Natural Flooding and Dams

Affects on Riparian Systems

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The composition, structure and dynamics of riparian vegetation are determined largely by past and present hydrologic regimes and geomorphologic conditions. To continue to thrive, riparian vegetation depends on alluvial sediments as a growth substrate, abundant moisture from surface flow, and relatively shallow alluvial water tables.

Hydrologists, geomorphologists, and ecologists have teamed to identify aspects of the physical environment that exert strong influence on riparian ecosystems. Evaluating current and natural dynamics of channel pattern, channel cross-section, and the size and distribution of bottomland landforms can help to identify which components of the system are in greatest need of restoration attention (See Briggs and Osterkamp, p. 18). Further, a growing database clarifies alluvial groundwater dynamics and the responses of stream and floodplain biota to various aspects of surface flow – such as timing, magnitude, frequency, duration, and rate of change.

Floods Influence Landforms and Biota

In riparian areas, flooding is a particularly important natural process, strongly influencing the physical environment of river bottomlands by eroding and depositing sediments, destroying and creating fluvial landforms, moistening sediments, flushing salts that have concentrated in sediments, and transporting plant propagules. These flood-driven processes largely determine the distribution, size, shape, and sediment characteristics of surfaces within a river bottomland upon which vegetation grows.

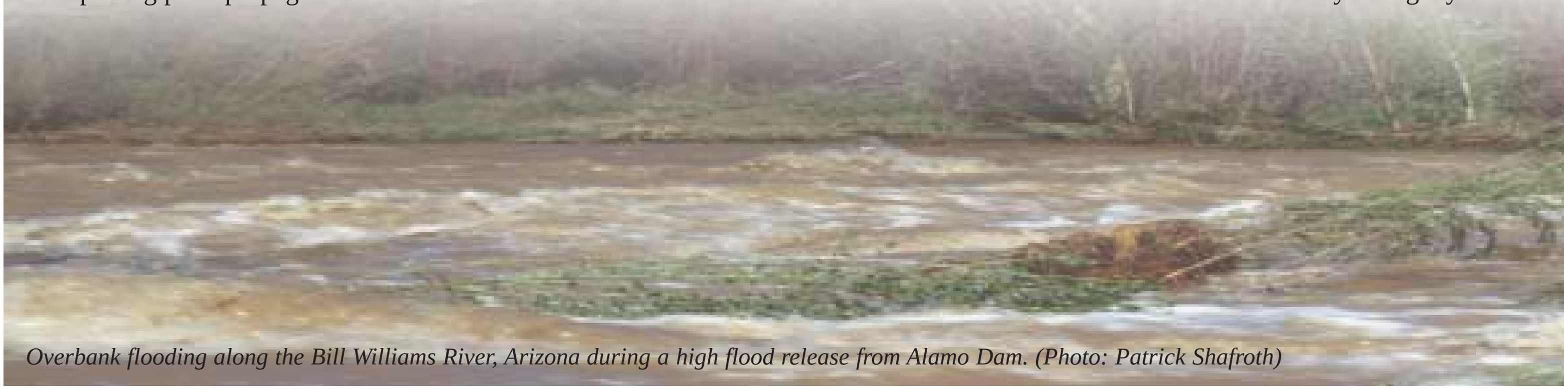
The life cycle of many riparian plants is intimately related to these site conditions and, hence, to flooding. In the Southwest, riparian restoration efforts often endeavor to promote the regeneration of native cottonwood and willow forests. The natural reproduction of these tree species is highly dependent on flood-driven processes. To germinate, the seeds require bare, moist substrates during a limited period of time in spring and summer. Floods naturally create these substrates. As flows recede following a flood, soils must remain moist enough for the drought-sensitive seedlings not to desiccate. Seedlings are also vulnerable to removal by subsequent floods. Given these rather specific requirements, successful seedling establishment of cottonwood and willow trees may only occur once every five to ten years, despite the fact that thousands of germinants can be found almost every year.

Surface Flows Affected by Dams

Today, most rivers in the Southwest have been dammed. While dams may be operated in a number of ways depending on the primary purposes, they nearly always affect surface flows downstream by changing the flooding regime. This usually involves a reduction in the magnitude and frequency of flood flows and a change in the timing and duration of flooding, all of which alter the physical conditions influencing riparian vegetation. These changes can adversely affect native species that are dependent on natural flooding regimes. Conversely, non-native species may be better suited to the new flow regimes (see Stromberg et al., p. 22).

Low flows are also important because they influence dry season alluvial water table depths, which can constrain the abundance and composition of riparian vegetation, particularly in arid regions. Downstream from dams, low flows are commonly altered in different ways as well, depending on dam operation priorities. In some cases, where flows are diverted from a reservoir, for example, low flows downstream may be reduced, leading to drier conditions than can be tolerated by many riparian plants. In other cases, where water is delivered for summer irrigation downstream, low flows may be increased, allowing for greater survival and growth of riparian plants than might have occurred with natural flows.

Given the importance of surface flow to riparian vegetation, an increasingly common restoration approach has been to manage streamflow downstream of dams. Changing dam operations may be feasible along rivers where patterns of downstream water delivery are flexible, when there is a possibility of purchasing land and water rights to ensure more flexibility, or when restoration downstream may be legally



Overbank flooding along the Bill Williams River, Arizona during a high flood release from Alamo Dam. (Photo: Patrick Shafroth) required and dam reoperation is found to be less expensive and more sustainable than active restoration. In the Southwest, this approach has often involved modifying the parts of the regulated hydrograph that are hindering cottonwood recruitment or survival.

Along rivers in Alberta, Canada, low flows have been increased to maintain the vigor of existing cottonwood forests, and the rate of flow recession following flood peaks has been controlled to promote seedling establishment. Along the Truckee River in Nevada and the Bill Williams River in Arizona, managed floods have been used in combination with controlled flow recessions to promote cottonwood recruitment. In these cases, the restoration objectives were achieved over many river miles, without costly, intensive, on-the-ground actions. It is important to recognize, however, that naturalized flow regimes alone may not supply all of the conditions required for successful restoration, particularly if sediment and geomorphic dynamics are still altered.

Dam Removal Considerations

Another means of mitigating the downstream effects of dams is to remove the dam altogether. Dam removal is on the increase throughout North America, primarily because many dams have become unsafe over time or are no longer serving the purposes for which they were originally constructed. Environmental restoration is seldom the primary or sole reason for removing dams, but restoration benefits may accrue. If there are no other dams upstream, dam removal may restore natural flow and sediment regimes and the associated natural processes that favor native riparian vegetation. However, large volumes of sediment trapped in the

See Flooding, page 27

Flooding, continued from page 21

reservoir during the life of the dam may be transported and deposited downstream, creating rather unnatural conditions. Thus, following dam removal, the dam-altered system may not be immediately restored, as it will need to adjust to this influx of sediment, as well as to a return to natural flows. The timing and nature of these system responses will vary from river to river and are not yet well-understood by scientists.

Opportunities to remove dams or to change dam operations are limited, and dam reoperations may not always provide all of the missing processes. In cases where only partial restoration of key processes is possible, more active restoration measures may be targeted to mimic what is still missing. For example, restoring naturally high magnitude floods and the associated physical disturbance, which is essential to the reproduction of desirable, native pioneer trees and shrubs, may not be possible. In these cases, active measures can be used to mimic the physical disturbance, such as bulldozing existing, undesirable vegetation, and following that activity with stream flows that moisten the surface. In cases where stream flows are too regulated to provide the moistening function, controlled irrigation may be necessary. Even when several active restoration measures are required, they are more likely to succeed if they tend to mimic key functions of natural processes.

Restoring natural flow regimes and fluvial processes can have numerous benefits. Restoration efforts that require many active measures and much future maintenance are generally less sustainable, more expensive, and confined to relatively small areas. In contrast, when natural processes are restored, restoration projects tend to be more sustainable, less expensive, and more extensive. Although in some cases, factors unrelated to a river's hydrology or geomorphology may be a central source of degradation, the success of riparian restoration efforts will be enhanced when the important roles of natural processes are considered and incorporated.

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Recommended Reading

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