

Tiny headwaters make mighty rivers

From stream to river: A true, trickle-down effect

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— Bern Sweeney, director of the Stroud Water Research Center

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Daniel P. Creighton/The Mercury

French Creek, seen here flowing among the boulders behind St. Peter’s Village in Warwick Township, is one of the region’s most closely monitored streams.

As it turns out, size matters, but not in the way that you think.

When it comes to water quality, smaller is where the action is.

That’s because the single largest determinant of how healthy the water of a stream or river will be depends on the tiny head-waters which give each stream its start.

It may be a rivulet, a marshy meadow with tea-colored water, or an intermittent stream that dries up in summer.

But its value, both to humans and the ecosystem, cannot be underestimated, scientists say.

“Small streams are big business,” said Bern Sweeney, senior research scientist and director of the Stroud Water Research Center in Avondale.

“Ninety percent of all stream miles in Pennsylvania are small streams,” he said. “It’s also where the majority of pollution enters.”

According to a report titled “Where Rivers Are Born,” sponsored by American Rivers and the Sierra Club, “small or head-water streams make up at least 80 percent of the nation’s stream network.”

Their benefits, which scientists at Stroud Water Research Center call “ecological services,” make for a long list.

“Intact small streams and wetlands provide natural flood control, recharge groundwater, trap sediments and pollution from fertilizers, recycle nutrients, create and maintain biological diversity and sustain the biological productivity of downstream rivers, lakes and estuaries,” according to the report.

Consider the case of “nutrients,” considered a good thing when you’re talking to a dietitian. But when talking about water, too many nutrients can cause a problem.

Coming in many forms, fecal matter and fertilizer being the most common, nutrients can cause algae blooms downstream in lakes or rivers, or even, in the case of the Susquehanna, one-third of Chesapeake Bay.

When small headwater streams trap and hold these nutrients, they can allow for their steady release into the environment at a rate that is not harmful.

They function similarly for stormwater — catching it, holding it, and slowing it down.

Studying these streams has also helped scientists understand the link between stream channel, its riparian shores and groundwater, proper function of which maximizes benefits to the system as a whole.

But, “when human actions, such as encasing streams in pipes, sever those connections, the result is poorer water quality and degraded fish habitat downstream,” according to the report.

“Streams are self-engineering systems. They’ve been doing it for millions of years and they’re very good at it,” said Sweeney

“The more natural the conditions, the healthier the ecosystem. But while it may take a stream 20 years to do something, someone may want it by next year,” Sweeney said.

And that’s when the trouble starts.

“Changes in surrounding vegetation, development that paves and hardens soil surfaces, and the total elimination of some small streams reduces the amount of rainwater, run-off and snowmelt the stream network can absorb before flooding,” notes the study.

The study found that “three decades of growth in storm sewers and paved surfaces around Watts Branch Creek, Md., more than tripled the number of floods and increased the average annual flood size by 23 percent.”

An increase in stormwater can also mean an unnatural increase in sediment, usually caused by an increase in erosion of the stream bank caused by faster-moving water.

One study found that disturbances such as urban construction can, at minimum, double the amount of

sediment entering headwater streams from a watershed, according to “Where Rivers are Born.”

“A Pennsylvania study showed how, as a 160-acre headwater watershed became more urbanized, channel erosion of a quarter-mile stretch of stream generated 50,000 additional cubic feet of sediment in one year, enough to fill 25 moderate-sized living rooms,” the report said.

“In a non-urban watershed of the same size, it would take five years to generate the same amount of sediment,” the report said.

If you think that’s not a problem, talk to officials who have to spend \$10 million to \$11.5 million every year to dredge enough sediment out of Baltimore harbor to keep it navigable for ships.

A study of a small stream in Oregon found that headwater streams, when functioning properly, can hold sediment for 114 years.

Smaller streams also have the largest surface area of soil in contact with available water, providing the greatest opportunity for filtration and re-charge of groundwater, helping to keep streams flowing during droughts.

A headwater stream’s filtration abilities were highlighted by a study of headwaters in the southern Appalachian Mountains that found that nutrients like phosphates and a nitrogen compound traveled less than 65 feet downstream before being completely filtered out of the water.

Bacteria, fungi and other microorganisms living on the bottom of the stream consume inorganic nitrogen and phosphorus and convert them to less harmful compounds.

A mathematical model based on a study of 14 headwater streams calculates that 64 percent of all inorganic nitrogen entering a stream is transformed within 1,000 yards.

Another study in eight northeastern states found that wetlands associated with first-order streams remove 90 percent of phosphorus.

Human activity here too can have a negative affect.

“Studies in Pennsylvania have shown that when the forest surrounding headwaters is replaced by meadows or lawns, increased sunlight promotes growth of grasses along stream banks,” according to “Where Rivers are Born.”

“The grasses trap sediments, create sod, and narrow the stream channel to one-third its original width,” the study reported.

The result? Nitrogen and phosphorus travel five to 10-times further downstream.

In 2003, the Environmental Protection Agency and the U.S. Army Corps of Engineers proposed changes to interpreting the Clean Water Act which would have removed protections for small headwater streams and wetlands, making all these problems worse, in the eyes of the scientists who authored the report.

The report argued that “the health of downstream waters” on which many human water supplies rely, “depends on continuing protection for even seemingly isolated wetlands and small streams that flow only part of the year.”

The 11 scientists who authored the report concluded “the goal of protecting water quality, plant and animal habitat, navigable waterways, and other downstream resources is not achievable without careful protection of headwater stream systems.”

Don Welsh, head administrator for EPA's Mid-Atlantic region, which includes Pennsylvania, explained that the EPA "was challenged about whether it had the authority to apply the Clean Water Act to those waters."

"So we put it out for comment and got like 782 gagillion comments back that some poor person back at headquarters had to open and calculate," said Welsh.

In the end, the federal government backed off the change.

"We just decided to continue to interpret it as we always had and just take each case on a case-by-case basis," he said.

The folks at Stroud consider that a wise choice and urge people to take responsibility for the little streams that may wander through their property.

"You should never do anything on your property near a stream that you wouldn't want someone upstream of you to do," Sweeney said.

"We have to get people to understand the idea that streams are common property," he said. "Since nobody owns them, nobody takes ownership of them, but they belong to all of us."