SMART Angler's Notebook

by Laurel Garlicki

A River Flows Through It

If you were asked to imagine a stream, what would come to mind? Each person asked would probably picture something a little different. Some would imagine a bubbling mountain brook. Others would dream of a warm, lazy creek teeming with rock bass or trophy smallmouth bass. Each of us would be right. Pennsylvania has more moving water than any other state—more than 83,000 miles. This water flows through Pennsylvania in one of six major watersheds, or basins: Lake Erie, Ohio, Susquehanna, Genesee, Potomac and Delaware. If you are familiar with the rivers after which the watersheds are named, you know that they differ greatly. They have been shaped by climate and thousands of years of geologic activity, including glaciers in some cases. These differences are the reasons why Pennsylvania has so many different kinds of fishing and boating opportunities.

Even in a watershed, though, one can find habitat differences. The babbling brooks, runs, streams, creeks and the major waterway in each watershed offer a variety of habitat types. These diverse waterways are home to nearly 160 species of fish and hundreds of invertebrate species. What follows is a simple explanation of why the differences occur within a watershed.

The boundaries of most major watersheds are found high in Pennsylvania's mountains. From there, the topography changes to more gradual slopes and often to very flat land. That is why the headwaters of a river, the Allegheny River, for example, are very different from the lower river near Pittsburgh. Even though they have the same name, they are very different waters, with different critters calling these waters home. That is why it is important to understand the changes that occur within a watershed. The transition from headwaters to larger rivers may be referred to as the **river continuum**.

The interactions of climate, moving water, surrounding geology and land topography affect the physical characteristics of the stream. The shape of the stream channel, the composition of the bottom, water temperature, and the water's chemistry (pH, alkalinity, hardness) are defined by this interaction.

These variables, especially temperature, bottom type and water chemistry, influence the type and number of organisms inhabiting the stream. Aquatic macroinvertebrates and other organisms have specialized **adaptations** (characteristics that help them survive). Some of these organisms are so specialized that they may be found only in specific sections of the watershed. Riffle beetle larvae, also called water pennies, are examples of this specialization. They have streamlined bodies and suction cups on their feet to help them cling to rocks in a swift headwater riffle. They feed on the film of algae growing on the surface of rocks.

Farther down the watershed, caddisfly larvae build elaborate tube-shaped nets to filter their food from slow-moving rivers. Some of these larvae are free-living. Others build shelters of sand and gravel on rocks. These specialized adaptations let these organisms live in particular spots in a watershed. That is, they may not be found in the entire watershed—only in those places where their needs are met.

The predators that feed on these and other aquatic invertebrate animals are what SMART Anglers' dreams are made of! Fish are more mobile and often have wider tolerances than the invertebrates they feed on. As a result, they can be found in several different places in the watershed.

The fish community also changes as we move through a watershed. For example, anglers in search of small but feisty brook trout take to cold, fast-moving headwater streams. Brook trout are well-camouflaged for this weedless environment. The rocky stream bottom also provides nooks and crannies where tasty insects like stonefly nymphs and caddisfly larvae live. Record-musky anglers will head to bigger waters such as the warmer, slower currents of a river. The dark vertical bars on the side of the musky help it blend with the aquatic plants it uses for cover. Those same aquatic plants attract prey. Anglers seeking brown trout or smallmouth bass will likely find their quarries in the waters in between.

Stream Order: "Brook," "creek," "run," "stream" and "river" aren't scientific terms for describing a waterway. Streams can be more accurately categorized by their stream order. A first-order stream has no tributaries and flows directly from its source—a spring, lake or melting snow. When two first-order streams join, they make a second-order stream. Two second-order streams join to make a third-order stream, and so on. Stream order increases only when two streams of the same order join. The use of stream order classification lets us make accurate comparisons between two streams.

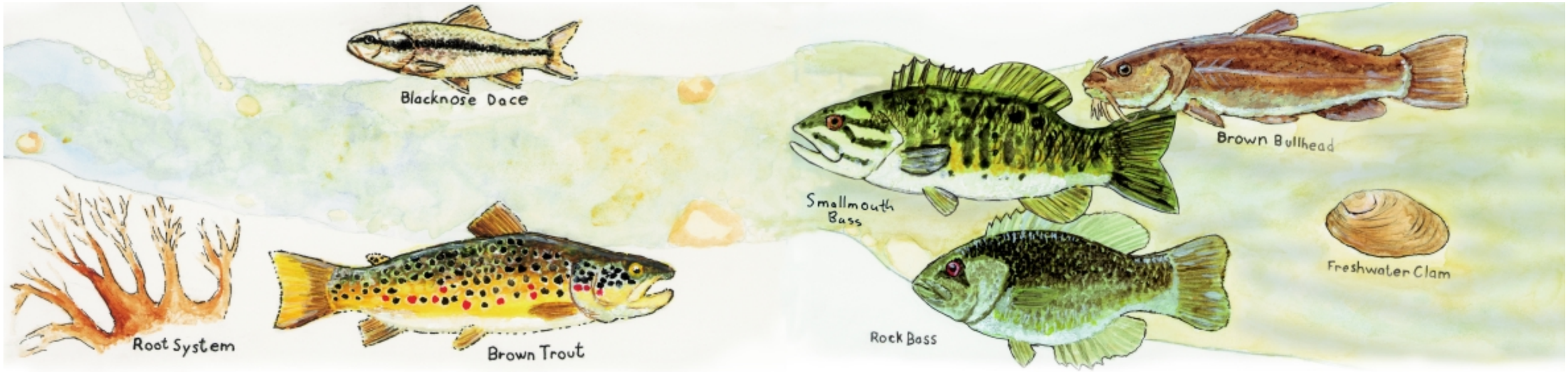
Headwater streams are usually cold, steep and fast-moving. They have steep gradients and high dissolved oxygen content, and they are shaded by the surrounding trees. The aquatic insect community is dominated by shredders and collectors like stonefly nymphs, caddisfly larvae and crane fly larvae. Brook trout, sculpins and dace also thrive in these habitats.

Trees are very important neighbors for moving water.

Illustration – Ron Kuhn

A river flows through it

This graphic highlights the changes that occur as we move down through a "typical" watershed. Typically, the amount of flowing water in a stream increases as you move down through the watershed. Often the speed at which this water moves and its temperature increase farther down in the watershed. The amount of dissolved nutrients also generally increases from the headwaters to the lower reaches of a waterway. Take note of the changes in the fish community from the headwaters to the lower reaches.



They shade the stream and help keep water temperatures cool. Tree roots stabilize the streambank and prevent soil from washing into the stream. The overhanging tree branches provide important shelter for fish and other organisms living in the water. One of the trees' most important contributions to first- and second-order streams is energy. The energy that drives the food chain in a headwater stream comes from *outside* the stream. Some species of stonefly and mayfly nymphs shred leaves and twigs that fall into the stream. Their wastes and smaller pieces of leaves and twigs are washed downstream.

Temperature is one of the biggest determining factors of fish populations. Each fish species has a preferred temperature range in which it can live, grow and reproduce. Biologists group fish into three preferred temperature categories: Coldwater (50 degrees to 65 degrees), coolwater (65 degrees to 70 degrees) and warmwater (70 degrees to 85 degrees). Temperature preferences among groups can overlap, creating "transition waters." Coldwater transition waters often hold brown trout, blacknose dace and longnose dace.

As the stream's gradient declines farther down in the watershed, the current slows in medium-sized creeks and rivers. Water temperature increases and the channel is wider. Bankside vegetation can shade only the edges of the water. Riffles and pools with cobble, gravel and sand become more abundant and provide ideal habitat for a variety of mayfly nymphs that act as collectors and grazers. More predatory insects are found here, compared to headwaters. In addition, the rocks are often covered with algae and other types of vegetation. If the water is cool enough in these streams—less than 70 degrees in the heat of summer, brown trout will be found here. If the water is warmer, smallmouth bass, rock bass and shiners call this habitat home.

Wider and deeper channels that meander through the river valley characterize the lower reaches of a river. Fine sediment drops out and accumulates on the bottom as the current slows. Bottom-dwelling collectors like clams, midge larvae, snails and burrowing insects make a living in the sediment and among the rooted aquatic plants. Hunters and searchers such as the predaceous diving beetle and dragonfly nymph move about in the water column in search of their next meal. Warmer water temperatures and lower dissolved oxygen are the preferred conditions for the largemouth bass, pumpkinseeds and brown bullheads that live here.

Energy to fuel the food chain can now be found *within* the river. Wastes that were generated upstream accumulate in the slow waters of the lower river. These nutrients act as fertilizer. A variety of rooted aquatic plants, algae and phytoplankton thrives here, creating the basis of the food chain.

"We all live downstream"

This phrase is more than a catchy slogan. It is a fact of life within a watershed. The waste from insects breaking down leaves in headwaters provides nutrients and food for others downstream. The amount and quality of water in a headwater stream influences the water quality downstream. Removing streamside trees in a headwater may affect other waters many miles away, farther down the watershed.

The word "watershed" is more than a buzzword or a technical term. Watersheds are complex systems in which many factors interact. The physical characteristics of a stream section in a watershed influence the biological community found there. The physical characteristics are the result of the interaction between moving water and the land it drains.

Differences between the major watersheds are more obvious. But even within watersheds there are differences. Those physical changes create unique habitats for organisms equipped with special adaptations suited for that habitat. It is the same water flowing down the same waterway that creates different habitat often miles away. A better understanding of this important but complex concept will likely lead to more enjoyable (and maybe more successful) days on the water.

Illustration – Ron Kuhn

References, more information

There are many excellent resources for information on this concept. They provide more information than we can cover in these four pages.

- *Pond and Brook*, by Michael J. Caduto, ISBN 0-87451-509-2.
- *Rivers and Streams*, by Patricia A. Fink Martin, ISBN 0-531-11523-2.
- *Stream Ecology—Structure and Function of Running Waters*, by J. David Allan, ISBN 0-412-29430-3.
- *Aquatic Entomology*, by W. Patrick McCafferty, ISBN 0-86720-017-0.
- *Pennsylvania Fishes*, published by the PA Fish & Boat Commission (also available online) ISBN 1-930369-01-8.

Web resources:

DCNR's Watershed Education program – www.watersheded.dcnr.state.pa.us/what/components.html
Stroud Water Research Center – www.stroudcenter.org/research
Portland State University – www.oaa.pdx.edu/cae/programs/sti/pratt/rcc.html
Michigan State University – www.kbs.msu.edu
PA Fish & Boat Commission web site – www.fish.state.pa.us