In the 1950s and 1960s people across Canada, the United States, and Europe began to notice increasing rates of smelly algae growth in lakes and wetlands. Increased nutrient loading was accepted as the cause, but which nutrient? Nitrogen, phosphorus, potassium, calcium, and other elements are all known to increase plant growth. To find an answer, ecologist David Schindler decided to do a large-scale experiment. Schindler and his colleagues divided an Ontario lake into two parts. They enriched one-half of it with nitrogen and the other half with phosphorus. The phosphorus-enriched half of the lake rapidly became eutrophic: algae and plants grew in such profusion that they choked out the sunlight, died, and decayed, producing a warm, smelly chemically and biologically altered ecosystem. The other half showed little change. With this classic study, Schindler and his colleagues demonstrated that phosphorus is the key limiting factor for plant growth in aquatic ecosystems. Add abundant phosphorus, and eutrophication results. This discovery led to drastic reduction in phosphates in household detergents and other products. Phosphorus is a natural and essential component of all living systems. Released by weathered rocks into soil and water, it is taken up by bacteria and algae, then incorporated into the food web. Our cells use it to produce countless essential compounds, including DNA and the energy-releasing molecule ATP. By weight, your bones are 7 percent phosphorus, and your body contains about 700 grams of the element. But since the 1950s the use of phosphorus fertilizers on farms has increased dramatically, and their distribution has expanded globally. At the same time, agricultural intensification has increased erosion rates, sending fertilizer-laden soils into streams and lakes at an accelerating rate. Limnologists Elena Bennett and Steve Carpenter estimate that recent expansion in phosphorus mining and trading have more than quadrupled natural rates of phosphorus inputs into freshwater ecosystems around the world, from 3.5 terragrams (trillion grams) per year normally to 13 terragrams now. Eutrophication is increasingly evident in developing countries, where phosphorus-rich fertilizers have become common in recent years. Further, our past activities will affect our water bodies for decades or centuries to come. Fertilizers will continue to wash off of farm fields, and the phosphorus currently in aquatic ecosystems may be recycled for centuries.

As this case shows, understanding the chemistry of ecosystems is essential to minimizing damage to our environment, or to restoring already damaged ecosystems. Environmental chemistry is therefore a growing discipline that needs dedicated students to ensure that our environment stays healthy—or returns to health.

This case also demonstrates the broad, multidisciplinary nature of environmental science. Understanding global phosphorus imbalances requires the expertise of hydrologists (who study water sources and the geography of water movement), climatologists (who study atmospheric distribution of moisture and airborne compounds), ecologists (who study ecosystem structure and functions), and toxicologists (who study organically harmful compounds), in addition to environmental chemists. They are among many.