Mountaintop Removal Mining: Assessing the Environmental Impacts

Mountaintop removal mining has attracted a great deal of criticism from environmental activists. But what do scientific studies tell us about the impacts of this mining method? Is the outcry justified?

Stream ecologist Margaret Palmer of the University of Maryland and a team of 11 other scientists aimed to find out. They reviewed all the scientific literature on mountaintop mining impacts. Writing in the journal *Science* in 2010, the team concluded that this method of mining causes "serious environmental impacts that mitigation practices cannot successfully address." The team also concluded that published studies indicate "a high potential for human health impacts."

Dr. Margaret Palmer, University of Maryland

The Appalachian forests that are cleared in mountaintop mining are some of the richest forests for biodiversity in the nation. Yet forest clearance—and the loss of biodiversity and ecosystem services—is merely the most obvious impact. Palmer's team stressed that many more consequences result when waste material from mountaintop removal is dumped into adjacent valleys, burying streams and trees.

Once buried, headwater streams are lost as ecosystems. Gone with them are certain rare endemic species, as well as the ecosystem's ability to cycle nutrients and produce organic matter for downstream systems. Flash floods also result: Because mining removes vegetation and topsoil, alters topography, and compacts soil, less rain infiltrates the ground, and instead rain runs off quickly, causing flooding downstream. Moreover, when a valley is filled with mined material, water that runs through the fill emerges at the bottom carrying a brew of toxic substances. Through the process of acid drainage (p. 649), the acidic water carries dissolved heavy metals leached from the rock.

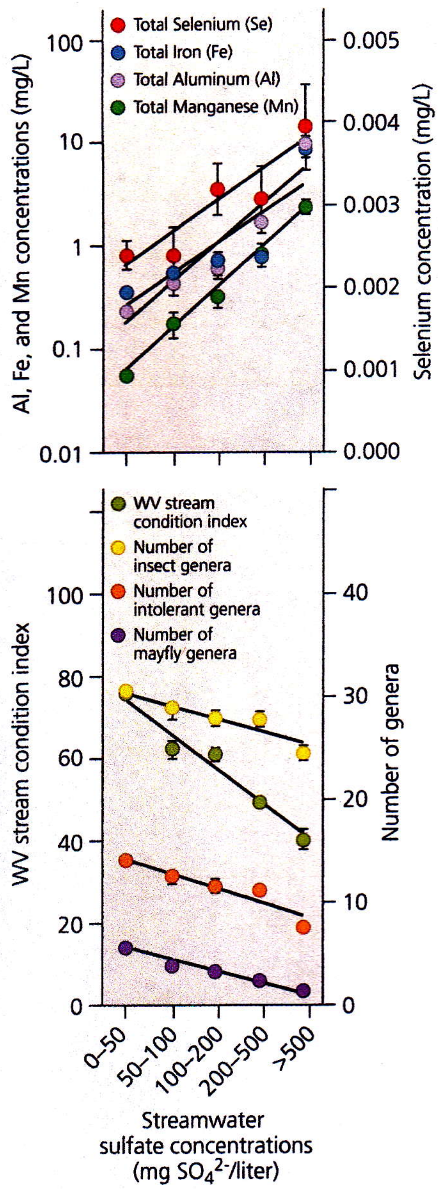
Researchers with the United States Geological Survey (USGS) carried out extensive water quality surveys in Appalachian streams in the late 1990s. For example, separate teams led by Katherine Paybins and by James Sams took hundreds of samples from diverse areas, chemically analyzed the samples, and then mapped their data, looking for geographic patterns. Their data clearly showed that concentrations of pollutants such as sulfates were strongly linked to upstream mining activities. They also showed that this pollution and its impacts (such as biodiversity loss) are long-lasting. Indeed, many studies show biodiversity declines in streams disturbed by mining, and no study has yet documented a recovery of stream life in the years after mining pollution.

Palmer's team tested for water quality impacts by tapping into a large database of measurements made by staff of the West Virginia Department of Environmental Protection. These workers had measured concentrations of pollutants in the waters of 1,058 streams in West Virginia and had recorded numbers and types of aquatic insects in the streams.

Palmer's team first confirmed that sulfate concentrations were tightly linked with upstream mining activity. They then looked for statistical correlations between sulfate concentrations and other water quality indicators, such as concentrations of selenium, iron, aluminum, and manganese. They found that concentrations of all these minerals rose with concentrations of sulfates (**see first graph**).

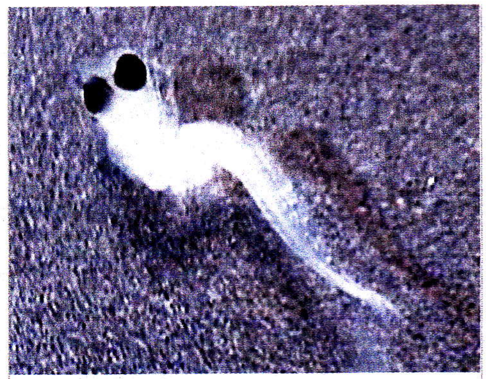
The researchers then graphed their insect data against sulfate concentrations (**see second graph**). All types of insects decreased as sulfate concentrations rose, suggesting that the changes in water chemistry brought about by mining were diminishing insect diversity in the streams.

Water pollution from mining can affect organisms higher on the food chain as well. Selenium is known to bioaccumulate (p. 385) in organisms and to cause birth defects (**see photo**). EPA scientists surveying 78 streams



Data from over 1,000 West Virginia streams show that (**top**) concentrations of four pollutants (selenium, iron, aluminum, and manganese) rise along with the increased sulfate concentrations that result from mining, and also that (**bottom**) insect diversity decreases with rising sulfate concentrations. *Source:* Palmer, M.A., et al., 2010. Mountaintop mining consequences. *Science* 327: 148–149. Reprinted with permission of AAAS.

near mines in 2002 found that 73 had selenium concentrations above the level at which studies have documented risks to insects, fish, and the birds that eat them.



High selenium concentrations in stream water can lead to birth defects. This embryo of a fish has a severely curved spine as a result of selenium downstream from a mine. *Source:* Lemly, A.D. 2008. Aquatic hazard of selenium pollution from coal mining, pp. 167–183, in G.B. Fosdyke, ed., *Coal mining: research, technology, and safety.* Nova Science Publishers, Inc.

Scientific research also documents health impacts on people apparently due to mountaintop mining. Health impacts come from inhaling air pollution and dust, drinking contaminated groundwater, and eating fish contaminated with selenium and other toxic substances. A 2009 study documented that people in mountaintop mining areas show elevated levels of lung cancer, heart disease, kidney disease, pulmonary disorders, hypertension, and mortality. The public health researchers who carried out this study, Michael Hendryx and Melissa Ahern, found that these health problems occurred in women as well as men, so they could not be due to direct occupational exposure among coal miners.

How much damage is too much, when it comes to a watershed? Various studies over the years have found that when over 5–10% of a watershed's area is disturbed by some sort of human land alteration, water quality and biodiversity in a stream decline. Mountaintop mining typically disturbs a greater percentage than this. For instance, of eight mountaintop mining permits issued in West Virginia in 2008, mining was allowed to cover 17–51% of each watershed.

Can mined mountaintops, filled valleys, and human health be restored to their original condition after mining? The science so far says no. A 2006 USGS study showed that even after reclamation efforts, groundwater from people's wells still contains higher levels of mine-derived chemicals than water from wells in unmined areas.

Reclamation efforts have traditionally focused on planting grasses and herbs—a far less diverse plant assemblage than was destroyed. Moreover, the degraded, compacted soils do not hold water, nutrients, or organic matter well, so trees have a hard time establishing. A 2008 study found little or no regrowth of trees and shrubs a full 15 years after reclamation was completed. Another study projected that even 60 years later, the soil would hold only 77% as much carbon as it did originally.

Palmer's team concluded that the U.S. government is failing to enforce the Clean Water Act and the Surface Mining Control and Reclamation Act and that these laws may not be strong enough to prevent severe impacts from mountaintop mining. The researchers urged the U.S. government to strengthen regulation of mountaintop mining practices. "Regulators," they wrote, "should no longer ignore rigorous science."

Just months after publication of this paper, the U.S. Environmental Protection Agency announced that it was strengthening its regulations on mountaintop mining. After reviewing EPA-sponsored and independent scientific studies, the agency adopted rules aimed at protecting 95% of aquatic life in Appalachian streams. Congress in 2010 was also considering bills to limit mountaintop mining and valley filling.