Riparian Forest Handbook 1

Appreciating and Evaluating Stream Side Forests

VIRGINIA DEPARTMENT OF FORESTRY

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Appreciating and Evaluating Stream Side Forests

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1. How To Use This Booklet

This handbook is organized to help you appreciate the importance of stream side forests, and to guide you as you evaluate a portion of a stream you may hope to restore. We begin with a discussion of why riparian forests are important. We then describe ways to evaluate the health of a riparian forest, and suggest methods for restoring a riparian forest.

A companion computer disk is available. It contains computer programs that help you organize information and compute the hydraulic geometry and sediment relationships that characterize your stream. Contact the Virginia Department of Forestry at (434) 977-6555, for more information.

We hope you enjoy reading and using this handbook and software. Armed with new information and insights into your stream, we encourage you to organize yourself and others to take positive steps to restore and protect the waters and riparian forests of Virginia!

Figure 1: *Forests are important to watershed health*

2. Why Riparian Forests Are Important

2.1 Riparian Forests Sustain the Stream Environment

By controlling water temperature, light, habitat diversity, channel morphology, food webs, and the species diversity of stream systems, riparian forests sustain the stream environment.

Temperature and Light

Maintenance of consistent daily and seasonal fluctuations in water temperature and ambient light levels is crucial to the viability of plant and animal populations.

Riparian forests dampen fluctuations in stream water temperature; blocking out heat to keep water cool during hot times, and capturing heat as it radiates from the soil and water to keep the stream environment warmer during cold times. The net effect is an environment more conducive to life, with less tendency for wide fluctuations in stream temperature.

Light levels are regulated in similar fashion. Brighter areas in small openings and at the tops of tree canopies contrast with shaded areas in lower portions of the forest stand, and on the forest floor. The result is a stable and varied habitat conducive to diverse plant and animal life.

Habitat Diversity and Channel Morphology

Biological diversity depends on available habitat. Available aquatic habitat depends, in large part, on the woody debris available to streams. Upon entering the stream channel, woody debris creates unique and diverse habitat for aquatic organisms, at many scales. As it slowly decomposes, woody debris releases nutrients that sustain aquatic life. The roughness and structural integrity created by woody debris act to stabilize the stream environment by absorbing the energy of water, and reducing the severity of erosive influences of stream flow. Debris dams formed by woody debris accelerate organic decay rates, making nutrients more available to aquatic organisms.

Absence of streamside forest can fundamentally change channel morphology (the dimension, pattern, and profile of a channel) resulting in habitat loss. Without trees a channel may become unnaturally wide, as stream banks erode. Water velocities may increase as water moves without the energy absorbing benefits of woody debris. Faster water combined with altered channel form can cause bank scour, stream straightening, and excess sediment deposition in the stream bed. Each of these affects can create a degraded environment that supports fewer aquatic plant and animal species.

Links between the presence of large woody debris in streams and abundant fish habitat are well documented in scientific literature. The surfaces of submerged logs and roots provide habitat that may support aquatic insect (macroinvertebrate) densities far higher than those supported on the stream bottom. Macroinvertebrates provide food for fish. Pools created by woody debris provide pockets of habitat otherwise unavailable to fish. In undisturbed forests, large woody debris create most of the pools formed in streams. Removal of woody debris by deforestation typically results in loss of pool habitat. Even when selective timber harvesting is done along streams, the removal of older trees causes a decline in aquatic habitat because of diminished inputs of large woody debris.

Food Webs and Species Diversity

Litterfall and algal production are the two primary sources of food energy inputs to streams. Both are intimately tied to the presence of riparian forest.

Litterfall, (leaves, twigs, fruit seeds, and other organic debris), is most abundant when riparian forests are present. Studies note that "streams flowing through older, stratified forests receive the greatest variation in quality of food for detritus-processing organisms."[1] Because large pieces of litter do not travel very far away from their origin, a stream side forest is needed along the entire length of a stream to ensure a balance of food inputs appropriate to the food chain of native species. Macroinvertebrate populations are affected by changes in litter inputs. The metabolic activity of some of these organisms may increase as streamside plants are removed. This allows woody material to be decomposed more quickly, making nutrients in this material less available to fish and other aquatic species.

The type and amount of algae produced in a stream is affected by the amount of light striking the water surface. Studies show that the algal community of a stream well shaded by older trees is dominated by single celled algae (diatoms) throughout the year. Streams in deforested areas often contain many thread like (filamentous) green algae, and few diatoms. While some macroinvertebrates such as crayfish and waterboatmen insects readily consume filamentous green algae, most herbivorous species of stream macroinvertebrates have evolved mouth parts specialized for scraping diatoms from the surfaces of rocks and wood. They cannot eat filamentous algae. Macroinvertebrate diversity tends to decline if a stream side zone is deforested.

2.2 Riparian Forests Remove Non-point Source Pollutants.

Riparian forests remove, sequester, or transform nutrients, sediments and other pollutants. Pollution removal depends on (1) the capability to intercept surface water and groundwater borne pollutants, and (2) the activity level of certain pollutant removal processes.

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[1] Chesapeake Bay Riparian Handbook, NA-TP-02-97, Section III.

Nitrate Removal

The mechanisms that remove nitrate from forest riparian zones are *denitrification and plant uptake*.

Denitrification is the biochemical reduction of nitrate to gaseous nitrogen, either as molecular nitrogen or as an oxide of nitrogen. As nitrogen in soil water is changed to a gas, it leaves the riparian zone and moves into the atmosphere. Forests act to facilitate this process, by stimulating microbial activity and contact between biologically active soil layers and groundwater.

Plant uptake is the movement of soil nutrients into a plant. Nitrate can be collected from soil water and sequestered in plant tissue. Active nitrate uptake by forest vegetation throughout the biologically active soil layers can provide long term sequestering of nitrate and other nutrients in woody biomass. Since the growth rate of a forest tends to be nitrogen limited, forests can respond to a nitrogen subsidy in the soil by both increased growth rates and the "luxury" of increased nitrogen uptake. Such a response will reduce the amount of nitrogen available to enter stream water.

Flood tolerant plant species, such as those found in many riparian forests, are adapted to process nitrogen and other nutrients in low oxygen environments. Flooding can enhance the nutrient uptake and growth of some species. Flood tolerant species often have unique metabolic responses, adapted to low-oxygen conditions. During flooding, for example, roots may become thicker, increasing porosity and allowing downward diffusion of oxygen. When selecting vegetation for restoring or managing a riparian forest, it is important to consider the ability of species to process and store nutrients under site specific conditions.

Microbial Processes

Microbial processes also immobilize pollutants in riparian forest buffers. Microbes may take up dissolved nutrients as do plants. Later, these nutrients may be mineralized following the death and decomposition of microbial cells. This process is similar to the release of nutrients by plants following litterfall. Over time, a net storage of immobilized nutrients occurs in forest ecosystems that are accumulating soil organic matter. If managed to encourage the accumulation of soil organic matter, riparian forests can support significant long-term nutrient storage by immobilization.

There are many different microbial degradation mechanisms that operate in forests, these including: aerobic, anaerobic, chemoautotrophic, and heterotrophic pathways. The wide ranging and diverse environments in riparian forests can support these mechanisms at many locations.

Removal of Surface-Borne Pollutants

Riparian forests trap sediment as surface runoff is intercepted by forest litter, organic soils, and tree roots. Water is slowed and sediment particles are deposited in the forest before they can enter the stream.

Nutrient runoff is controlled by riparian forests in similar ways. The sediments carrying nutrients may be deposited on the forest floor and erosive processes may be reduced. The high infiltration rates characteristic of forest soils allow runoff to move into groundwater, eliminating surface movement of nutrients to the stream. Nutrients borne in surface runoff may be diluted by incoming rainfall and throughfall beneath the forest canopy. Nutrients my be adsorbed in reactions with forest litter and forest soil.

Figure 2: *Healthy forest soils store nutrients*

2.3 Riparian Forests Provide Many Natural Benefits[2]

Leaf Food

Leaves fall into a stream and are trapped on woody debris (fallen trees and limbs) and rocks where they provide food and habitat for small bottom dwelling creatures such as insects, amphibians, crustaceans, and small fish. Survival of these creatures is critical to the aquatic food chain.

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[2] Adapted from Alliance for the Chesapeake Bay source materials published in 1996.