Ecology of Riparian Ecosystems

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PLSC 480: Management of Urban Forest Edges
The University of Maryland – College Park
Spring 2016

Contents

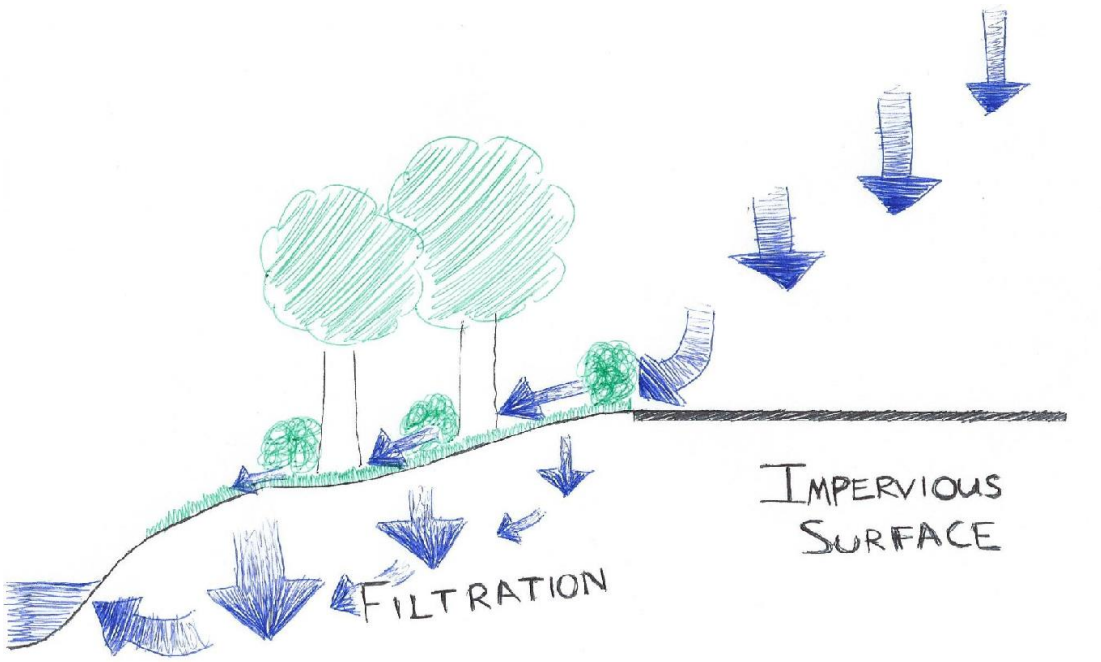
Riparian Ecosystems: Public Fact Sheet

Riparian ecosystems are where the land connects with rivers and streams, and encompass both the land and water portions of this connection. To remain stable and functional, these ecosystems should consist of a floodplain adjacent to the river and continue upland into a more densely forested area. These floodplains and forests contain a wide variety of native species native, as well as many species that are migratory or may be from different regions of the world.

These ecosystems are fragile and susceptible to damage, especially in modern cities where there are a lot of manmade structures and surfaces. They deal with all of the rainwater and water that flows through and on the top of the ground. Due to modern urban development, many of these riparian ecosystems have been removed or destroyed, leaving just the bare waterway. The lack of riparian ecosystems can lead to many things that bring harm to the environment on a local, regional, and even a global scale.

General facts and information about riparian ecosystems:

- Over the past 200 years, approximately 80 percent of all riparian ecosystems across North America and Europe have either been removed or destroyed.
- Waterways protection has already been enacted in the United States through the 1972 Clean Water Act.
    - Further protection of waterways is being studied, and involves the restoration and protection of riparian ecosystems.
- Riparian ecosystems are some of the most biodiverse ecosystems in the world, hosting numerous species of plants and animals.
    - Riparian ecosystems host robust plant life, and can be inhabited by a large amount of plants across the world. This plant life, in turn, can support more plant and animal life.
    - Many species of native and migratory birds use riparian ecosystems as a place to live and move through.
    - A healthy riparian ecosystem will support fish and other aquatic life by improving the water quality of rivers and streams.
- The abundance of plants in riparian areas can moderate temperature in surrounding areas, making it cooler in the summer and warmer in the winter.
    - Abundant plant life also helps reduce air pollution. Cities are the number one producer of greenhouse gases, and trees are the number one method for reducing greenhouse gas emissions.
- Runoff caused by impervious surfaces like pavement and asphalt runs through riparian ecosystems before entering rivers and streams.
    - This runoff water contains contaminants that are bad for aquatic ecosystems (rivers, streams, and other bodies of water).
    - The contaminants are significantly less harmful to riparian ecosystems than they are to aquatic ecosystems, so the collection of contaminants in riparian ecosystems is of less concern.



This diagram shows the flow of rainwater over impervious surfaces into a riparian zone. The rainwater falling on the impervious surface becomes runoff water, skimming the impervious surface. It eventually reaches the riparian zone where it is absorbed into the soil and through the plants that filter it. The water then reaches the waterway where it continues downstream.

- Riparian ecosystems act as a buffer between the land and the water to protect the water from harm, but also to protect the land from the water.
    - Naturally occurring riparian areas act as floodplains during heavy rain events and will accommodate any excess water that the rivers can't hold during a flood event.
    - In places where streams lack proper riparian buffers, overflowing rivers and streams cause flood developed land and cause damage to human property.
- In cities, the storm drainage systems often dump stormwater directly into waterways, completely avoiding any filtration process.
- The plants in riparian ecosystems aid in the filtration of the runoff water, but also prevent the riverbanks from eroding over time.
    - Riverbank erosion can enlarge rivers to the point where they become a public concern because further erosion could damage of manmade structures and buildings.

Introduction

In the urban landscape, ecosystems are being fragmented into smaller and smaller pieces that lack the connectivity and resources to function properly. Riparian zones are ecosystems that act as an ecotone, or interface, between aquatic and terrestrial ecosystems. A properly functioning riparian ecosystem provides a multitude of ecosystem services that help keep the surrounding area healthy and sustainable (Mander et al 2005). Thus, when riparian ecosystems are fragmented and aren't functioning properly, they fail to perform these services that help maintain a healthy environment.

Due to urbanization and the fragmentation of riparian zones, riparian zones and rivers are often destroyed or put underground into pipelines for more building space (Naimen et al. 1993). This breaking up of riparian zones and waterways, as well as the installation of impermeable surfaces, can lead to issues that get exacerbated in areas with functioning riparian ecosystems.

Characteristics of a Riparian Ecosystem

Riparian ecosystems are interfaces between terrestrial and aquatic ecosystems, and display the interaction between these two different types of ecosystems (Gregory et al. 1991, Bilby 1988, Naimen et al. 1993). The riparian zone is adjacent to a waterway with flowing water, and is a low-lying area that increases in elevation moving outwards from the aquatic/terrestrial interface (Gregory et al. 1991). Thus, the primary component needed for an ecosystem to be considered riparian is the presence of a flowing waterway (Gregory et al. 1991, Bilby 1988, Naimen et al. 1993).

This waterway will be at the lowest elevation point in the ecosystem since it needs to be on par with the natural level of groundwater (Gregory et al. 1991). Moving outward the terrestrial component of the ecosystem will be slightly higher, but low enough to act as a floodplain during heavy rain events (Gregory et al. 1991). Because of the proximity to waterways, soils in riparian ecosystems can be hydric, meaning that they are saturated with water long enough for the upper portion of the soil matrix to be in anaerobic

conditions (Bedison et al. 2013). Although not all riparian ecosystems contain hydric soils, they are all susceptible to flooding (Bedison et al. 2013).

Flooding and runoff in riparian zones will carry nutrients that get deposited into the soil matrix (Bilby 1988). The deposition of abundant nutrients in riparian soils leads to excess levels of ions and compounds like phosphorous and nitrogen (Bedison et al. 2013). Thus, riparian soils are only habitable for select plant species that can tolerate the unique conditions created by flooding and nutrient deposition (Bilby 1988). Vegetation in riparian ecosystems is very diverse considering the unique conditions; in fact riparian ecosystems are some of the most biodiverse ecosystems (Naimen et al. 1993).

The unique conditions like periodic flooding and high nutrient levels create disturbances that are beneficial for exotic species and can allow them to overtake riparian ecosystems, effectively decreasing biodiversity (Gonzalez et al. 2015). The presence of vegetation benefits the ecosystem as a whole by stabilizing the soil matrix, keeping temperatures low, and filtering pollutants (Gregory et al. 1991, Bilby 1988, Naimen et al. 1993). The width of the effective vegetated zone in a riparian ecosystem is the riparian buffer, and the buffer's size varies based on factors like stream size and topography (Gregory et al. 1991).

Rooting vegetation into riparian soils influences the geomorphology of riparian zones, which is known to constantly change (Gregory et al. 1991, Bilby 1988, Naimen et al. 1993). The geomorphology, or the shape of the land, of riparian zones is unique because it is constantly changing due to the flow of water (Gregory et al. 1991, Bilby 1988, Naimen et al. 1993). Flowing water has the ability to pick up sediment in one area and deposit it elsewhere, and the faster the water moves the more energy it has to deposit more sediment (Gregory et al. 1991, Bilby 1988, Naimen et al. 1993). This principle appears in riparian zones where rivers and waterways constantly change shape and position because of the movement of sediment (Gregory et al. 1991, Bilby 1988, Naimen et al. 1993). When rivers and waterways bend and turn the water slows down, leading to less sediment movement and a more stable waterway position. Rooting from vegetation

can further stabilize the waterway by stabilizing the riverbank soil, restricting soil movement (Gregory et al. 1991, Bilby 1988). Urban waterways differ in the natural occurrence of these geomorphological changes and can experience increased erosion and increased water velocity (Paul & Meyer 2001).

Urban Riparian Ecosystems

In urban landscapes, watersheds are drastically altered, leading to a change in the hydrology of riparian ecosystems (Paul & Meyer 2001). The most significant difference between urban and natural watersheds is the amount of impermeable surface cover present in urban watersheds; they can have upwards of 75-100 percent impermeable surface coverage (Paul & Meyer 2001, Arnold & Gibbons 1996). Impermeable surfaces lead to increased runoff of surface water and decreased infiltration of water into the groundwater supply (Paul & Meyer 2001, Arnold & Gibbons 1996). The increased runoff means that stormwater drains and urban riparian ecosystems must make up for the lack of permeable surface elsewhere and deal with the increased input of water (Paul & Meyer 2001, Arnold & Gibbons 1996).

This surface runoff water introduces another problem into the mix—pollution from numerous indistinct sources in the urban landscape, also known as nonpoint source pollution (Arnold & Gibbons 1996), in contrast to point source pollution, where pollution is from a distinct source like a pipeline (Arnold & Gibbons 1996). Nonpoint source pollution contains contaminants that are harmful to the environment such as excessive nutrients and toxic contaminants like heavy metals and pesticides (Arnold & Gibbons 1996).

Another problem in urban riparian zones is the lack of connectivity in a forested riparian ecosystem. Due to urbanization, unconnected riparian ecosystems lack the ability to cycle natural components that maintain healthy ecosystems (Naimen et al. 1993). Sediment, which is a detriment in terms of pollution, is also necessary to deposit organic matter that enriches the soils (Gregory et al. 1991). When an urban riparian ecosystem is heavily

flooded because of excessive impervious surface in the watershed and the lack of riparian ecosystem to handle the water load, the ecosystem can lose a large amount of organic matter due to sediment deposition (Paul & Meyer 2001). Sediments in urban riparian ecosystems can also be too finely textured, making them unable to hold a significant amount of organic matter, which can lead to a decrease in vegetative production (Paul & Meyer 2001).

Function

Riparian ecosystems have many functions and provide services to the local and regional environment (Naimen et al. 1993). A properly functioning riparian ecosystem filters surface and subsurface water flow, prevents riverbank erosion, filters air pollution, and provides habitat for a variety of species and active corridors for species to move through an increasingly fragmented urban landscape (Mander et al 2005).

Filtration of surface and subsurface flows is a crucial function of riparian ecosystems, especially in urban landscapes that have highly altered flow paths (Paul & Meyer 2001, Arnold & Gibbons 1996). Urban landscapes have a large amount of impermeable surface that impedes the natural water cycle processes of infiltration and penetration into the soil (Arnold & Gibbons 1996). These impermeable surfaces redirect the natural flow of water that used to infiltrate into the soil, creating a large amount of runoff water (Paul & Meyer 2001, Arnold & Gibbons 1996). This runoff flow across the surface will pick up pollutants and sediments that then get carried into the waterways (Arnold & Gibbons 1996). Filtration performed by the riparian ecosystem during rain events is a crucial ecosystem service because otherwise these pollutants will run directly into the waterways and continue downstream (Paul & Meyer 2001, Gregory et al. 1991, Bedison et al. 2013). The nonpoint source pollutants that are filtered out by riparian ecosystems are viewed as the largest threat to water quality in the United States (Arnold & Gibbons 1996). The nutrients and pollutants deposited into the soil matrix in riparian ecosystems lead to the high concentrations of phosphorous and nitrogens that are characteristic of riparian ecosystems (Bedison et al. 2013).

Another important function of riparian ecosystems is their ability to prevent soil erosion along riverbanks (Gregory et al. 1991). The vegetation in riparian ecosystems provides soil stability by deeply rooting into the soil strata and stopping soil from eroding (Gregory et al. 1991, Bilby 1988, Gonzalez et al. 2015). Limiting soil erosion contributes to keeping riparian ecosystems healthy because soil contains the nutrients needed for the vegetation to persist (Paul & Meyer 2001). In cases where urban riparian ecosystems fail to prevent erosion there can be substantial loss of human property.

Air pollution is leading to the phenomenon of global warming. Urban landscapes are responsible for more than 78 percent of greenhouse gas emissions, and need to find ways to offset their large emissions of greenhouse gases (Paul & Meyer 2001). Carbon sequestration, the long-term storage of carbon removed from the atmosphere, is a function of organisms in the soil and vegetation (Cierjacks et al. 2009). Healthy riparian ecosystems can sequester large amounts of carbon and are useful tools in combating air pollution (Bedison et al. 2013, Cierjacks et al. 2009).

As interfaces between terrestrial and aquatic ecosystems, riparian ecosystems have "sharp environmental gradients, ecological processes, and communities" (Naimen et al. 1993). Riparian ecosystems have a handful of diverse habitats like edge, forest, aquatic, and early successional habitat that host numerous species (Naimen et al. 2000). The biota present in riparian ecosystems includes aquatic vertebrates and invertebrates, aquatic vegetation, terrestrial invertebrates and vertebrates, as well as a wide variety of exotic and native plant species (Naimen et al. 1993, Naimen et al. 2000, Gonzalez et al. 2015).

Disturbance regimes are viewed as the main reason for biodiversity in riparian ecosystems (Naimen et al. 1993). Constant flooding of riparian ecosystems uproots existing vegetation and gives way to new vegetation, but the presence of large woody debris can impede this process (Gregory et al. 1991, Bilby 1988, Naimen et al. 1993). Large woody debris is a key geomorphic feature in riparian ecosystems that will provide shelter from the flooding torrents and create an island effect where plants don't get uprooted (Paul & Meyer 2001, Gregory et al. 1991, Bilby 1988, Naimen et al. 1993).

This island of vegetation will be able to mature and withstand future flooding events (Naimen et al. 2000). Multiple islands of mature vegetation eventually make up the diversity of vegetation present in riparian ecosystems. Biodiversity is important in an ecosystem allowing it to resist large scale disturbances, like disease, that could otherwise wipe it out.

In urban landscapes, the fragmentation of natural ecosystems is considered a major threat to biodiversity because it limits the free movement of species between patches of ecosystem (McKinney 2008). Riparian ecosystems combat this fragmentation by acting as corridors for the movement of the varied species they host (Naimen et al. 1993). Riparian corridors include the waterways as well as the ecosystem's upland areas of vegetation (Naimen et al. 1993). The most well documented use for riparian corridors is the spread and biodiversity in vascular plants, but other organisms like migratory birds also rely on the corridors (Naimen et al. 1993, McClure et al. 2015). Although riparian corridors are crucial components in maintaining connectivity in the fragmented urban landscape, more 80 percent of the riparian corridors in North America and Europe have been destroyed in the last 200 years (Naimen et al. 1993).

Conclusions

Riparian ecosystems are crucial components of the increasingly fragmented urban landscape. They are fragile and susceptible to disturbances, requiring attention and care (Naimen et al. 2000). By acting as a corridor for species movement they increase local and regional biodiversity. They provide ecosystem services including, but not limited to filtration of surface and subsurface water flow, prevention of riverbank erosion, filtration of air pollution, habitat for a variety of species, and active corridors for species to move through the increasingly fragmented modern landscapes (Mander et al).

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