*Integrated List of Waters* that identifies impaired waterbodies. Existing state and federal incentives make forest buffer restoration not only possible, but financially lucrative. Additionally, because restoration techniques are cost effective, deploying them on a larger scale could lessen significantly the burden on Pennsylvania's agricultural community to help rectify the state's water quality ills.

CBF continues to research the benefits of forested buffers with partners such as the Stroud Center and share ideas and techniques with the agricultural community and other stakeholders to restore forest buffers that are vital to streams and the Bay.

USDA NRCS

**Visit www.cbf.org/Pennsylvania or call 717-234-5550 for more information.**

**To read the full report, go to www.pnas.org/cgi/content/abstract/101/39/14132**

*Credits:*
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***"Riparian deforestation, stream narrowing, and loss of stream ecosystem services,"** PNAS, September 2004; 101: 14132–14137*

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CHESAPEAKE BAY FOUNDATION
***Save the Bay***

*The Chesapeake Bay Foundation is a nonprofit organization dedicated soley to saving the Chesapeake Bay. Its motto, save the Bay, defines the organization's mission and commitment. With headquarters in Annapolis, Md., state offices in Maryland, Virginia, and Pennsylvania, and a varied group of educational centers and programs, CBF works throughout the Chesapeake's 64,000-square-mile watershed. Founded in 1967, CBF is a 501(c)(3) not-for-profit organization. CBF is supported by more than 140,000 active members and has a staff of 150 full-time employees. Approximately 95 percent of CBF's $17.5 million annual budget is privately raised.*

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# *Forested Buffers*
## *The Key to Clean Streams*

CHESAPEAKE BAY FOUNDATION

For years, researchers have known that healthy forests bordering streams are highly effective at preventing numerous pollutants from reaching the water. New research has shown that streamside forests also multiply the streams ability to cleanse itself of many of the pollutants that do make their way into the water.

Huron River Watershed Council

In an exhaustive study published in the September 2004 *Proceedings of the National Academy of Sciences*, Stroud Water Research Center, located in Avondale, Pennsylvania, examined sixteen streams in eastern PA to determine the differences in pollutant processing capacity between forested and non-forested segments. Stroud found that forested streams were far more efficient at removing key pollutants in the water than non-forested streams. In the case of nitrogen pollution, forested stream segments removed 200 to 800% more than non-forested segments—a finding that should prove vital to regional water quality improvement programs.

## REDUCING NITROGEN AND PHOSPHORUS POLLUTION

Nitrogen and phosphorus, commonly referred to as nutrients, are compounds that occur naturally but become pollutants when they exist in excessive amounts in waterways. Stroud researchers found that parts of forested streams were able to process significantly more nitrogen than contiguous sections of streams devoid of forest buffers, with most streams showing a two- to eight-fold increase. Decreases in phosphorus concentrations between the forested and non-forested streams were not statistically significant in this study. Whether an unforested stream could process phosphorus as well as a forested stream remains unclear.

## PESTICIDE DEGRADATION

Stroud studied degradation of the herbicides atrazine and linuron and the insecticides Dursban™ and methoxychlor and found that pesticide degradation in forested stream reaches was somewhat higher than in non-forested reaches. Researchers expected that pesticide breakdown actually would be greater in deforested reaches because of the significant role sunlight plays in this process. It appears, however, that the higher pesticide degradation was a result of the increased stream width and reduced water velocity that more than compensated for the lower sunlight levels reaching the water.

Without healthy streams, it is not possible to have a clean Bay. Since 1997, CBF has worked with farmers, municipalities, and landowners to voluntarily reforest more than 1,500 miles of stream buffers and restore more than 4,000 acres of wetlands in Pennsylvania. To find out more about these programs, call 717-234-5550 or visit www.cbf.org/Pennsylvania.

CBF and the Stroud Water Research Center have formed a partnership designed to study Pennsylvania streams and advocate for state policies to restore and protect them. We are collaborating on a long-term study examining the impact of forested buffers on the water quality of south-central Pennsylvania Streams. CBF and Stroud are committed to improving the health of state streams, rivers, and the Chesapeake Bay through sound science and effective policy.

## INCREASED LARGE WOODY DEBRIS

Branches and tree trunks are important habitat components to stream life because they directly support wildlife and, indirectly, shape the physical condition of streams. Anglers appreciate the key role woody debris plays in creating favorable fish habitat. The Stroud study showed forested stream segments have more than six times the amount of large woody debris than grass-buffered areas, even though nearly two-thirds of the grass buffered sites were immediately downstream of forested areas.


*CBF Staff*

## ABUNDANT STREAM MACROINVERTEBRATES

The study demonstrated a significant increase in the abundance of macroinvertebrates— animals lacking backbones that are big enough to see with the naked eye, such as aquatic snails and crayfish—for forested stream segments when averaged across all streams and all sites. This included an increase in pollution-sensitive mayflies and stoneflies.

## INCREASED STREAM WIDTH

Although previously observed by others, this study scientifically demonstrated that forested streams actually are wider than their deforested counterparts. This important finding was strengthened by the observation that wider streams also have a greater variety of sizes of cobble and gravel, providing more habitat for fish and macroinvertebrates.

*USDA NRCS*

In streams, most organisms live on the stream bed. Forested streams can double roughly the effective stream bottom area through stream widening. Therefore, a network of tree roots or a gravel and cobble bottom in a forested stream can increase the overall effective habitat more than a thousand times when compared to a bare mineral soil bottom in a grass-buffered stream.



## HEALTHY BUFFERS, HEALTHY STREAMS

The answer to the question why forested streams are so effective at processing contaminants lies in how forests affect the physical, chemical, and biological conditions of a stream.

The Stroud study demonstrated that forested streams in much of Pennsylvania tend to be wider, have lower water velocity, and a rougher stream bottom, resulting in two times the effective stream bottom area. All of these factors work synergistically to enhance ecological conditions and in-stream pollutant processing. Meadows or grass buffers do not provide as many benefits.

The cumulative results in returning Pennsylvania streams to their natural, fully forested state could have a dramatic effect on water quality. Stroud researchers estimate that if riparian forest buffers were fully restored—with no changes to current point source discharges and non-point source runoff—overall stream pollution levels would decrease significantly. This is particularly true for nitrogen pollution.

In fact, Stroud notes that their study probably understates the benefits of forested buffers because all deforested reaches included in their study were in good condition, unlike the heavily-used pastures on many farms. Moreover, the sections that were studied were relatively short and researchers only investigated a select number of ecosystem benefits.

Reforesting streamside areas could have a dramatic improvement in watershed health could have a monumental effect on Pennsylvania's efforts to clean up streams and remove them from the federal EPA's

### Forested v. Non-forested Streams Summary

| Study Variable | Effect of Stream Type | |
|---|---|---|
| | Forested | Non-forested |
| Stream Velocity | + | – |
| Water Temperature | + | – |
| Stream Width | + | – |
| Streambed Habitat Quality | + | – |
| Nitrogen Processing | + | – |
| Phosphorus Processing | +/– | +/– |
| Pesticide Degradation | +/– | +/– |
| Large Woody Habitat | + | – |

*+ means positive impact or increased pollutant degradation*
*– means less impact and less effective pollutant degradation*
*+/– means no significant difference*

*CBF Staff*