Biology in Focus
Better Lives Through Better Science

New Hope for Acid Streams

Across the nation, a toxic pollutant turns clean streams orange, kills fish and plant life, and smells like rotten eggs. The culprit is acid mine drainage, the poisonous water leaking from more than 500,000 abandoned and inactive mines in 32 states. The toxic discharge is a problem for operational mines as well. In the Appalachian coal region, for example, acid mine drainage has degraded more than 8,000 miles of streams and has left some aquatic habitats virtually lifeless.

The states suffering the most damage from acid mine drainage are Kentucky, Ohio, Pennsylvania, Tennessee and West Virginia. In some areas effects are severe: drinking water is contaminated, aquatic biodiversity has been diminished and activities such as sport fishing and swimming are no longer possible. In fact, the U.S. Environmental Protection Agency has singled out acid mine drainage as the number one water-quality problem in Appalachia. Estimates place cleanup costs in Pennsylvania alone at around $5 billion.

To help overcome these problems, the USGS Leetown Science Center, in Leetown, West Virginia, is developing an innovative treatment technology for acid mine drainage that will help return waters to their healthy state. Moreover, the new technology will likely save taxpayers and private companies millions of dollars. Field tests forecast operational costs 20 to 45 percent lower than conventional treatment methods. The center's research will not only be applicable to acid mine drainage, but also to acid problems caused by other sources such as power plants and chemical companies.

To date, defunct mines have contaminated public and private lands with more than 50 billion tons of untreated mine waste, a problem the USGS Leetown Science Center is addressing through the development of a new technology.

Photo by D. Hardesty, USGS

The Problem Begins With Fool's Gold

Acid mine drainage is produced during the mining process when water comes in contact with pyrite-laced coal and bedrock. As pyrite—an iron-sulfide mineral commonly known as fool's gold—is exposed to air and water a chemical reaction produces sulfuric acid. The sulfuric acid, in turn, dissolves metals such as

aluminum, iron and manganese present in the rock. The result is an orange-colored toxic brew that often seeps into groundwater and nearby streams.

The Leetown technology.

The production of acid mine drainage can occur during several phases of the mining process, even long after the mine is closed. When piles of rock containing sulfide minerals remain in contact with air and water, acid generation can continue for decades or even centuries. And the effects of the acid generation can be felt many miles downstream and many years into the future. In Great Britain, for example, Roman mine sites dating back 2,000 years continue to generate acid mine drainage today.

A stream contaminated with acid mine drainage.

Mining for a Better Solution

In the last 20 years, public awareness, environmental laws and new mining techniques have greatly reduced the production of acid mine drainage by operational mines. Still, a far greater problem exists in the countless abandoned and inactive mines that produce most of the country's acid mine drainage. To date, these defunct mines have contaminated public and private lands with more than 50 billion tons of untreated mine waste.

This is a problem that Barnaby Watten of the USGS Leetown Science Center thinks about daily. Watten is the scientist who invented, and is perfecting, the Leetown technology. His goal is to improve the treatment of acid mine drainage by designing a safe, efficient and cost-effective technology.

The Leetown technology works by infusing acid mine drainage with carbon dioxide to temporarily increase acidity. This new mixture is then routed through limestone reactors where its high acidity causes the limestone to readily dissolve. As the limestone dissolves and reacts with sulfuric acid, acid mine drainage is neutralized. To minimize costs, carbon dioxide is recycled back into the process.

"We hope the Leetown technology will soon be used to restore rivers and streams, reduce treatment costs and ultimately enhance the quality of people's lives."

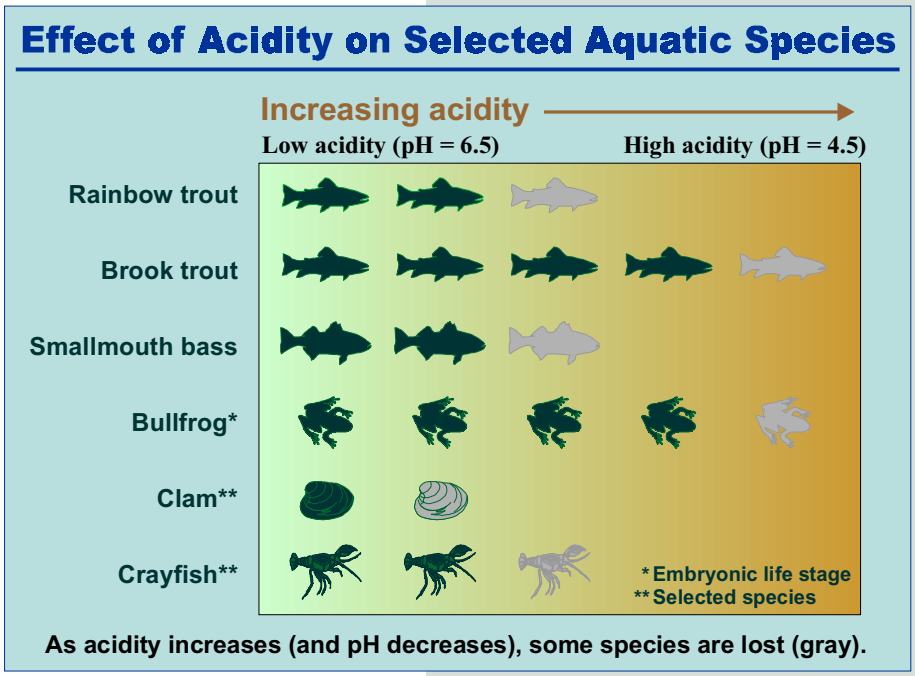
Barnaby Watten, scientist
USGS Leetown Science Center

Bet You Didn't Know:

- **In West Virginia, the coal industry spends approximately $1 million each day treating acid mine drainage.**
- **Coal provides more than 55 percent of our electricity nationwide. While we depend on this abundant, affordable resource, we also need efficient technologies to address acid mine drainage.**
- **Streams severely contaminated with acid mine drainage typically lack fish and other aquatic organisms due to the water's high acidity and harmful concentration of metals.**
- **In Pennsylvania, acid mine drainage results in a revenue loss of about $67 million each year because of decreased sport fishing.**

By working through its science centers, the USGS Biological Resources Division promotes sound management of the nation's biological resources.

Watten says a bonus of the Leetown technology is that it also removes undesirable metals. As the acidity of the effluent is reduced, metals such as iron and aluminum separate from the water as sediment in a settling pond or tank. In contrast, effluent from conventional technologies can contain harmful metals that blanket streambeds and threaten aquatic life.



As acidity increases (and pH decreases), some species are lost (gray).

The decontamination process developed by the USGS can result in what is called super-treated effluent because of its extremely low acidity. A benefit of super-treated effluent is that it reduces the acidity of the stream to which it returns. Accordingly, the Leetown technology needs only to treat a portion of the stream flow rather than the entire stream. This not only enhances the stream's health, but it also reduces the need for large, expensive equipment and decreases the costs of all aspects of the treatment process.

In addition to being practical and less costly, the Leetown technology is safe. Current technologies often use hydrated lime, a powder that can burn the skin and cause blindness. Many years ago, a former colleague of Watten's lost his vision when hydrated lime accidentally blew into his eyes. Overdosing a stream with lime or other related agents can also lead to poor water quality. The Leetown technology, says Watten, doesn't make use of these substances.

A Shared Vision to Improve Resource Management

"So far, field tests of the Leetown technology have been very encouraging," says Watten. "At one site we were able to treat water that no one would have considered treating with limestone in the past." Additional field tests are under way at sites in Pennsylvania and Maryland involving partnerships with state agencies, Pennsylvania State University, the Freshwater Institute and the National Park Service. "One of our goals in building these cooperative projects," says Leetown Science Center Director Bill Palmisano, "is to demonstrate the effectiveness of partnerships and a shared vision to improve our resource management."

The next steps for the USGS Leetown Science Center are to conduct further field tests and create cooperative research and development agreements to assist in application of the technology. Watten says that, "We hope the Leetown technology will soon be used to restore rivers and streams, reduce treatment costs and ultimately enhance the quality of people's lives."

To learn more about acid mine drainage and the nation's biological resources, visit the following Internet locations:

<http://www.lsc.usgs.gov/welcome.htm>
<http://biology.usgs.gov>
<http://amli.usgs.gov/amli>
<http://water.wr.usgs.gov/mine>
<http://biology.usgs.gov/outreach/infocus.htm>

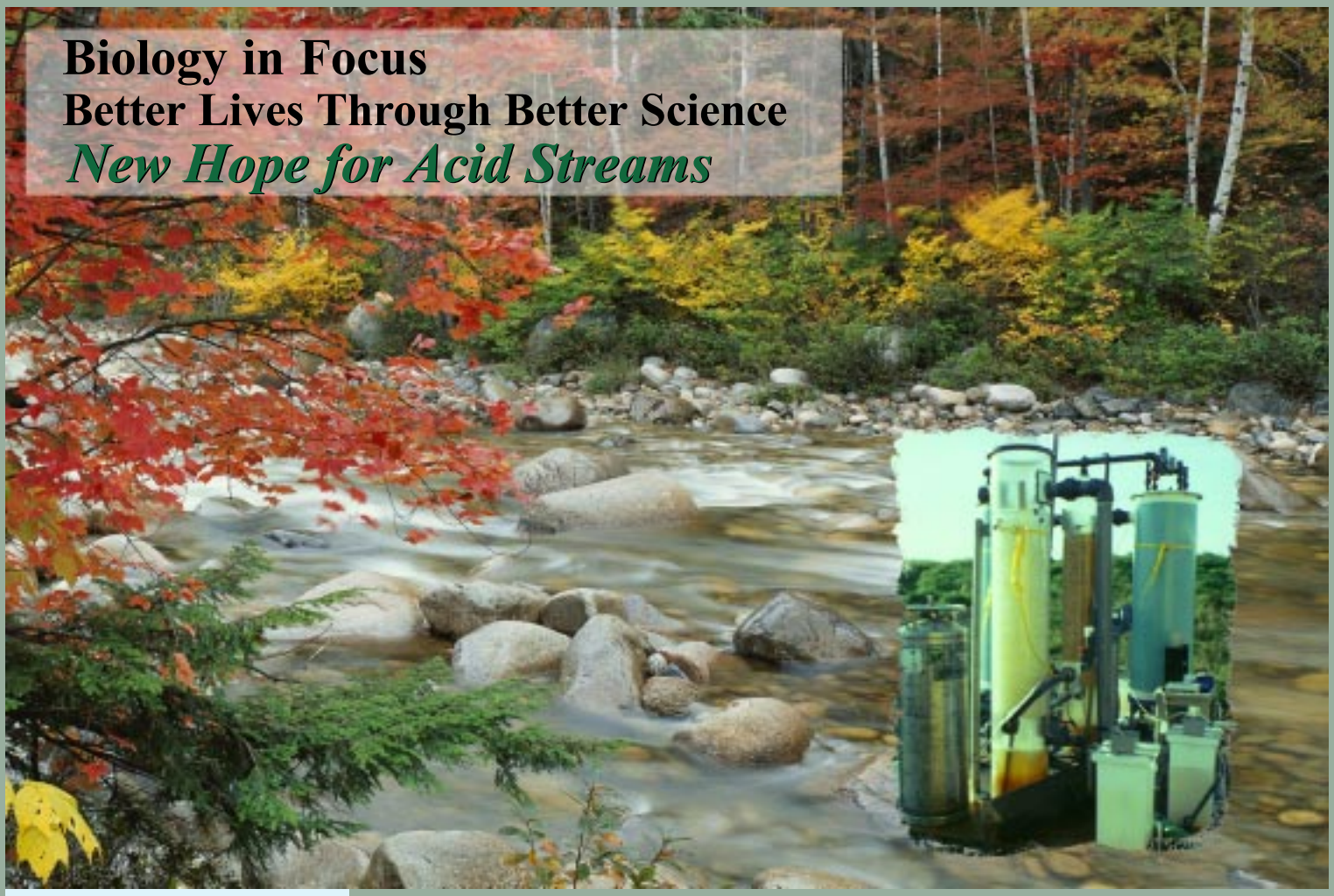
Or contact:

Barnaby Watten
Leetown Science Center
1700 Leetown Rd.
Kearneysville, WV 25430
Phone: (304) 724-4425
E-mail: barnaby_watten@usgs.gov

Biology in Focus

Better Lives Through Better Science

New Hope for Acid Streams



U.S. Geological Survey
Biological Resources Division
12201 Sunrise Valley Dr.
Reston, VA 20192

Mapping
Biology
Geology
Water