Riparian function and benefits in Austin, Texas.

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Structure of Healthy Riparian Buffers

Riparian zones are "transitional semi-terrestrial areas regularly influenced by fresh water, normally extending from the edge of water bodies to the edges of upland communities" (Naiman et al. 2005). This ecosystem includes all of the biotic (plants, animals, bacteria, fungi) and abiotic (soil, water, nutrients) components that intersect dynamically in this diverse and highly productive place (Naiman and Decamps 1997, McClain et al. 2003). Although the physical make-up of a riparian ecosystem varies dramatically over time and space, there are some general characteristics and forms that are consistent and predictable in the Austin area (Duncan et al. 2011, Richter and Duncan 2012):

- Riparian areas have dense canopies (~70% cover), well-developed and diverse understories (~40% cover, ~16 species per site), and patchy but diverse ground cover (~25% cover, ~13 species per site) - Figures 1 and 2.
- Riparian areas have a wide range of obligate and facultative wetland plant communities, a thick layer of moist humic material over loose rich soil, and a strong component of larger woody debris (both autochthonous and flood-deposited).
- Riparian areas have a diverse mix of seedlings, saplings, mature and dead woody species, ensuring recruitment and replenishment of the forest over time.
- The width of a riparian area varies widely depending on floodplain shape, groundwater and surface water hydrology, and climate. Generally, the larger the drainage area, the wider the functional riparian zone, and the wider the riparian zone, the more ecosystem services that it provides – Figure 1.

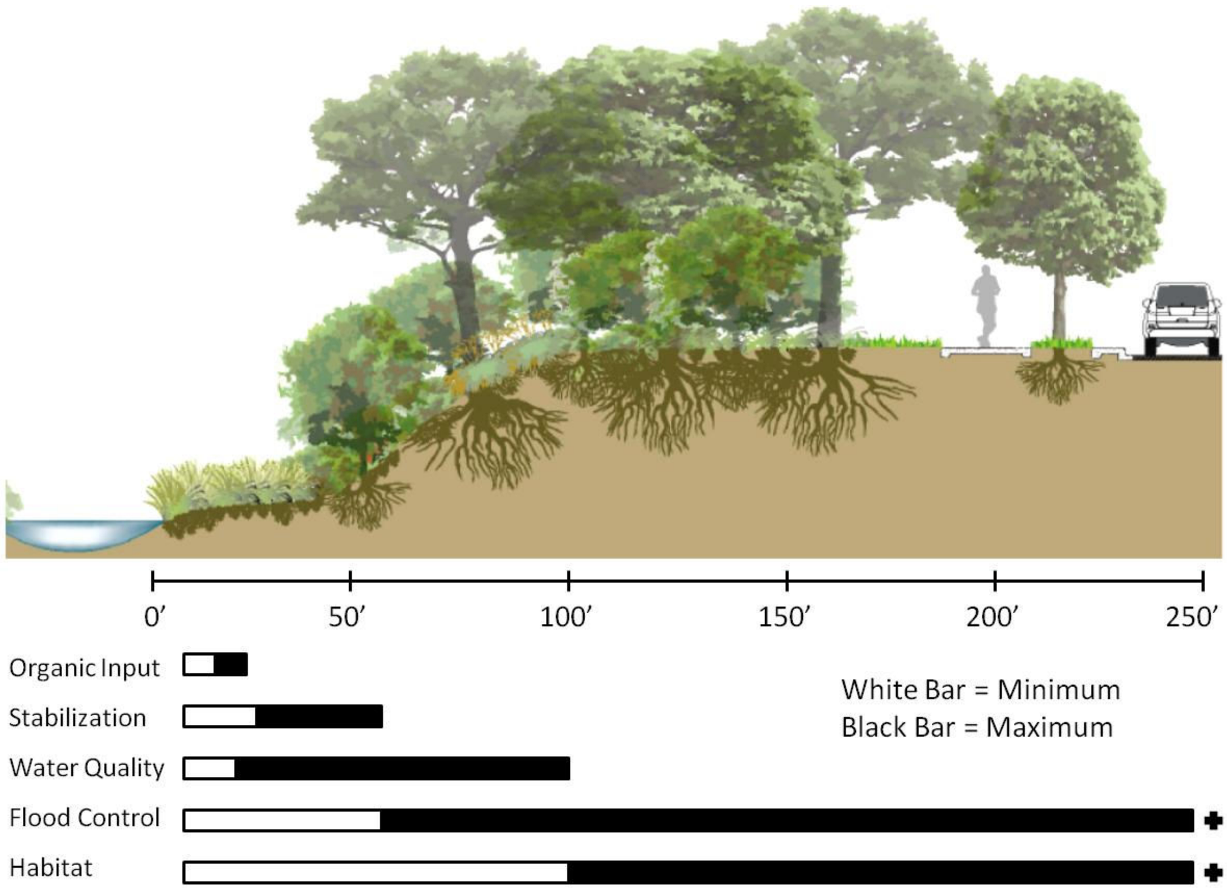

Figure 1. Cross-section of a functional riparian buffer in a headwater stream in Austin, TX with relative ecosystem services provided for different widths (D. Nuffer).

Figure 2. Example riparian buffers in the Central Texas Plateau (Left) and the Blackland Prairie Ecoregions (Right).

Function of Healthy Riparian Buffers
There is a robust body of peer-reviewed literature documenting the relationships between riparian vegetative buffers and receiving water body health. For the purposes of this paper, the benefits provided by riparian buffers will be broken down into the three missions of the Watershed Protection Department (WPD): Water Quality, Flooding and Erosion.

<u>Water Quality</u>

Riparian buffers are widely recommended as a tool for filtering and processing non-point source pollutants during run-off events. These pollutants include:

- **total suspended solids** (Blanco-Canquil et al. 2006, Lee et al. 2003, Dosskey 2001, Hickey and Doran 2004, Lowrance et al. 2002, Abu-Zreig 2001, Karr and Schlosser 1978);
- **nutrients** (Vidon et al. 2010, Mankin et al. 2007, Hickey and Doran 2004, Stone et al. 2004, Lee et al. 2003, Meals and Hopkins 2002, Vought et al. 1995, Osborne and Kovacic 1993, Haycock and Pinay 1993, Groffman et al. 1991, Magette et al. 1989);
- **herbicides/pesticides** (Krutz et al. 2005, Syversen and Haarstad 2005, USDA 2000, Rankins et al. 2001); and
- **bacteria/parasites** (Winkworth et al. 2008, Sullivan et al. 2007, Tate et al. 2006, Tate et al. 2004 Atwill et al. 2002, Entry et al. 2000).

The processes by which these pollutants are removed in riparian areas are complex and varied, but include infiltration, dilution, sorption, uptake by vegetation and degradation by microbial activity (Dosskey 2001, Krutz et al. 2005). In general, sediment-bound pollutants are the most easily removed in riparian areas, but due to the high biological diversity, productivity and physical complexity of these areas, they are also very efficient at processing and taking up dissolved constituents as well (Phillips 1989, Gift et al. 2010).

There are also clear physical benefits that riparian areas provide that improve stream health. Providing shade to both aquatic habitats and riparian soils is a critical component to moderating temperatures and reducing evaporation (Naiman et al. 2005, Allan 2004, Hynes 1970). Lower temperature water holds more oxygen and supports a wider and more sensitive range of organisms. In addition to lowering temperatures, reduced light in the stream system reduces growth and productivity of nuisance algae communities (Sturt et al. 2011). Riparian vegetation also provides a complex habitat and food source for the diverse life forms that live in the streams, soils and canopies of these systems. Abundant organic carbon and micronutrients that result from flooding inputs, vigorous vegetation growth, death, and leaf-drop are the basis of this diverse and highly productive food chain (Cavalcanti and Lockaby 2006, Naiman et al. 2005, Meyer and Wallace 2001, Pollack et al 1998).

<u>Flooding and Hydrology</u>

The effect a riparian area has on stream hydrology is heavily dependent on soils, underlying geology, channel modification, and catchment size (Phillips 1989, Osborne and Kovacic 1993). In addition to removing pollutants from stormwater, healthy riparian areas also improve hydrology in stream systems by working as a sponge: absorbing water during wet periods and releasing it slowly during drier periods (Groffman et al. 2003, Schueler 1995, Junk et al 1989, Poff et al. 1997). Naturally vegetated riparian floodplains have the ability to increase the baseflow component of the hydrograph and to slow and attenuate downstream flood effects compared to degraded or deforested floodplains (Web and Leake 2006, Allan 2004, Tabacchi et al 2000, Darby 1999, Toner and Keddy 1997, Bren 1993, Gordon et al. 1993, Hynes 1970). Since water is generally the most limiting resource in Austin-area streams, baseflow is a keystone variable that drives overall stream health and ecological function (Glick et al. 2010, Auble et al 1994). Increased predictability in baseflow provides for longer lived, more diverse life in streams, increasing the streams ability to process nutrients and essentially clean itself. This more resilient ecosystem is able to maintain function throughout a wider range of climactic and development-driven variability.

<u>Erosion</u>

Riparian vegetation promotes bank and general geomorphic stability by anchoring soils (flow resistance) and reducing near-bank flow velocity (Reubens et al. 2007, Thorne 1990, Waldron 1977, Darby 1999, Gordon et al. 1993, Leopold et al. 1964). The more established, diverse and deeply rooted the vegetation, the more stable and resistant the bank material is to erosive flows. Although large woody debris can cause bank erosion, and can be a flood concern, particularly in urban areas, it often serves as an energy dissipater and sediment trap that help stabilize a natural stream system (Gurnell et al. 2002, Abernathy and Rutherfurd 2000, Rosgen 1997, Abt et al. 1994, Lee et al. 1993, Gordon et al. 1992, Leopold et al. 1964).

Riparian Restoration and Enhancement

Managed succession is the guiding principle for the WPD riparian restoration program. The goal is to facilitate the establishment of a self-sustaining and resilient native plant community that requires minimal management inputs (irrigation, mowing, herbicide/fertilizers) and promotes establishment and recruitment of diverse native species.

This approach is adaptive and can be revised and improved as we track the success of individual projects. The following are the primary management components of all WPD riparian restoration projects:

Soil Amendment

- Conduct soil tests to determine soil organic carbon and compaction. Add organic soil carbon for compacted soils and or soils with low organic matter by applying compost and/or wood chips. Coir blankets + porous ceramic can be used to improve water holding capacity and soil aeration in compacted soils in areas with gentle slopes (less than 3:1).

Native Species Seeding

- Seed with high diversity (≥ 25 species) grass and forb native species mixes at 3 times the manufacturer recommended seeding rate. Mixes should be matched to each site according to light and moisture level profiles (e.g. dry versus moist conditions and shade, part shade, or light demanding spp.) Seeds must be raked in for increased seed-soil contact.

Tree Seedling Planting

- Tree seedlings (< 1 year old) should be planted in the riparian area between November and February, spaced 3 feet from each other, in a ratio of one canopy species to two understory species.

A diverse native species mix is required, with no species representing more than 20% within each size category.

Exotic Invasive Species Control

- Control shall be phased for mature woody species, opening up canopy gaps, but preserving some cover to protect soil and provide shade. Girdling is the preferred control method for larger trees. Young trees (≤1"basal diameter) and seedlings should be removed manually if possible using weed wrenches where soil disturbance is not a concern. For exotic invasive grasses, remove all above ground biomass consistently until stores are depleted and/or use herbicides if necessary (See City of Austin Invasive Species Management Plan, and Field Resource Manual, http://www.austintexas.gov/invasive).

Summary

The preservation, rehabilitation and restoration of healthy riparian buffer areas is a critical component to any watershed management approach (Broadmeadow and Nisbet 2004), due to the efficiency of these areas in providing water quality, erosion prevention and ecological services. These benefits are proportional to the size and land management practices of these buffers, with more services for larger buffers (> 300 ft) and for buffers that have a native, self-sustaining community of canopy, understory and ground cover vegetation. Every effort should be made from a regulatory perspective to buffer all waterways from development and, from a restoration perspective, to return basic structure and function of these degraded area to the highest levels achievable.

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