Mountain streams: Still living in the '50s

Even half a century may not be long enough to restore biodiversity to streams with a traumatic past, according to a study in the southern Appalachians.

Years of flowing through farmlands, swallowing sediment that erodes off slopes or gets kicked up by cattle, can leave a stream ecologically impoverished long after a forest has regrown on its banks, report Fred Benfield of Virginia Polytechnic Institute and State University in Blacksburg and his colleagues. Analyzing watersheds in North Carolina, the researchers found that the best predictor of animal diversity in a stream during the 1990s is land use back in the 1950s.

"Our findings challenge assumptions about both the maintenance and future recovery of biodiversity in disturbed streams," they say in the Dec. 8 PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES. They warn that healing a river may take more time, and in some cases more land, than current practices acknowledge.

The researchers compared 12 mountain streams flowing through forested watersheds with 12 that are "pretty well hammered ecologically" by abundant agriculture, Benfield says. Using a variety of measurements, the researchers checked the diversity of fish, snails, aquatic insects, and other invertebrates.

Agricultural streams lagged behind most of the forested ones in diversity of invertebrates and had few of the fish species that thrive on sedimentfree stream beds. However, 2 of the 12 forested streams also fit this depleted pattern, and "we were pulling our hair out trying to figure out what the heck was going on," Benfield recalls. "They looked exactly like agricultural streams."

Old aerial photos solved that puzzle and also addressed smaller differences in stream diversity. Poring over archived pictures and current satellite images, coauthor Paul V. Bolstad of the University of Minnesota in St. Paul calculated what portion of each watershed had been agricultural or forested during each decade of the past 50 years. Although the mystifying streams run through forests now, during the 1950s, their watersheds had been 52 percent agricultural.

When researchers looked in more detail, differences in the current diversity of the other watersheds also reflected land-use patterns in the 1950s more closely than those in the later decades. The researchers also found that land use in the whole watershed accounted for a stream's diversity better than did land use in the 30-meter-wide strips running along the banks. Many protection efforts focus on such margins.

Coweeta LTER Project

Shope Fork shows signs of land use decades ago.

Stream ecologist J. David Allan of the University of Michigan in Ann Arbor says that the new study "reverses the way we've been thinking" about stream management. "We're kidding ourselves, hoping that protecting the margins will balance off adverse effects throughout the landscape. It's important, but we need to look beyond the margins."

The long shadow of past land use makes sense to stream ecologist Stanley V. Gregory of Oregon State University in Corvallis. "There could be layers of effects that go back 200 or 300 years," he speculates. Streams may have longer memories than their human neighbors, especially since people today move so often.

Finding clear evidence for long-term effects is difficult, and Gregory applauds the effort in North Carolina. "The relevance of this is for the future," he says. "We're making changes our grandchildren are going to live with." —*S. Milius*

Light goes on for antimatter-rich H_2O

Scientists are old hands at making water heavy. They combine an atom of oxygen with two deuterium atoms, which are hydrogen atoms containing a neutron as well as a proton. Conceiving of a new, remarkably light variety of water, a pair of chemists calculate that it is possible to replace the hydrogen protons with antimatter particles known as positrons. These are the positively charged antimatter counterparts of electrons.

Studies of "positronic water" could deepen understanding of how clusters of charged particles interact, says David M. Schrader of Marquette University in Milwaukee. Scientists already use penetrating beams of positrons to study materials. If positronic water indeed forms in this bombardment, they say, it may alter the radiation pattern emitted by the material and give additional information to researchers determining the material's physical properties.

By predicting the behavior of molecules whose atoms will be much more mobile than those of ordinary water, Schrader and Nan Jiang, also of Marquette, are subjecting theories of molecular energies and chemical reactions to an extreme test, says Alec T. Stewart of Queen's University at Kingston, Ontario. "This sort of stuff goes one step at a time, and this is another good step."

More than 40 years ago, experimenters succeeded in coaxing electrons and positrons into a short-lived coexistence as positronium, a hydrogenlike atom with a positron replacing the proton. They have since induced positronium to form two-atom molecules with ordinary elements, such as hydrogen and chlorine.

Positronium differs from antihydrogen, which is the full antimatter complement to hydrogen. Scientists first created antihydrogen nearly 3 years ago by joining positrons with antiprotons, which are as massive as ordinary protons but negatively charged (SN: 11/30/96, p. 340).

In the Dec. 7 PHYSICAL REVIEW LETTERS, Schrader and Jiang describe their quantum-mechanics calculations predicting that two positroniums plus oxygen can form a fleetingly stable molecule. The bonds between positronium and oxygen would have only about one-fourth the strength of hydrogen-oxygen bonds and would not form a fixed angle. Moreover, the positronic water molecule would be about 75 percent bigger than a molecule of ordinary water, they conclude.

Don't expect ever to sip a glass of positronic water, however.

"First, it would explode right away" because of antimatter-matter annihilations, Schrader says. The researchers estimate that each molecule would last only 220 picoseconds before its positrons and electrons would collide and vanish in a blaze of gamma rays.

Even if positronic water could somehow be kept intact, the scientists can't yet predict important characteristics that depend on interactions between atoms, such as whether it would form a liquid at room temperature. "There is no reason to believe it would be similar" to ordinary water, Schrader says.

Researchers now face the formidable challenge of forcing two positronium atoms into the same molecule, says Lester D. Hulett Jr. of Oak Ridge (Tenn.) National Laboratory. "A three-body collision [of two positronium atoms and an oxygen atom] is not all that likely," he says.

If seekers of positronic water, however, can use the intense positron beam at Lawrence Livermore (Calif.) National Laboratory or the more powerful ones being built in Japan, they hope to detect the first positronic water molecules within a decade, Schrader says. —*P. Weiss*