Riparian Zones: 2) History and Human Impacts

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Human Impacts on Riparian Zones

The impacts of Native Americans on riparian systems are rather hard to judge. Native American populations tended to fluctuate with climatic shifts, as did impacts on the landscape. Certainly riparian areas were used as sources of water, pelts, fish and other raw materials, and may have served as camping grounds for migrating tribes. Thus there may have been relatively small areas that were impacted. In some areas of the country, such as the Southwest, rather advanced and extensive irrigation systems were used and water flows were diverted. Flood plains were developed for agriculture in some regions.

Beavers

The first potential impact of European settlers on riparian zones came earlier than most might realize. The North American beaver was highly sought after for the European clothing market. Therefore, beaver populations in eastern North America were rapidly depleted (Spencer 1985). The removal or reduction of beaver populations from streams in western North America came at a surprisingly early date. In the 1820's, the Hudson Bay Company adopted a policy of deliberately over-trapping beavers in areas that bordered the Pacific Northwest. The strategy was designed to discourage trappers from other countries from attempting to claim territory over which the Hudson Bay Company wished to maintain control. The situation was summed up by Cline (1974) as follows, "The executives for the Hudson Bay Company knew that the American fur-trading companies were operating on a shoestring. . .if catches were small, Indian hostilities great, or other difficulties arose, American companies could sustain losses for only a few years, if that, before going bankrupt". By the end of the 19th century, many of the beavers in North America had been removed from riparian systems (Clements 1991), and the beaver may even have approached extinction (Naiman and Melillo 1984).

Why would removal of beaver populations have a major impact on riparian systems, and how common were beavers prior to settlement of North America? The answer to the second part of the question is startling. Prior to European settlement, estimates indicate there were between 60 and 400 million beavers, with a density of about 10 beavers per square mile in their primary habitats (Naiman and Melillo 1984). The following quote was given by Nelson (1918) concerning the abundance of beaver, "When North America was first colonized, beavers existed in great numbers from coast to coast, in almost every locality where trees and bushes bordered streams and lakes, from the Yukon Delta, in Alaska, and the MacKenzie Delta, on the Arctic coast, south to the mouths of the Colorado and the Rio Grande. Vertical distribution from sea level to 9,000 feet". Clearly there were plenty of beaver in North America, but how might their removal have influenced the streams and lakes with which they were associated?

The influence of beavers on the structure and functioning of riparian zones may be substantial, at both the local and at the landscape level. Johnson and Naiman (1987) considered the beaver to be a "keystone species" in that its influence on the ecosystem goes well beyond its requirements for food and space. Specifically, beaver may alter the hydrology and nutrient cycling in a stream or even an entire river system. Naiman et al. (1986) suggested that prior to removal of the beaver, large amounts of carbon and nutrients (eg. nitrogen) were retained in the upper portions of watersheds rather than being transported downstream.

Beaver dams tend to slow the velocity of water, which causes sediment and debris carried by the steam to be deposited behind the dams (Johnson and Naiman 1987). Because the beaver dams backed up water, the water table increased (Elmore and Beschta 1987), creating wetland patches that are important to the diversity of the landscape. In fact, Kay (1994) has suggested that thousands of years of beaver activity may have created many of the West's fertile valleys. Once beavers were removed the dams were no longer maintained and eventually dam failure occurred. As dams gave way, stream energy became confined to discrete channels rather than being dissipated, which caused down-cutting and erosion (Elmore and Beschta 1987). The potential of the stream systems to store water in the flood plains would also have declined as the beaver dams failed.

Livestock

The next major impact of human settlement on riparian systems involved the introduction of livestock into the western U.S. The impacts, again, probably began earlier than most people realize. By the 1590s, cattle, sheep, and goats had been introduced into what is now the southwestern U.S. (Holechek et al. 1989), and by the 1700s most Indian pueblos in the southwest had sheep flocks, some numbering up to 30,000.

The western livestock industry did not develop until after the Civil War. Although the numbers may not have been entirely accurate, the Dept. of Commerce census indicates that in 1870 there were 4.6 million cattle in the 17 western states, 35 to 40 million in 1884, and 27 million in 1890 (USDC 1943). Why the dramatic changes over this 20-year period? Cattle prices were relatively high and a great deal of investment capital from the eastern U.S. and Europe was devoted to expanding cattle operations in the wide open West. Some cattle operations in Montana generated profits of 25 to 40% for their investors during this period (Mitchell and Hart 1987). The sheep industry was also expanding during this period. Drought and/or severe winters in the late 1880s and early 1890s, coupled with low cattle prices, greatly reduced the number of cattle in the western U.S. However, the extremely high livestock numbers had a major impact on rangelands of the West, both uplands and riparian systems. There were numerous reports of overgrazing in newspapers and livestock association publications during the latter part of the 1800s (Holechek et al. 1989). The situation was summed up by this quote from Griffiths (1902):

> From a natural tendency to increase rather than diminish the number of stock has resulted in a condition of shortage of feed, which was foretold years ago by those who were studying the treatment of the ranges. This condition has awakened great activity in investigations of questions pertaining to the preservation of the feed supply of the public pasture lands. So numerous are the requests for information, advice, and suggestions for the improvement and management of the ranges which are received in the Office of the Agrologist that it is very difficult to give all of them the attention which they deserve.

During the period Griffiths was surveying conditions on the range, there was no control over grazing on public lands in the West. The general rule was, whoever got there first used the forage. Griffiths concluded that many ranges were producing only one-third of their potential.

The lack of management on the rangelands of the West caused a number of problems in addition to reduced forage production. Reynolds (1911) described the relationship between heavy sheep grazing of the Wasatch Mountains in Utah, and flooding and sedimentation caused by the removal of vegetation. The loss of water sources as a result of gully formation (or down-cutting) in stream systems was also mentioned. Cottam and Stewart (1940) described the vegetation of the Mountain Meadow area in southwestern Utah prior to and after the settlement of the area. This site was a common stop for the wagon trains heading from the East to California; it was also the site of the Mountain Meadow Massacre, where over 100 emigrants were killed by white men and Native Americans led by John D. Lee. The following quote from Cottam and Stewart (1940) provides an interesting brief history of the site, "March 23, 1877, while awaiting execution at the scene for the Mountain Meadow massacre, John D. Lee told the officer in charge that the entire landscape had undergone such great changes in general aspect as to make impossible the accurate designation of particular landmarks of the massacre. The huge wash, 30 feet deep and 40 feet wide, had not then gutted the old meadow, but unrestricted grazing and a severe current drought had killed most of the forage plants and they had been replaced by shrubs". Thus, over a 20-year period an important watering point on the trail to California had more-or-less been lost.

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Unfortunately, only in the past 10–15 years has much emphasis been placed on riparian areas. During the previous 50 years nearly all the emphasis was on improvement of upland range communities. There appears to be progress towards a more balanced approach, where uplands and riparian zones both receive attention in the planning process. A more detailed discussion of grazing and riparian zones can be found in Platts (1991) and Elmore and Kauffman (1994).

Herbicides

After World War II, the phenoxy herbicides, principally 2,4–D became available for manipulation of vegetation (Vallentine 1971). During the same general time frame, there was a prevailing attitude that phreatophytic vegetation (plants that use ground water) should be removed to increase streamflows and thus water yield. The combination of availability of 2,4–D and the desire to improve water yield resulted in extensive spraying of streamside vegetation from 1940 to 1970. The U.S. government provided matching funds on spraying projects that were intended to increase water yield. Unfortunately, at the time there was little appreciation for the importance of the woody vegetation in holding stream banks together during peak flows.

Mechanical Treatments

Many of the larger streams and rivers in the western U.S. have been subjected to mechanical manipulations of one sort or another. After World War II there was a good deal of heavy equipment available at relatively low prices (Elmore, personal communication). Many streams and rivers were straightened with the intention of reducing the flood hazard. Hunter (1991) cites the case of the John Day River, which was straightened after the floods of 1964. The thought behind the project was that straight reaches will carry water faster than meandering reaches and therefore the flood hazard will be reduced. Unfortunately, as Hunter points out, fish habitat is greatly reduced, erosion increased, and there must be a continual effort to keep the river confined to the artificial channel.

Riparian vegetation is also influenced because the riparian zone is restricted to a narrow band along the river, the flood plain and river are functionally separated, and timing and intensity of flows are greatly altered. By separating the river from the traditional flood plain there is less opportunity for water storage. The result is generally greater peak flows in the spring, but also lower minimum flows in late summer or early fall.

Photo 1. *The Crooked River in central Oregon. There is nothing crooked about this stretch, which was straightened during road building. (Photo courtesy of John Buckhouse).*

Road building is another factor influencing the structure of many stream systems (Photo 1). Unfortunately, relatively little thought is generally given to stream function during the road building process. Furniss et al. (1991) point out that in most cases it is impossible to build roads that do not adversely affect streams.

There are many other forms of mechanical alterations of river systems, including dams, domestic and agricultural diversions, bank stabilization, dredging for navigation, etc. Many of these treatments are more obvious to the casual observer than the treatments listed above. But basically, any factor that influences the structure and functioning of stream and river systems will impact riparian vegetation.

Logging

There are a number of ways in which logging operations can potentially impact streams, and thus riparian vegetation. As is the case with livestock grazing and other human activities, relatively little attention was given to the impact of logging on riparian systems until the past 10–15 years. In some areas, particularly the Pacific Northwest, streams and rivers were used as a means of transporting logs. This practice is not common today, but the impacts of previous activities may be long lasting. In order to transport logs it was necessary to remove debris, boulders, and other obstructions from the stream. The large volume of logs floating down a stream had negative impacts on channel shape and riparian vegetation. If the reader has an interest in timber harvesting and silviculture in relation to riparian habitat, Chamberlin et al. (1991) provide useful information. A detailed discussion of log transportation in waterways is provided by Sedell et al. (1991).

Mining

Historical mining activities have significantly altered riparian habitats in specific locales in the western U.S. Some of the early mining technologies are particularly noteworthy. The hydraulic mining that occurred in northern California and parts of the Pacific Northwest during the late 1800's and early 1900's was especially damaging. A pressurized stream of water was used to wash loosely consolidated gravels from stream banks so that gold ore and gravel could be separated. The effect was to destroy stream structure and produce tremendous sediment loads. A significant portion of San Francisco Bay was thought to have filled with sediment during the hydraulic mining period in the Sierra Nevada.

Dredging of streams was relatively common in the Rocky Mountains during the early part of this century. Dredges varied in size, but the basic principal remained the same. The dredge traveled up or down a stream separating ore from streambed material, and dumping the tailings alongside the stream (Photo 2). Because the dredges were not particularly efficient, and the price of gold fluctuated, some stream stretches were dredged several times.

A more subtle influence of mining activities on stream systems relates to changes in stream chemistry. Old tailing piles can leak various undesirable compounds into stream systems for years after a mine has been abandoned. One of the most common effects is acidification of stream stretches. Unfortunately, changes in stream chemistry can occur miles downstream, depending on the nature of the mining and the stream system. A detailed review of mining impacts has been compiled by Nelson et al. (1991), and they cover a wide range of potential impacts and potential mitigations.

Recreation

As with livestock and wildlife, humans tend to be drawn to riparian areas, and spend a disproportionate amount of time in riparian areas. Some potential impacts of recreation on riparian areas relate to road and trail building, campsites, bank trampling, off-road vehicle use, mountain biking, etc. Some reservoirs were built primarily for recreation. Over the years, a wide range of treatments have been tried to improve fishing. In some areas willows were sprayed to improve fishing access to streams, woody debris and beaver dams were removed with the intention of improving upstream and downstream fish migration, and log dams have been built in streams. Fish populations have been manipulated both by using rotenone to kill "trash" fish and by stocking with hatchery fish. In general, the effects of recreation tend to be localized with the majority of ri-

Photo 2. *Mining dredges completely altered streams and associated riparian zones. (Photo courtesy of Warren Clary).*

parian areas receiving relatively dispersed activity. Some of the recreation-related activities, such as stocking of non-native fish, may have much larger impacts on aquatic animal and insect populations than on riparian vegetation, per se. Recreation is not a major focus of this paper, so the reader should consult the review by Clark and Gibbons (1991) if more detailed information is desired.

Other Impacts

The factors listed above probably account for the overwhelming majority of human impacts on riparian areas. However, the list is certainly not all inclusive. Changes in upland vegetation, either through conversion to agriculture, fire suppression, or introduction of invader plant species can have an impact on water and sediment movement to riparian zones. A previous section dealt with the linkage between upland and riparian vegetation. Water diversions for industrial, agricultural, and urban uses also have the potential to alter streamflows and thus riparian vegetation. We can only guess how the increases in atmospheric CO_2 will influence the landscape. There is a large body of research indicating that plant productivity will increase about 30% if CO_2 doubles from preindustrial levels.

Humans have also been rather active in introducing alien plant species. In some cases the introductions are intentional, in most cases accidental. Some introductions have had a major impact on upland vegetation. For example, cheatgrass was introduced into the western U.S. around the turn of the century and now dominates more than 100 million acres in the Intermountain West (Mack 1981). The invasion of cheatgrass has resulted in very frequent wildfires in some areas (as often as once every 5 years), which may dramatically decrease plant species diversity (Whisenant 1990). If wildfires are frequent enough, one result will be increased erosion and sediment loading into streams. Lacey et al. (1989) found that invasion of spotted knapweed increased sediment yield and runoff by 192 and 56% respectively, compared to bunchgrass rangeland. Changes in runoff and sedimentation levels may have either positive or negative effects depending on the nature of the riparian areas. In a degraded stream system, some input of sediment can help the bank building process if the vegetation is able to trap the sediment. Alternatively, large inputs of sediments can change the functioning of a stream. Medina and Martin (1988) described a situation in southwestern New Mexico, where a large wildfire in the headwaters of a stream upset the dynamic equilibrium of the system. In this instance, the wildfires were followed by storms that deposited large amounts of sediment in sections of the stream, thereby raising the channel bottom. As the morphology of the stream channel adjusted to the addition of sediments, riparian vegetation also changed.

In the past there seemed to be relatively few introduced invader species that had the ability to dominate riparian plant communities. There were certainly cases where "weeds" became a component of riparian communities, especially on the drier end of the scale. However, in recent years a number of species that can totally dominate a riparian zone have become noticeable on the landscape (Sheley et al. 1995, Young et al. 1995).

Conclusions

Riparian areas are very important components of the landscape, even though they may comprise only a small percentage of the land area. These areas are closely linked to the surrounding uplands which serve as the source of water and sediment that are the life blood for stream systems and associated riparian vegetation. A wide range of human activities have impacted riparian zones. The challenge to resource managers is to define the impacts on a particular stretch of stream, and where possible work toward improving both the structure of the stream and the associated vegetation.

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