# Fact Sheet #1: Functions of Riparian Areas for Flood Control

[This fact sheet was prepared by *Russell Cohen, Rivers Advocate,* **Division of Ecological Restoration, Massachusetts Department of Fish and Game**. This document is intended for educational purposes only and does not necessarily represent the viewpoint of agencies and commissions having regulatory authority over riparian lands. Last updated: June 11, 2014.]

### *How do riparian areas provide flood control?*

Riparian areas are the lands adjacent to, and/or interacting with, rivers and streams. Naturally vegetated riparian areas (uplands as well as floodplains) serve a number of beneficial functions for flood control. An undeveloped, vegetated floodplain reduces the force, height and volume of floodwaters by allowing them to spread out horizontally and relatively harmlessly across the floodplain. Water that floods into vegetated floodplains reenters the main channel slowly, enabling it to be soaked up by the "sponge" of floodplain wetland soils and streamside forest leaf litter. Living, decaying and dead vegetation on riparian lands that falls or extends into the water provides numerous barriers against moving water, which slows it down so water is not delivered downstream as quickly. Such vegetation also intercepts and detains runoff from adjacent upland areas that would otherwise flow directly into rivers and exacerbate flooding conditions downstream. The root systems of streamside forest and emergent aquatic vegetation keep pores of the soil open so that two to three times more water can infiltrate the soil compared to lands used for cultivation or grazing.

In addition, trees, shrubs and herbaceous plants in riparian areas use large amounts of water in transpiration, which, in effect, transfers floodwaters to the atmosphere. Several thousand gallons per acre of water are used by plants each day, thereby drying the soil and making more room in the "soil sponge" for floodwater. The combined effect of all of these functions is a significant reduction in peak flows and flooding downstream. Naturally vegetated riparian forests thus help prevent thousands of dollars in property damage and obviate the need for human-made flood control measures and structures.

### *What alterations to riparian areas impair their ability to provide flood control?*

Removing streamside forests from riparian areas impairs their ability to provide flood control in several ways. Floodwater detention is substantially reduced by removing the natural barriers of live, decaying and dead woody and other vegetation from the forest floor. Removing streamside forests will also result in an increase in soil compaction and reduction in soil porosity. The placement of buildings or other structures within the floodplain or floodway portion of the riparian area is likely to reduce floodwater storage and conveyance, thereby increasing the risk of flood damage to those, or other preexisting, buildings or structures. Even if the proposed alteration is on a portion of the riparian area that lies uphill from the 100-year floodplain, any alteration that decreases the riparian area's ability to absorb precipitation through gradual infiltration into the ground, such as the removal of forest cover or an increase in impervious surfaces, will contribute to an increase in the frequency, duration and severity of flooding events downstream.

All of these impacts combine to cause a significant decrease in infiltration and a subsequent increase in the speed and amount of flood runoff. Furthermore, floodwater reduction through transpiration is likely to be reduced, as grass transpires much less water than forest vegetation. Last but not least, removal of vegetative cover from riparian areas results in more sediment being delivered into the river. Excessive sedimentation reduces flood storage, as eroded sediments settle out of the current and fill channels and deeper spots on the river so they can no longer convey or hold as much water. This reduction of storage capacity increases peak discharges and the likelihood of flood damage.

Placing impervious surfaces such as roofs and parking lots within riparian areas impairs their capacity to detain and absorb flood waters and runoff from adjacent uplands, and increases the volume and speed of runoff from the riparian area into adjacent streams, resulting in increased flooding and storm damage downstream and the subsequent risk of serious damage to lives and property. Increased watershed imperviousness typically amplifies normal streamflow patterns. Not only does it result in higher high flows as stormwater, with little or no opportunity to infiltrate the soil, is directly discharged into rivers and streams, exacerbating downstream flooding, impervious surfaces result in lower low flows. During periods of low precipitation, the lack of previous infiltration into groundwater reduces baseflow, and causes many urbanized streams to stagnate, putrefy and even dry up completely. Stormwater management systems for impervious surfaces typically only mitigate (lessen the severity of) but do not eliminate this problem.

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Structural attempts at flood control, such as confining watercourses into narrowly corseted channels and levees, have the effect of raising both the velocity and the height of any subsequent flood flow and make it all the more frightening and destructive when a river breaks through defenses, such as in the severe flooding experienced by the Mississippi River system in the 1990s. [The effect can be like that of a bursting dam.] Channelization of meandering streams cuts the water storage capacity of those streams and causes water to flow more rapidly downstream, exacerbating flooding and storm damage downstream. An increase in water velocity also increases a river's erosive power, placing bridge supports, embankments and other vulnerable areas at greater risk of being undermined. Even if channelized river segments and, on a smaller scale, drainage pipes for a low-lying development, have the effect of conveying flood flows quickly away from that particular location, they will nevertheless increase peak flows downstream. In other words, the cumulative impact of altering riparian areas for the purpose of accelerating the rate at which floodwaters move downstream will exacerbate the severity, duration and frequency of flooding events downstream: the flooding problem is not controlled; it is merely relocated from one spot to another.

***Why are vegetated riparian areas along smaller streams as significant for flood control as along the larger rivers?***

A large proportion of the water in the state's rivers is contributed by the smaller tributaries flowing into them. If riparian areas along these brooks and streams are altered in a manner that impairs their flood control function, the cumulative impact of streams discharging flood flows into rivers at a greater volume and velocity will result in worsening flooding in mainstem river communities, even if mainstem floodplains are safeguarded against further development. Furthermore, the same development on a small stream is likely to have a greater negative impact on flooding conditions than that same project would have along a larger river (e.g., the runoff from one large parking lot can itself be enough to overwhelm a small stream channel).

***What are some best management practices for riparian areas to maintain and enhance their flood control function?***

Alterations of riparian areas (through structural attempts at flood control or otherwise) can throw a river's delicate equilibrium with its floodplain out of balance in often unpredictable ways, sometimes resulting in much unforeseen damage. The most effective means to avoid such damage and to protect the flood control functions of riparian areas is to preserve and/or restore them to a naturally vegetated condition, letting the rivers flow and flood where they may, and to avoid and minimize the removal of streamside forests and the placement of buildings and other impervious surfaces within riparian areas. Particular attention should be made to improving and protecting forest cover on riverine uplands, which, due to their steeper slopes, have the greatest potential for exacerbating flooding conditions when detention and infiltration capacities are reduced due to forest removal.

"Natural Valley Storage", a technique pioneered in Massachusetts, which protects upstream floodplains in a natural vegetated state, is a great way to control downstream flooding. The U.S. Army Corps of Engineers, an agency that has historically promoted dams for flood control, nevertheless recommended and implemented a natural valley storage project along the upper Charles River which has to date saved many millions of dollars in flood damages downstream by preventing the floodplain from being developed and subsequently losing its flood storage function. Quoting the Corps' 1972 study report: "Nature has already provided the least-cost solution to future flooding in the form of extensive [riverine] wetlands which moderate extreme highs and lows in streamflow. Rather than attempt to improve on this natural protection mechanism, it is both prudent and economical to leave the hydrologic regime established over millennia undisturbed. In the opinion of the [Army Corps] study team, construction can add nothing." It is interesting to note that among the 17 natural valley storage areas that the Corps' 1972 report found critical to flood control, several lie some distance from the Charles mainstem and are connected to it by streams or brooks. This is an important point to remember: areas critical to flood control in a watershed are often distant from the mainstem.

***What are some additional benefits of keeping floodplains naturally vegetated?***

Maintaining or reestablishing vegetation in riparian areas increases the water-holding capacity of soil, which helps to recharge groundwater supplies. The slowing and dispersal of runoff and floodwater by floodplain vegetation allows additional time for this water to infiltrate and recharge groundwater aquifers. Floodplain soils and vegetation can also help to purify the water as it filters down to the aquifer. Once there, the groundwater can reemerge and seep back into surface water (often referred to as “baseflow”). This is especially important during the drier months, as healthy baseflow discharges help reduce the frequency and duration of low streamflows and the higher temperatures, higher pollutant concentrations and other adverse conditions to riverine ecosystems brought on by periods of low streamflow. Last but not least, naturally vegetated floodplains function as important fisheries and wildlife habitat (see respective fact sheets for details).