Chapter 1

INTRODUCTION TO STREAMS AND RIVERS

- The Living Stream Environment
- The River System
- What Is Stream Flow and Why Is It Important?
- The River Continuum Concept

The Living Stream Environment

A healthy stream is a busy place. Wildlife and birds find shelter and food near and in its waters. Vegetation grows along its banks, shading the stream, slowing its flow in rainstorms, filtering pollutants before they enter the stream and sheltering animals. Within the stream itself are fish and a myriad of insects and other tiny creatures with very particular needs. For example, stream dwellers need dissolved oxygen to breathe, rocks, overhanging tree limbs, logs, and roots for shelter, vegetation and other tiny animals to eat and special places to breed and hatch their young. For many of these activities they might also need water of specific velocity, depth, and temperature.

Human activities shape and alter many of these stream characteristics. We dam up, straighten, divert, dredge and discharge into streams. We build roads, parking lots, homes, offices, golf courses and factories in the watershed. We farm, mine, cut down trees, and graze our livestock in and along stream edges. We also swim, fish and canoe in streams. Volunteers should be aware that the surrounding land affects stream habitat.

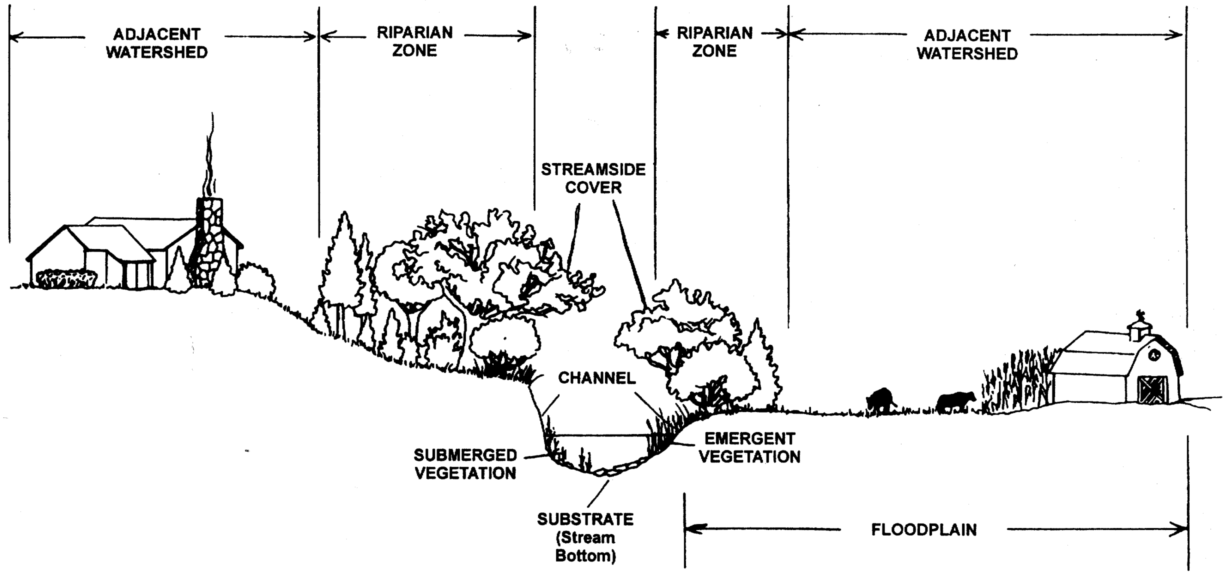

Figure 1.1 Components of a stream and the surrounding land

These activities can dramatically affect the many components of the living stream environment (Figure 1.1). These components include:

The **adjacent watershed** includes the higher ground that captures runoff and drains to the stream.

The **floodplain** is the low area of land that surrounds a stream and holds the overflow of water during a flood (Figure 1.2).

The **riparian zone (buffer)** is the area of natural vegetation extending outward from the edge of the streambank. The riparian zone acts as a buffer to pollutants entering a stream from runoff, controls erosion and provides stream habitat and nutrient input into the stream. A healthy stream system generally has a healthy riparian zone. Reductions and impairment of riparian zones occur when roads, parking lots, fields, lawns and other artificially cultivated areas, bare soil, rocks or buildings are near the streambank.

The **streamside cover** includes any overhanging vegetation that offers protection and shading for the stream and its aquatic inhabitants.

The **bankfull** line is defined as the line on the stream bank marking the normal maximum water flow level before excess water spills into the riparian zone or floodplain. The bankfull discharge is expected to occur every 1.5 to 3 years on average (Figure 1.2).

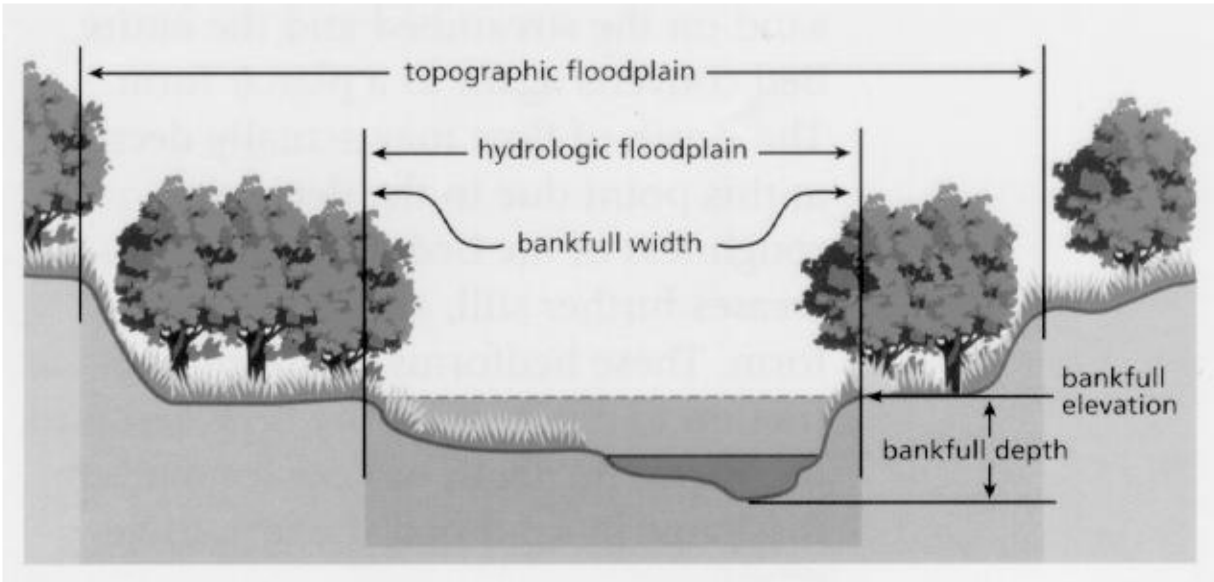

Figure 1.2 Components of the floodplain and bankfull

The **stream bank** includes both an upper bank and a lower bank. The lower bank normally begins at the normal water line and runs to the bottom of the stream. The upper bank extends from the break in the normal slope of the surrounding land to the normal high water line.

Stream vegetation includes emergent, submergent and floating plants. Emergent plants include plants with true stems, roots and leaves with most of their vegetative parts above the water. Submergent plants also include some of the same types of plants, but they are completely immersed in water. Floating plants (e.g., duckweed, algae mats) are detached from any substrate and are therefore drifting in the water.

The **channel** of the stream is the width of the stream at bankfull discharge.

Pools are distinct habitats within the stream where the velocity of the water is reduced and the depth of the water is greater than that of most other stream areas (Fig. 1.3). A pool usually has soft bottom sediments.

Riffles are shallow, turbulent, swiftly flowing stretches of water that flow over partially or totally submerged rocks. This is where you can hear the sound of the water moving.

Runs or **glides** are sections of the stream with a relatively low velocity that flow gently and smoothly with little or no turbulence at the surface of the water.

The **substrate** is the material that makes up the streambed, such as clay, cobbles or boulders.

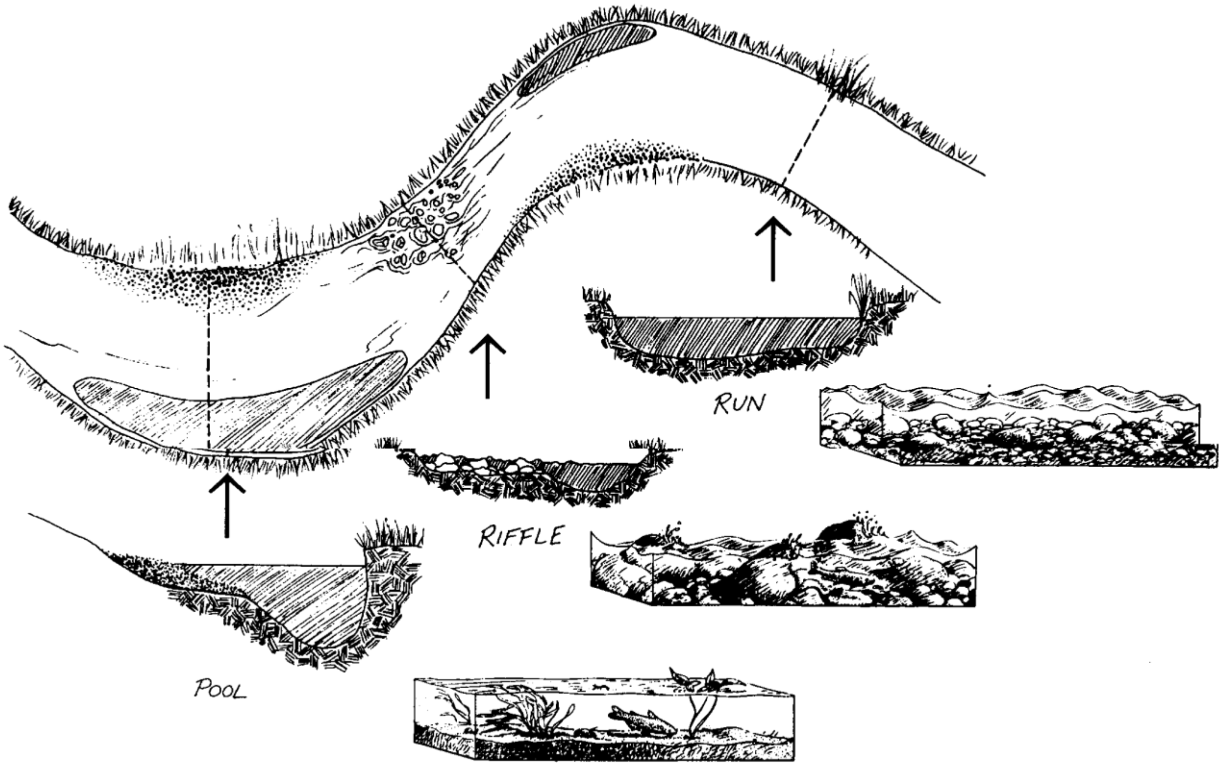

Figure 1.3. Components of the River System

Whether streams are active, fast moving, shady, cold and clear, or deep, slow moving, muddy and warm—or something in between—they are shaped by the land they flow through and by what we do to that land. For example, vegetation in the stream's riparian zone protects and serves as a buffer for the stream's streamside cover, which in turn shades and enriches (by dropping leaves and other organic material) the water in the stream channel.

Furthermore, the riparian zone helps maintain the stability of the streambank by binding soils through root systems. This helps control erosion and prevents excessive siltation of the stream's substrate. If human activities begin to degrade the stream's riparian zone, each of these stream components—and the aquatic insects, fish and plants that inhabit them—also begins to degrade. The Macroinvertebrate Monitoring Manual includes methods that volunteers can use to assess the stream's living environment—specifically, the insects that live in the stream and the physical components of the stream (the habitats) that support them.

The River System

Stream scientists categorize streams based on the balance and timing of the storm water runoff and baseflow components. There are three main categories:

Ephemeral streams flow only during or immediately after periods of precipitation. They generally flow less than 30 days out of the year and persist as dry riverbeds throughout most of the year.

Intermittent streams flow only during certain times of year. Seasonal flow in an intermittent stream usually last longer than 30 days per year.

Perennial streams flow continuously during both wet and dry times. Base flow is generally generated from the movement of ground water into the channel.

As streams flow downhill and meet other streams in the watershed, a branching network is formed (Figure 1.4). When observed from above, this network resembles a tree. The trunk of the tree is represented by the largest river that flows into the ocean or Gulf of Mexico. The "tipmost" branches are the **headwater streams**. This network of flowing water from the headwater streams to the mouth of the largest river is called the **river system**. Water resource professionals have developed a simple method of categorizing the streams in the river system. Streams that have no tributaries flowing into them are called **first-order streams**. Streams that receive only first-order streams are called **second-order streams**. When two second-order streams meet, the combined flow becomes a **third-order stream**, and so on.

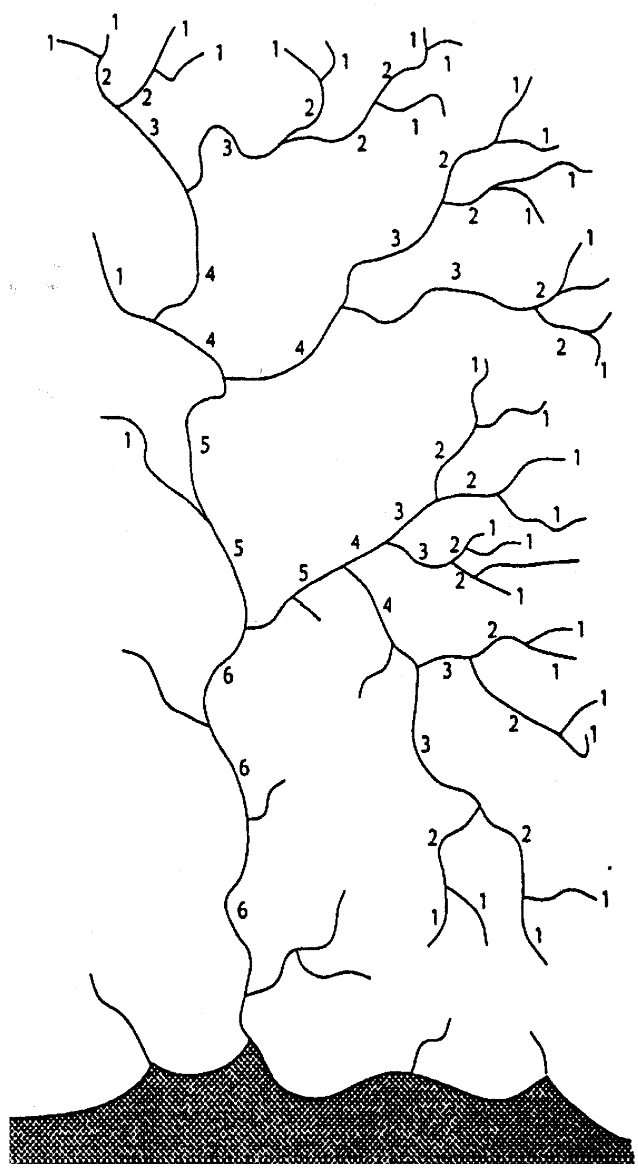

Figure 1.4 River system orders

What Is Stream Flow and Why Is It Important?

Stream flow, or discharge, is the volume of water that moves over a designated point over a fixed period of time. It is often expressed as cubic feet per second (cfs).

The flow of a stream is directly related to the amount of water moving off the watershed into the stream channel. It is affected by weather, increasing during rainstorms and decreasing during dry periods. It also changes during different seasons of the year. Stream flow decreases during the summer months when evaporation rates are high and shoreline vegetation is actively growing and removing water from the ground. August and September are usually the months of lowest flow for the majority of streams and rivers in most of the country.

Water withdrawals for irrigation purposes can seriously deplete water flow, as can industrial water withdrawals. Dams used for electric power generation, particularly facilities designed to produce power during periods of peak need, often block the flow of a stream and later release it in a surge.

Flow is a function of water volume and velocity. It is important because of its impact on water quality and on the living organisms and habitats in the stream. Large, swiftly flowing rivers can receive pollution discharges and be little affected, whereas small flowing streams have less capacity to dilute and degrade wastes.

Stream velocity, which increases as the volume of the water in the stream increases, determines the kinds of organisms that can live in the stream (some need fast-flowing areas, others need quiet pools). It also affects the amount of silt and sediment carried by the stream. Sediment introduced to quiet, slow-flowing streams will settle quickly to the stream bottom. Fast moving streams will keep sediment suspended longer in the water column. Last, fast-moving streams generally have higher levels of dissolved oxygen than slow streams because they are better aerated.

The River Continuum Concept

Imagine a small stream in the north Georgia mountains. Ideally this headwater stream (first or second order) would be characterized by many small riffles interspersed with pools of cool water with extensive shade and cover provided by tree canopy. Generally these streams are so small they possess few or no fish. Throughout the year, and especially in the fall, leaves and other organic debris are swept overland into the stream. Aquatic microbes and macroinvertebrates consume this organic matter in much the same way worms break down yard waste in a backyard compost pile. Shredders and collectors—names given to organisms that possess adaptations for shredding intact organic matter and collecting detritus—are the primary aquatic macroinvertebrates that inhabit these headwater streams (Figure 1.5).

As we progress downstream, the river becomes broader and canopy cover is reduced. The water temperature also increases. These third, fourth and fifth order streams are progressively influenced less and less by the surrounding land. The aquatic populations of fish and macroinvertebrates likewise change. Collectors slowly predominate while cold-water fish like trout and smallmouth bass give way to perch and ultimately catfish. This progressive change in the physical characteristics and biological communities in a river is called the River Continuum Concept.

The River Continuum Concept is an attempt to generalize changes in a stream as it progresses in size from a first order to second, fifth and larger order streams (Figure 1.5). This conceptual model not only helps to identify connections between the watershed, floodplain, and stream systems, but also describes the way in which biological communities develop and change from the headwaters to the mouth. The River Continuum Concept can place a site or reach in context within a larger watershed or landscape and thus help individuals define and focus monitoring and restoration goals.

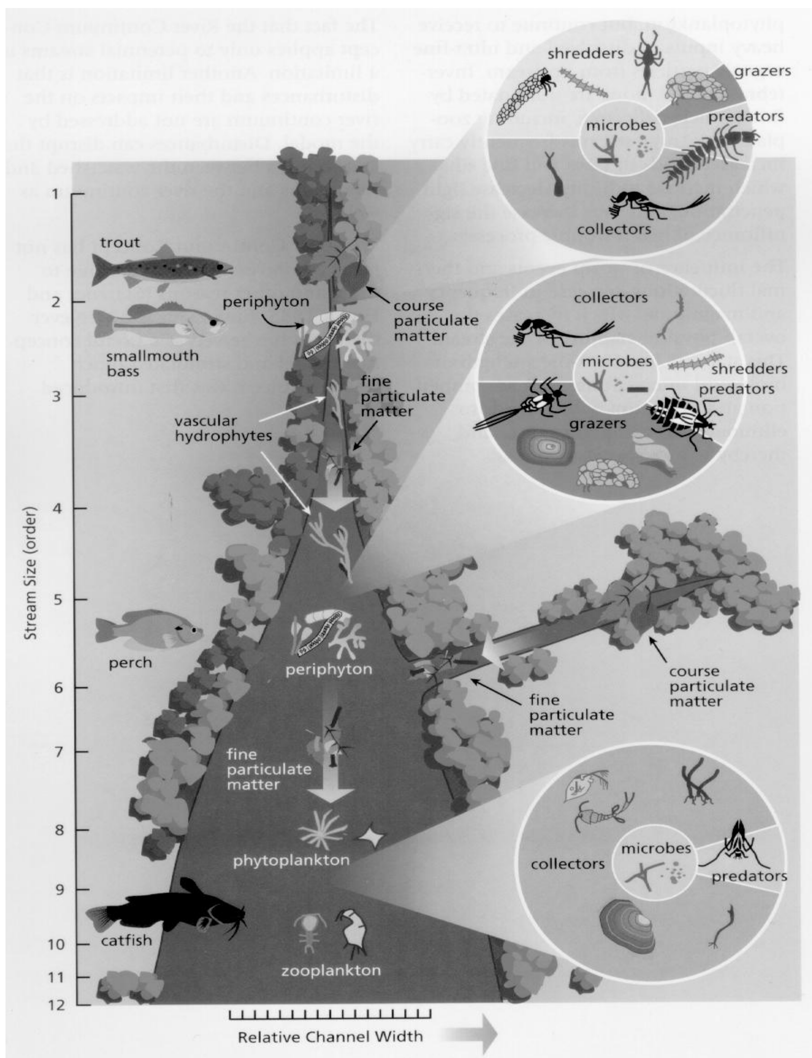

Figure 1.5 Model of the River Continuum Concept