

Hello and welcome to the National Institute of Environmental Health Sciences Superfund Research Program monthly Research Brief podcast. This month's Research Brief, Number 285, was released on September 5th, 2018, and discusses why shallow lake food webs may have more arsenic than deep lake food webs.

Lake properties impact the amount of arsenic that transfers from sediments into the aquatic food web, according to a new Superfund Research Program (SRP) study. Researchers discovered high concentrations of arsenic in the water and plankton of well-mixed shallow lakes.

With warm summer temperatures, the water near the surface of a lake is heated by the sun, making it less dense than colder water beneath. In deep lakes, this leads to thermal stratification, a phenomenon where lakes develop a discrete top layer of warm water that doesn't mix with the colder water near the bottom.

In contrast, the water in shallow lakes warms more uniformly, enabling these lakes to remain well-mixed with only brief periods of stratification. According to the study by University of Washington (UW) SRP Center researchers, this mixing leaves more of an opportunity for arsenic in the sediments to move up into the overlying water and enter the aquatic food web.

A research team led by Rebecca Neumann, Ph.D., and James Gawel, Ph.D., examined the movement of arsenic from sediments into water in four urban lakes, with varying levels of water mixing, in the Puget Sound region of Washington. Because the lakes are downwind of a former copper smelter site, a source of arsenic emissions, the lakes have high or moderate levels of arsenic-contaminated sediment. The researchers took water and plankton samples over the course of a year to account for seasonal differences. Each lake was sampled once or twice per month at four different water depths.

In lakes with strong seasonal thermal stratification, high levels of arsenic were limited to the bottom thermal layer that formed during the summer. However, in weakly-stratified lakes with higher levels of mixing, the entire water column, including surface waters, had elevated concentrations of arsenic during the summer. In both types of lakes, arsenic concentrations were lowest over the winter.

They also explored the accumulation of arsenic into plankton at each lake. Comparing two lakes with similar levels of sediment arsenic, they found that plankton in the weakly-stratified lake accumulated up to ten times more arsenic than plankton in the stratified lake.

In weakly-stratified lakes, they primarily found arsenic in the form of arsenate, which is readily taken up by plankton because it is structurally similar to phosphate, an essential nutrient for plankton growth. Once it is taken up by plankton, arsenic can be transferred through the food web to other organisms who eat them, including to fish consumed by humans.

Arsenic contaminated sediments have been documented in lakes across the United States, resulting from a variety of sources including historical application of arsenic herbicides to surrounding areas, disposal of hazardous waste, and aerosol smelter emissions.

According to the authors, well-mixed shallow lakes, which are common in densely populated urban areas, may be uniquely vulnerable to environmental and human health risks from arsenic contamination in sediments. Smaller urban lakes play an important role in supporting human recreation and food needs, yet they are understudied compared to larger, thermally-stratified lakes, especially with regards to arsenic contamination.

The authors add that well-mixed water columns likely promote bioaccumulation of arsenic both by positioning arsenic closer to phytoplankton near the surface of the water and by favoring a form of arsenic that is readily taken up by phytoplankton. Hence, lake mixing status may be a good metric for assessing the vulnerability of aquatic life to arsenic accumulation in impacted lakes.

If you'd like to learn more about this research, visit the Superfund Research Program website at www.niehs.nih.gov/srp. From there, click on "Who We Fund" and follow the links to the University of Washington research summary. If you have any questions or comments about this month's podcast or if you have ideas for future podcasts, contact Maureen Avakian at avakian@niehs.nih.gov.

Join us next month as we discuss more exciting research and technology developments from the Superfund Research Program.