Characterization of Riparian Systems*

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Introduction

The purpose of this introductory paper is simply to bring together in a general way some of the more important factors influencing riparian ecosystems. Riparian ecosystems are defined as those "on or by land bordering a stream, lake, tidewater, or other body of water." Open water is the key to this definition and to the context of this paper. A riparian system is the interface between terrestrial and aquatic ecosystems. It may also include adjacent vegetation that can influence both the aquatic system and the terrestrial-aquatic interface. Judging how much open water is enough to qualify an area as "riparian" depends on wildlife requirements. For example, how long must an intermittent stream run to provide for the essential needs of key wildlife? Unfortunately, discussion of such criteria is outside the scope of this paper. Instead, six kinds of environmental factors influencing the riparian system will be discussed.

Since this is a streamside management symposium, remarks will be further limited to riverine riparian zones. These are exciting because the riverine system is a dynamic, moving-water setting in which the terrestrial soils and vegetation can and do change naturally and where the aquatic system is constantly in a state of flux. This inherent lack of stability tends to cause frustration in some of us because we have a natural desire for constancy and like to characterize things into neat little boxes. However, riverine riparian systems can't be described by a simple set of characteristics; the situation is more like Pandora's spilled box.

The site potential for both aquatic and terrestrial components can be changed by management activities such as livestock grazing, logging, and the creation of physical structures such as roads and dams. And site potentials can also be changed by natural factors such as fire, beavers, and the action of water itself. The single most basic characteristic is the interaction of land and vegetation with water—moving water. Riverine systems are characterized by the ratio of low to high flows and particularly by their storm-handling properties, often expressed in terms of the characteristics of 25-, 50-, or 100-year floods. This paper will introduce general characteristics of the riverine riparian ecosystem.

Livestock Grazing

Particularly east of the Cascades, livestock have caused both vegetation and site change due to excessive utilization of available forage. When livestock grazing in an area is improper, the palatable vegetation is used to excess and may decrease or even disappear. For example, heavy livestock use can prevent tree and shrub reproduction. Eventually, vegetation might change from an aspen-willow-sedge complex to just sedges and grasses in a riverine riparian setting. This change in vegetation not only affects the kind of wildlife that will inhabit the terrestrial portion but may also influence the microclimate of the aquatic system and its interface with the terrestrial system.

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Many times improper livestock grazing also results in soil and site damage or change. Undercut streambanks, highly desirable for fisheries habitat, can be broken down by the pressure exerted by livestock. The change from vertical to sloping streambanks usually results in a widening of the stream bottom. As a consequence, water depths are reduced. These changes are generally disadvantageous to fisheries because water temperatures rise and protective cover is reduced.

Proper livestock use can be defined as that utilization of plants that will maintain or improve productive vegetation and sods as desired for land management. Proper use can be designed to allow streambanks to return, over time, to a near-vertical profile from a sloping one. The Wickiup exclosure on the Malheur National Forest (Bear Valley Ranger District) suggests that sloping streambanks may begin to elevate with light livestock use in as few as 3 to 5 years. Elevation begins with light use of streambank vegetation. Leaving a sufficient plant height traps sediments during high flows. Trapped sediments then elevate streambanks by being incorporated into rhizomatous root masses as these are built by natural processes.

Livestock grazing in the riverine riparian ecosystem is a complex management issue dealing with how the intensity and season of use can be designed to accomplish specific goals. Much of the complexity is related to the question of how to manipulate grazing animals to attain the desired utilization at the specified season.

Timber Harvest

Timber harvest, particularly that using regeneration cutting such as clear-cut or shelterwood methods, has an immediate effect on the existing plant community. One effect is a change in the microclimate of the aquatic system and the aquatic-terrestrial interface. Streamside shade is reduced, which may cause water temperatures to increase. In addition, removing trees adjacent to the stream course reduces deposition into the stream of large organic debris and leaf and needle material, which provide habitat and food sources for primary insects in the aquatic food chain. Debris remaining from logging can also have an influence on the stream channel and on the vegetation adjacent to it. The debris may enhance fish habitat in moderate amounts. Excessive debris may foster stream erosion during high flows or floods, and jams can impede fish passage.

The act of tree harvest itself can induce site changes in both the aquatic and terrestrial ecosystems. Access to forest stands growing in riparian areas may be by roads or by skip trails, the impacts of which will be discussed next. However, logging need not have a detrimental impact on the riparian or aquatic sites. Yarding systems can be designed for minimum negative impact.

Physical Structures

Physical structures or mechanical manipulations within the riverine riparian setting can produce both intentional and unintentional impacts. Unintentional impacts are those resulting from activities not designed to enhance the riparian ecosystem, such as road-building, channelization for flood control, or installation of dams. Intentional impacts result from structures or activities designed to enhance the riparian system. These can include the use of log weirs or rock gabions placed in or along the stream to divert flow and hopefully create improved fisheries habitat, the placement of rocks or other structures to reduce streambank erosion, and the alteration of stream courses to increase sinuosity.

Roads, even old railroad grades, may have a variety of impacts on the riverine riparian ecosystem, such as changing the hydrologic system, channelization, and decreases of stream sinuosity. Road-building dramatically and permanently changes terrestrial sites and may permanently change some aquatic sites and the nature of the stream flow. In spite of this, many measures can be used to ameliorate the effects of road or railroad building.

Dams constructed for hydroelectric power, irrigation, or flood control permanently change the riverine ecosystem to a lake riparian ecosystem. Downstream aquatic characteristics change, and travel routes for migratory fisheries are disrupted. If a channelized stream is treated with gabions and rock weirs to increase its sinuosity and disrupt its rate of flow, the fisheries habitat may be enhanced. Water tables may also be raised, providing a greater diversity of plant species.

Fire

The management impacts of livestock grazing, timber harvest, and mechanical disturbances suggest people may be responsible for major changes in the vegetation, aquatic, and site attributes of the riverine riparian ecosystem. But the natural environment can be just as disruptive. Fire has affected the riparian ecosystem for eons. It tends to have two kinds of effects: direct effects on the vegetation in the riverine riparian setting and indirect effects brought about by denudation of a watershed. The hydrologic and erosive characteristics of burned watersheds tend to change in ways that will probably affect the riparian area.

On the west side of the Cascades, a crown fire might result in the killing of a stand of Douglas-fir; this event would be followed by the proliferation of salmonberry and red alder. One hundred years later, red alder might still be dominant in the riverine riparian setting in comparison to adjacent hillsides, where the alder might have been completely replaced by Douglas-fir. Interestingly, east of the Cascades, with suppression of underburning, quaking aspen seems to be regenerating quite successfully under canopies of ponderosa pine or open Douglas-fir on suitable sites.

Another impact of fire on the riverine riparian ecosystem is the effect of crown fires that burn a major portion of a drainage. Killing the forest results in reduction in interception, reductions in transpiration and in water removal from the soil, and often in significant changes in the water flowing through the riverine system, both increases in water flow and alterations in its chemical composition. The deposition of logs and trees into the riverine system is also a factor. Burning of a watershed can significantly change the riverine riparian setting under average precipitation regimes. However, the occurrence of 25-, 50-, or 100-year floods or of floods due to storm activity can increase impacts on the riverine system.

These effects of fire have been part of the natural evolution of our riverine riparian ecosystems in the Pacific Northwest. For example, the Siuslaw National Forest, a tremendously important watershed for both salmon and steelhead, was 90 percent burned by fires occurring 110 and 140 years ago. These widespread crown fires burned nearly every drainage in the forest. But the forest still provides some of the best anadromous fish habitat in western Oregon. Few people deny the tremendous impact that fire can have on the riparian setting and on the watershed. We must also learn to understand the magnitude of past natural fire, the extent of areas burned, the frequency of burning, and the impacts these events may have had on the riverine riparian system.

Beavers

Beavers are obligate riparian residents. They have two major effects on riparian ecosystems: They can change site characteristics by building dams and change vegetative species composition by overutilization of food supplies. If beaver populations increase to the point that forage becomes limiting, excessive utilization often results in serious decline of staple food supplies such as woody vegetation. Mass starvation of the beaver population may result from a major change in the vegetation such as the elimination of alder and willow, creating a sedge-grass meadow.

Beavers also create major changes in aquatic and terrestrial sites. A series of dams can significantly slow water flow and raise stream levels, resulting in high terrestrial water tables. At times, these water tables may be so high that some existing water-tolerant (but not water-obligate) plants will die or will not be able to reproduce and will eventually be eliminated from the plant community. For example, a conifer stand growing on a first terrace can be killed and replaced by sedges as a result of flooding by a beaver dam. This reduces the shading of a stream whose flow has also been slowed. A change in water table usually alters the competitive ability of plant species within the community, resulting in major shifts of species dominance and composition.

Beaver dams have direct effects on the aquatic system. Dams disrupt fish migration through the streams. Slowing stream water may provide opportunities for siltation and for increased heating, resulting in warmer temperatures downstream. The long-term presence of dams will create new sites as the areas silt in and are colonized by emergent vegetation. Beavers are still a major factor influencing many streams in the Northwest. Their influence on what we perceive as natural riverine riparian ecosystems must be appreciated.

The Water Influence

Water, the "rip" of riparian, is the most dynamic natural environmental factor in the riverine riparian ecosystem. It is dynamic because of two unique characteristics: the variation in flow levels that occurs over the year and the appearance of 25-, 50-, and 100-year floods, both associated with catastrophic events. In the Pacific Northwest during the months of August and September, precipitation is least and usually the volume of stream flow is minimal. Sometime during the winter or early spring when snow packs melt and precipitation may also be falling, maximum peak flows are reached. One example is Meadow Creek on the Starky experimental area of the Wallowa-Whitman National Forest. Meadow Creek's average low flow is 3 to 5 cfs, whereas its average high flow is 300 cfs—a 100-fold seasonal difference. Such variations are reflected in the water depth over spawning gravel used by anadromous fish. High flows and their duration tend to influence streambank cutting and erosion.

Characteristics of high and low flows and of the flowing water are greatly influenced by upstream watershed conditions. A watershed burned by crown fire (or clear-cut logged) would have different influences on water quality, quantity, and flow fluctuations compared to a watershed in 120-year-old timber stands.

The second unique riverine riparian environmental factor is flooding. Floods are often categorized by flow characteristics following storms occurring at 25-year, 50-year, or 100-year intervals. In the Pacific Northwest, these floods are caused by a great variety of climatic conditions. For example, the Christmas week flood of 1964, a 50-year event that seriously damaged many areas west of the Cascade crest, was brought on by warm rain falling on a wet snowpack during elevating temperatures, a winter occurrence. In contrast, the Mitchell flood of 1957 occurred in the middle of summer. A severe thunderstorm produced 2 to 3 inches of precipitation in a 30-minute period (also a 50-year event). This flash flood damaged many areas in central Oregon and almost washed out bridges to the town of Mitchell.

During January 1984, two weeks of very cold weather followed by a warming trend and rain opened up frozen rivers in the LaGrande area of eastern Oregon. Runoff lifted anchor ice off the bottom and floated it downstream, causing extensive damage to vegetation, roads, and bridges. It destroyed the cattle control fences on an area being used for a riverine riparian study on Meadow Creek in the Starky experimental range.

These floods tend to cause a catastrophic geological impact on the riverine riparian area. The natural structure of terrestrial components and the terrestrial-aquatic interface have been created by the riverine system with its fluctuating seasonal flows and flood characteristics. Evidence of this action is found in the presence of outwash terraces and old meandering stream channels. Vegetation is also directly affected. For example, black cottonwood requires a freshly laid silt deposit in the spring of the year for optimum germination and growth of seedlings. This species is dependent upon 50- or 100-year flooding for its regeneration in areas distant from the main stream channel. Most black cottonwood stands on Government and Hayden Islands in the Portland, Oregon, area are trees less than 50 years old—all of them post-dating the Vanport flood of May 31, 1948, a late spring event.

Riverine riparian ecosystems have evolved naturally under conditions of constant yearly perturbations and periodic devastation from fires, floods, and even beavers. This evolution has endowed the ecosystem with amazing resilience and superior toughness that help it withstand the rigors imposed by modern man. It is a system that cannot be understood, or even comprehended, from a single point in time during the warm summer growing season. Sites must be visited three or four times a year to document the differences between high and low flows and the lengths of time during which these extremes occur. And the riverine riparian system must be appreciated in the context of the occurrence of 25-, 50-, and 100-year floods—the major environmental factor shaping the land, the stream, and the vegetation.

Summary

Riverine riparian systems are characterized by water action—the "rip" of riparian. This natural water action is composed of high and low seasonal flows and the occurrence of 25-, 50-, and 100-year floods, which may happen for a wide variety of reasons. Other natural factors that influence both aquatic and terrestrial components include the impacts of beavers and of fire. Management activities such as livestock grazing, the building of roads, dams, and other structures, and timber harvest generate unnatural impacts.

The riverine riparian ecosystem has evolved in a highly dynamic, unstable environment in which devastation and destruction have been normal components. It is an ever-changing part of the larger ecosystem with values that far exceed the small proportion of land area it occupies.