Research Points To Inexpensive Aid For Acidic Streams

UNIVERSITY PARK (Centre Co.) — Researchers in Penn State's College of Agricultural Sciences have found that a few feet of pipe, some concrete manhole sections, and a pile of limestone rocks can make an acidic stream flow cleaner, thanks to a Swedish idea and a commitment to finding an inexpensive solution to a severe problem.

Dean Arnold, adjunct assistant professor of aquatic ecology in the School of Forest Resources, said tht several diversion wells designed to introduce calcium into streams polluted by acid mine drainage have succeeded in neutralizing the acidic water to levels that allow the return of insects, fish, and other aquatic life.

According to Arnold, a diversion well is a very simple machine with no moving parts that bashes calcium carbonate rocks — limestone, to the layperson — together until the stones are reduced to a size fine enough to be dissolved in the stream. Lime applications have long been used to neutralize acids in soil and water, but applying lime to streams previously was too cumbersome and costly.

Acid mine drainage is caused by seeping groundwater from active and abandoned mines, according to Arnold. Once coal is mined, the surrounding rock material — often containing pyrite — is left exposed to groundwater and oxygen. Pyrite, or iron disulfide, easily dissolves in water.

"Water causes pyrite to break down into two parts — sulfuric acid and ferric hydroxide — both of which are harmful," Arnold said. "We worked with lime applications 15 years ago to neutralize acid rain in lakes and streams and tested various machines to add lime to streams. A machine from Sweden worked like a champion, but it cost $36,000. However, we saw another Swedish company's design for a diversion well, which was much less expensive."

Using the Swedish well as a model, Arnold and his students designed their own version. They used concrete sections for manholes and polyvinyl chloride pipe. A diversion well works by damming a stream and inserting an 8- to 10-inch pipe through the dam to divert water into a large well dug deep enough to allow water to drop at least 8 feet. The water is piped under the pressure of gravity into limestone rocks. The force of the water acts as a giant blender, churning the stones into chips and pieces small enough to dissolve in water. The lime-laden overflow is then reintroduced into the stream.

"The key was to find a system that is inexpensive, simple, reasonably weatherproof and capable of being maintained by untrained personnel," Arnold said. "All you have to do with a diversion well is make sure the well is about half-full of limestone and that water is flowing through the pipe."

Arnold says the best results have come from limestone, also called calcium carbonate, that is about 95 percent calcium. He warns that dolomite, also called magnesium carbonate, will not work in diversion wells because it is harder to break up.

Research conducted over the past two years by Matt Gray, graduate student in wildlife and fisheries science, shows that insect and fish populations significantly improve after treatment. "An acidic stream has a pH of 4, while a healthy stream has a pH greater than 6," Gray said. "The streams treated by our diversion wells get a consistent reading of pH 5 to 5.5."

As a result, Gray relates, acidified streams where few plants, insects or fish could be found before treatment have shown marked improvement in biological indicators of stream health. "Mayflies, which are extremely sensitive to acid in streams, have returned," he said. "We found fish coming back into our study streams as well."

Much of Gray's research centers on whether the improved streams could generate a food system with enough nutrients to support a fish community. He studied sodium loss, which causes high mortality in trout released in acidic streams, and found no significant losses after the diversion well treatment.

Gray also studies how leaves falling into the stream decompose. In acidic water, leaves do not decompose quickly, leaving little food for insects. Gray's research found that leaf litter broke down much faster in the treated water. "Leaf litter is the basis of the food chain in a small stream," Gray said. "Increase decomposition and

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