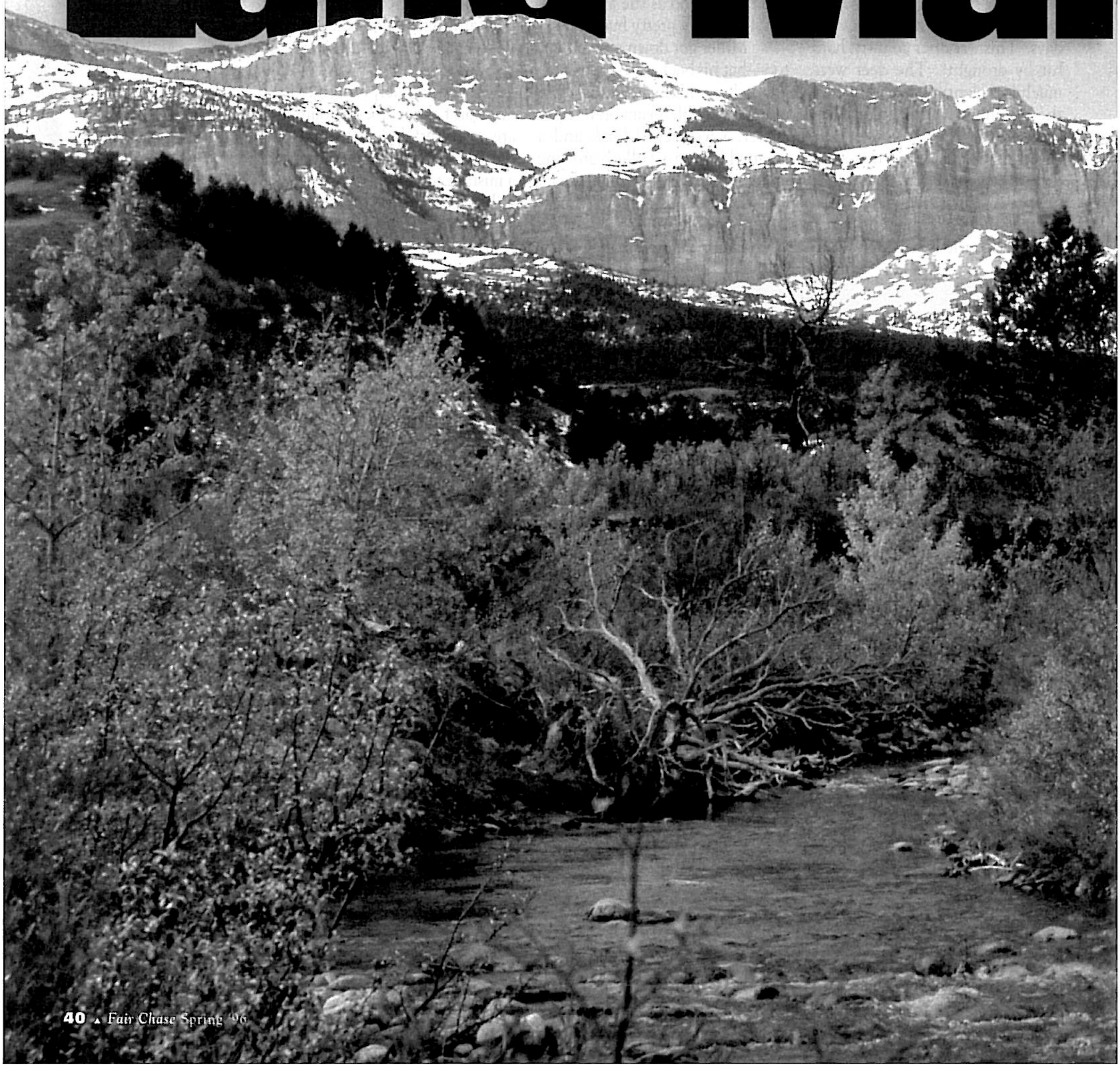
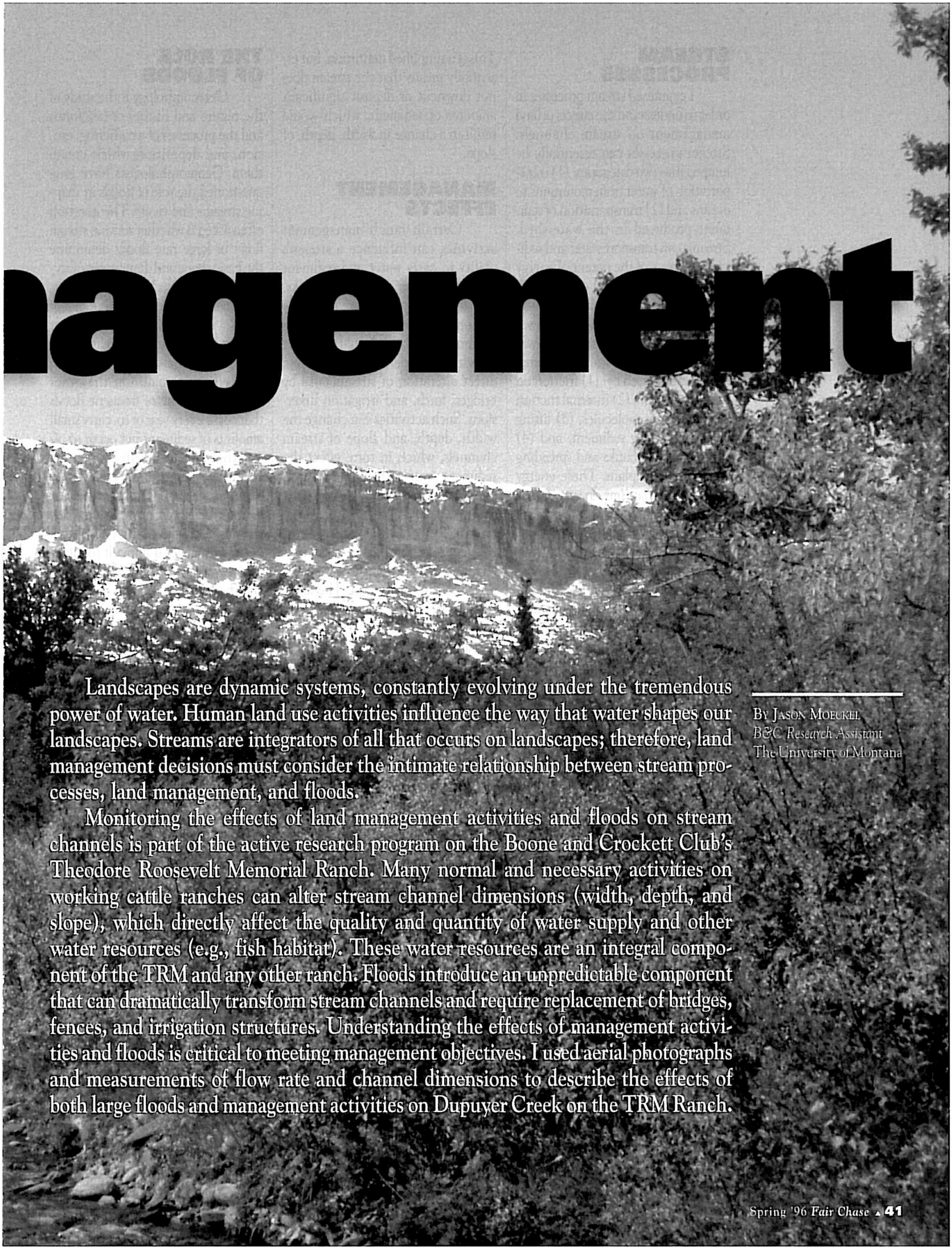
THE ROCKY MOUNTAIN FRONT

Floods & Land Man





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Landscapes are dynamic systems, constantly evolving under the tremendous power of water. Human land use activities influence the way that water shapes our landscapes. Streams are integrators of all that occurs on landscapes; therefore, land management decisions must consider the intimate relationship between stream processes, land management, and floods.

Monitoring the effects of land management activities and floods on stream channels is part of the active research program on the Boone and Crockett Club's Theodore Roosevelt Memorial Ranch. Many normal and necessary activities on working cattle ranches can alter stream channel dimensions (width, depth, and slope), which directly affect the quality and quantity of water supply and other water resources (e.g., fish habitat). These water resources are an integral component of the TRM and any other ranch. Floods introduce an unpredictable component that can dramatically transform stream channels and require replacement of bridges, fences, and irrigation structures. Understanding the effects of management activities and floods is critical to meeting management objectives. I used aerial photographs and measurements of flow rate and channel dimensions to describe the effects of both large floods and management activities on Dupuyer Creek on the TRM Ranch.

STREAM PROCESSES

I examined stream processes in order to understand the effects of land management on stream channels. Stream processes can essentially be lumped into two categories: (1) transportation of water from mountains to oceans and (2) transportation of sediment produced in the watershed. Streams can transport water and sediment because of the potential energy created by water falling on the landscape. This energy is called potential energy due to its elevation above sea level and the force of gravity. As water flows through a stream channel, energy is dispersed by: (1) friction on the channel bed, (2) internal friction between water molecules, (3) lifting and transporting sediment, and (4) overtopping its banks and spreading onto the flood plain. These energy dispersal mechanisms operate simultaneously; however, channel dimensions (width, depth, and slope) influence sediment transportation and spreading onto the flood plain. These same stream channel dimensions are determined by the amount and timing of water and sediment passing through the channel. A stream in equilibrium can transport the water and sediment produced by its watershed without major changes in channel dimensions. This is a simplified definition, but essentially means that the stream does not downcut or deposit significant amounts of sediment, which would result in a change in width, depth, or slope.

BELOW: AN EXAMPLE OF BANK TRAMPLING ON THE SOUTH FORK OF DUPUYER CREEK.
INSET: MIDDLE CROSSING OF THE DUPUYER CREEK.

MANAGEMENT EFFECTS

Certain ranch management activities can influence a stream's ability to carry water and sediment by changing the shape of its banks, altering runoff, or increasing the amount of sediment that enters the stream. These ranch management activities include: livestock grazing, direct alteration of streambanks by bridges, fords, and irrigation diversions. Such activities can change the width, depth, and slope of stream channels, which in turn, effect the sediment transport characteristics. During floods, streams overtop their banks and deposit sediment and nutrients onto the flood plain. However, bridges confine stream channels and prevent the water from reaching the flood plain. The additional water is forced to flow under a bridge, generating tremendous amounts of energy. This additional energy erodes stream banks sometimes leading to collapse or abandonment of the bridge. It also results in excessive sediment deposition downstream, degrading fish habitat (see inset photo).

Excessive use by livestock can cause soil compaction, reducing infiltration capacity, and increasing the amount of water delivered to a stream. Concentrated use of stream banks results in bank collapse and sloughing and can greatly reduce the grasses and shrubs that stabilize streambanks. This trampling widens the stream and creates a shallower stream, disrupting the sediment transport process. A stream bank that is well covered by vegetation is less likely to erode during a flood than one that is predominantly exposed gravel, sand, and fine materials. These land management activities influence a stream channel's response to floods by altering its ability to transport water and sediment produced in the watershed.

THE ROLE OF FLOODS

Geomorphology is the study of the nature and history of landforms and the processes of weathering, erosion, and deposition which create them. Geomorphologists have long questioned the role of floods in shaping streams and rivers. The question often asked is whether routine stream flows or large rare floods determine the basic shape and dimensions of rivers and streams? The answer is uncertain. Conventional wisdom suggests large floods transport tremendous amounts of sediment at once, but occur so seldom that the total effect is small. On the other hand, smaller, more frequent floods that occur every year or so, carry small amounts of sediment but occur so often that the total effect is large. However, scientists only began measuring stream channels in the last century and only on relatively few streams. This short recorded history of streams makes it difficult to differentiate between inherited features and the effects of modern stream action. Inherited features, such as gullies, abandoned stream channels, and past beaver activity can have a lasting influence on streams and must be considered whenever possible.

Dupuyer Creek on the Theodore Roosevelt Memorial Ranch is a good example of a stream with several inherited features. The most significant inherited features are the result of channel change during the 1964 flood. The 1964 flood, the largest recorded flood in western Montana, had profound effects on channel patterns throughout the northern Rocky Mountains. Channel patterns describe how the stream looks from an aerial view; for example a stream that winds its way through a valley is described as meandering compared to one that flows nearly straight within its valley. The measurement we use to describe the meandering nature of a stream channel is called sinuosity. Sinuosity is measured from aerial photographs by dividing the total stream length by the length of the valley. Before the '64 flood, Dupuyer Creek had an average sinuosity of about 1.5. Since the flood, the stream has remained significantly straighter with an average sinuosity of about 1.3. This difference in sinuosity means the stream is about 1,100 feet shorter per mile of valley and is also steeper and wider since the 1964 flood.

A stream where the sinuosity has been dramatically decreased, such as Dupuyer Creek, is subject to a shift in energy dispersal mechanisms. This shift in energy dispersal results in a change in sediment and water transport processes. Such a shift can accelerate streambank erosion, possibly increasing sinuosity to previous levels. The time required for such a change to occur is uncertain. This shift in energy may also scour the channel bottom, picking up cobbles and gravel, transporting them downstream. In this case, the channel becomes deeper (downcut), steepening the banks, which are more easily eroded during floods.

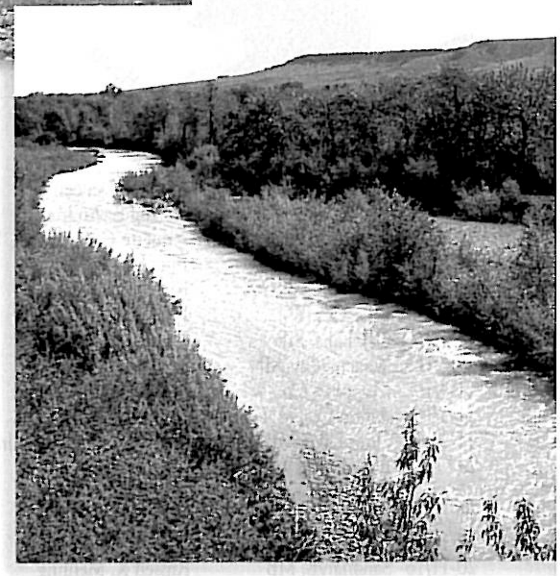
Dupuyer Creek is actively eroding its banks and is apparently increasing its sinuosity. Some sections of the stream are scoured, resulting in a deeper channel that provides limited fish habitat. The several bridges and fords on the ranch continue to affect channel dimensions. Several of these bridges and fords had to be reconstructed in the summer of 1995 (see "Back at the Ranch," *Fair Chase* Fall 1995). The bridge and ford crossings on Dupuyer Creek will continue to be a problem because of instability in those areas. Some of the instability is a result of the 1964 flood and subsequent floods, some because of the flat and wide nature of the crossings, and some because of changes in width, depth, and slope from the bridges and fords themselves.

The record flood of 1964 was followed by a large flood in 1975. Because of the short recovery time between these two large flood events, the current stream may be vastly different than it would have been if only the 1964 flood had occurred. Woody vegetation wiped out in 1964 would have only begun to reestablish itself in 1975; thus, the protective benefits of streambank vegetation would have been minimal in 1975, resulting in high rates of erosion.

Floods may also require a change in management activities. For example, streambanks are saturated with water during and after flooding. Saturated streambanks are more susceptible to damage by cattle. Therefore, a rancher may need to delay cattle grazing in riparian areas for several weeks following floods. Large floods also have a tendency to remove a lot of vegetation. Any additional loss of vegetation due to grazing or trampling can delay recovery and may prolong the disturbance effect. This streambank vegetation is essential for bank stability and is also a very important source of food in aquatic food chains.

Overall, the 1964 flood has been the dominant factor in current channel dimensions of Dupuyer Creek. At the same time, land management and its effects can and do compound flood effects. This caution is not meant to diminish the effects of the 1964 flood, which was indeed a tremendous flood, but rather to point out that careful land management can reduce the effects of floods. Land use activities in the early part of the century, primarily livestock grazing, may have enhanced flood related changes: there is no way of knowing prior conditions and previous management philosophies; however, census records suggest very heavy livestock use around the turn of the century. Continued stream monitoring and knowledge of current livestock management, will allow us to differentiate between land use effects and natural effects such as the 1964 flood.

Floods can cost millions of dollars and many lives. They can also have a lasting effect on the landscape. Our role in landscape evolution continues to expand. However, with the history of a stream in mind, and with an understanding of current stream processes, we can better plan our land use to accommodate floods and maintain fish habitat.



THE ABOVE PHOTOS SHOW AN UNDISTURBED STREAM, BOTTOM, VERSUS A FORD CROSSING, TOP.