Environment

Janet Raloff reports from Hilton Head Island, S.C., at a National Acid Precipitation Assessment Program conference

Lime for your drink? Here's a new twist

More than 60 years ago, managers of Norwegian salmon hatcheries conducted the first reported "liming," or chemical neutralization, of waters acidified by industrial air pollutants. This treatment, named for the limestone commonly used in the procedure today, typically involves applying mineral powders or pellets directly to affected lakes or streams. Though it yields an almost immediate and potentially revitalizing increase in pH, its benefits vanish as the water containing the buffering agent flushes out of the system and is replaced by untreated water. In lakes, the replacement typically occurs after a year or two, notes Harvey Olem, a Washington, D.C.-based consultant. And that's why researchers are beginning to focus their attention on watershed liming – an alternative buffering strategy that's expected to provide at least five to 10 years of benefits per treatment, says Olem, who conducted a peer-reviewed survey of liming science and technology for the federally funded National Acid Precipitation Assessment Program.

Rather than liming the acidified waters themselves, this treatment limes the land draining into them. According to Olem, watershed liming can yield a host of additional benefits unattainable with conventional liming. For instance, by parceling out its alkaline therapy more slowly and uniformly, watershed liming should prevent the potentially toxic over-buffering that has resulted from some poorly controlled direct-lake treatments, in which pH levels sometimes rose as high as 9, Olem says. Moreover, by neutralizing water before it enters lakes or streams, the new approach would prevent potentially large pulses of acidic snowmelt or rain drainage from entering a waterway and creating large, undiluted pockets of highly acidic water. Many sensitive aquatic species can die from chronic exposure to a pH of 6 or from acute exposures to more acidic levels. Aquatic biologist Patricia T. Bradt at Lehigh University in Bethlehem, Pa., notes that rain with a pH of 4.2 to 4.8 is fairly common in Pennsylvania.

Researchers in the United States and Europe are currently testing the alternative strategy. One experiment initiated last October used helicopters to shower 1,000 metric tons of limestone pellets onto the forested slopes above two streams feeding Woods Lake in New York's Adirondack mountains. "This is the first watershed liming in the United States, and the first anywhere to involve lots of careful measurements," says project manager Donald Porcella, of the Electric Power Research Institute in Palo Alto, Calif. During the next two years, researchers from five collaborating universities will assist the institute in monitoring water-acidity changes and other effects of the experimental liming on aquatic and terrestrial ecology.

The EPA's National Surface Water Survey has identified 2,500 lakes and 36,000 kilometers of streams as having pH levels of 6 or lower. Though this total may include some naturally acidic waters – existing in that state for perhaps millennia – a large fraction are believed to have suffered significant acidification due to industrial air pollutants.

Olem says researchers have estimated that half the U.S. surface waters acidified by air pollutants will eventually recover under the emissions-control strategies most likely to emerge from strengthened Clean Air Act regulations. "The other half will remain acidic," he observes. And for them, "liming may be an option – a tool – for restoring their fisheries."

Harald Sverdrup, a chemical engineer and liming expert from the Lund (Sweden) Institute of Technology, cautions that "liming doesn't solve all [ecosystem] problems – just a suite of the worst." Nonetheless, he says, it is the fastest remedy for surface-water acidification. And, short of stiff emissions controls, liming is also the "most effective" method known, concludes Olem in his survey report.

Physics

An absence of antigravity

Several research teams have failed to confirm the puzzling results of a recent experiment by two Japanese physicists, who reported that under certain circumstances a spinning gyroscope may partially counter the Earth's gravitational pull (SN: 1/6/90, p.15). James E. Faller and his colleagues at the Joint Institute for Laboratory Astrophysics in Boulder, Colo., repeated the Japanese experiment by looking for signs of weight loss in a spinning gyroscope consisting of a brass top about 2 inches in diameter sealed in a small plastic chamber. "We conclude that within our experimental sensitivity, which is approximately 35 times larger than needed to see the effect reported . . . , there is no weight change of the type . . . described," Faller and his team write in the Feb. 19 PHYSICAL REVIEW LETTERS. A French group reporting in the Feb. 22 NATURE has obtained similarly negative results.

Why the Japanese researchers detected such an effect in the first place remains a mystery. According to their paper in the Dec. 18 PHYSICAL REVIEW LETTERS, they went to considerable trouble to eliminate possible sources of error. However, they may have overlooked some subtle but important details, says mechanical engineer S.H. Salter of the University of Edinburgh in Scotland. The trick is to find a mechanism that could produce a small weight loss when the gyroscope is spinning clockwise (as seen from above) but not when it's spinning counterclockwise or standing still.

"It is possible to construct an argument to show that vibration in the gyro, compounded by nonlinearity in the weighing mechanisms . . . , could lead to a misleading result," Salter comments in the Feb. 8 NATURE. Tiny differences in the tracks that house the ball bearings at the two ends of the spinning gyroscope could produce vibrations sufficiently large to affect the results. Moreover, laboratory balances like the one used to weigh the spinning gyroscopes aren't necessarily designed to handle vibrating loads accurately.

The way the baseball bounces

Sometimes the difference between a fly ball that's caught and a home run is a matter of inches. One factor influencing how far a player can hit a baseball is the amount of "bounce" the ball has. Measured as the coefficient of restitution (the ratio of an object's velocity after a collision to its velocity before the collision), the bounce factor affects a well-hit ball's launch velocity and hence a fly ball's range.

The rules of major-league baseball specify that a baseball's coefficient of restitution must lie between 0.514 and 0.578. That's enough leeway to make a difference on the order of 15 feet – roughly the width of a baseball field's warning track – in the horizontal distance a well-hit fly ball may travel, says David T. Kagan of California State University in Chico. Kagan describes his calculation in the February AMERICAN JOURNAL OF PHYSICS.

Kagan makes a number of assumptions and approximations in his calculations that limit the accuracy of his estimate. He assumes, for example, that the collision between a bat and a ball has the same coefficient of restitution as that measured officially by firing a baseball at 85 feet per second at a wall of ash. However, a bat may absorb energy differently, and the actual relative velocities in typical ball-bat collisions are considerably higher than 85 feet per second, which could lower the effective coefficient of restitution. It's also difficult to quantify the amount of drag, which varies considerably throughout a ball's flight as the air passing the ball becomes more or less turbulent. Furthermore, real baseballs may not vary as much as the rules allow.

Is the difference between a warning-track out and a home run really influenced by slight variations in the baseball? Kagan replies, "Probably not."