources can do the most good.

Care must be taken to avoid the approach of simply attacking that which is most ugly. Efforts to rehabilitate a new gully may be expensive and risky. Efforts to prevent a gully or rehabilitate an old gully with a widening floodplain may be cheaper and provide more benefit.

Highest Priority Stream Reaches

Highest priority streams are ones that still have and use their floodplain (Fig. 1 A), but could, through improper management, lose access to it through downcutting. Streams that still rely on water-loving stream bank vegetation will respond to improved riparian management strategies most quickly. This is due to the vegetative resilience that comes with water and nutrient availability, and the dissipation of energy over the floodplain.

Proper management is especially critical in stream valleys that are long and deeply filled with erodible sediments. These stream types have consistently depended upon vegetation for streambank and meander integrity. Once headcuts form, they are very difficult to heal with vegetation. The time to act is before the threshold is exceeded and the gully initiated.

Lowest Priority Stream Reaches

Lowest priority streams are unlikely to respond to management, even if they are the ugliest and even if they were once very pretty. Where a stream has downcut and is totally confined in the bottom of a gully (Fig. 1 B), management inputs to the stream channel are likely to be wasted unless structures are used to take almost total control of its drainage. Management efforts should instead be directed at the upstream and upslope watershed, or better yet, at other riparian areas and watersheds that are likely to respond more rapidly.

Protection or careful riparian management may permit vegetation to grow at the base of the gully wall. However its effect controlling erosion or improving channel morphology will likely be minimal while the gully is narrow. The opportunity for benefits to exceed costs is lowest in the early phases of gully evolution discussed above. The benefit/cost ratio for management increases as the gully bottom widens. Structural control of narrow gullies using check dams is normally cost prohibitive and risky except on very small drainages.

Increasing Priority Stream Reaches

The ability of riparian vegetation to produce a narrow stream channel, good for cold-water fish, appears to increase dramatically at about the time the gully bottom becomes wider than the active channel (Fig. 1 D). At this time the floodplain forming inside the gully can dissipate some flood energy. Riparian management then becomes significantly more important.

The benefit/cost ratio of investments increases more with gully widening if the benefits are measured on site. These benefits include improved fish habitat, riparian vegetation, and aesthetics. To the degree that sediment is a concern downstream, the rate of gully widening (erosion) becomes more important. Eventually though, the gully must widen to become stable. If sediment downstream is a big problem, the benefits from investments to prevent the gully in the first place could have paid for some rather intense management.

Selection of priority stream reaches for riparian management is only the first step. Classification can also be used to select the most appropriate management strategy for priority settings. A variety of grazing and other rangeland management strategies may be appropriate in certain settings; however, none of them is a panacea. Each riparian and upland grazing problem should be solved by choosing a remedy that fits the objectives. Land and riparian classification can be instrumental for identifying potential responses. However, monitoring that identifies the nature of the problem is essential.

Literature Cited

Elliott, J.G. 1979. Evolution of large arroyos—the Rio Puerco of New Mexico. Unpublished M.S. thesis, Colo. St. Univ., Fort Collins. 106 p.

Rosgen, D.L. 1985. A stream classification system. Riparian ecosystems and their management: Reconciling conflicting uses—First N. Am. Riparian Conference (proceedings). Tucson, Ariz. April 16-18. USDA For. Ser. Gen. Tech. Rept. RM 120, p 91-95.

Swanson, S., Miles, R., Leonard, S., and Genz, K. 1988. Classifying rangeland riparian areas: The Nevada Task Force approach. J. Soil and Water Cons., 43(3):259-263.

Van Havern, B.P., and W.L. Jackson. 1986. Concepts in stream riparian rehabilitation. Trans. 51st N. Am. Wildl. and Nat. Res. Conf. 280-289.