New findings on emerging contaminants

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American and Canadian scientists are finding that out of sight, out of mind can no longer be the approach we take to the chemicals in our waters. Substances that we use everyday are turning up in our lakes, rivers and ocean, where they can impact aquatic life and possibly ourselves.

Derek Muir of Environment Canada and colleagues have determined that of the 30,000 or so chemicals used commercially in the United States and Canada, about 400 resist breaking down in the environment and can accumulate in fish and wildlife. These researchers estimate that of this 400, only 4 percent are routinely analyzed and about 75 percent have not been studied. These “emerging chemical contaminants,” or ECCs, are not necessarily all new substances. But with improved detection technologies, their unexpected potential impacts on the environment and human health are just now coming to light.

At a press conference at the Annual Meeting of the American Association for the Advancement of Science (AAAS) at the Sheraton Boston Hotel, on Saturday, February 16, a panel of researchers will discuss their current findings about how ECCs are affecting aquatic environments and may be coming back to haunt us in unanticipated ways.

John Incardona and Nathaniel Scholz at National Oceanic and Atmospheric Administration’s Northwest Fisheries Science Center and the West Coast Center for Oceans and Human Health found that polycyclic aromatic hydrocarbons (PAHs) left in Pacific waters after the

Exxon Valdez oil spill caused heart defects in herring and pink salmon embryos. PAHs from various sources, including oil spills and urban runoff, remain a threat to fish in coastal areas. The scientists think these chemicals can cause the hearts of fish embryos to beat slower and slower, resulting in heart deformities and a buildup of fluid around the hearts. During the last six years, they tested the effects of PAHs on zebrafish, which medical researchers have determined to have systems comparable to those of humans. The zebrafish embryos' hearts were severely malformed after absorbing PAHs through their skin.

"What isn't good for them, isn't good for us," Incardona says. Given the amount of PAH emissions that come out car tailpipes daily, especially in dense, urban areas, "basically, we are breathing an aerosolized oil spill." He says PAHs should be considered as "prime suspects for cardiovascular impacts related to air pollution."

Combining Chemicals can be Dangerous

Scholz is also finding that although the effects of a single chemical may not be deadly, combinations of chemicals in our environment can be more potent. Pesticides are regulated one by one, but in the environment they can mix with other pesticides and such mixtures are not regulated.

Water quality monitoring of rivers and streams has shown that threatened and endangered coho salmon and steelhead habitats throughout the Northwest are widely contaminated with pesticides that have run off from urban areas and agricultural land. The researchers looked at mixtures of five common insecticides and found that some combinations were much more toxic to the juvenile salmon than any one of the chemicals acting alone. The researchers say the enhanced toxicity of pesticide mixtures could be a more important factor in salmon population declines than previously realized.

“Current risk assessments based on a single chemical will likely underestimate impacts on wildlife in situations where that chemical interacts with other chemicals in the environment,” says Scholz. The current findings may have implications for human health because these insecticides act on the nervous systems of salmon and humans in a similar way. Also, mixtures of pesticide residues can be common in the human food supply.

Turtles Show Toxic Chemicals Persist in the Marine Environment

Stain repellents for carpets and nonstick coatings on food packaging derived from compounds known as perfluorinated compounds, or PFCs, are tough. But the same toughness that helps PFCs resist spills and grease also makes them resistant to breaking down in the environment. This means that PFCs can easily contaminate bodies of water and be ingested by wildlife.

Jennifer Keller of the National Institute of Standards and Technology (NIST) and the Hollings Marine Laboratory in Charleston, S.C., and her colleagues have monitored PFCs in loggerhead sea turtles along the U.S. East Coast to study the effects of the pollutants on these marine animals. Loggerhead turtles accumulate PFCs in their tissues because they eat filter feeders such as mussels that remove contaminants from the water.

Keller’s team found that turtles with high concentrations of PFCs showed signs of liver damage and were immunocompromised. Keller says, “Endangered sea turtles run a gauntlet of stresses in the oceans, and chronic exposure to contaminants may impair their defenses against disease or their ability to reproduce.” Because reptiles and humans have similar immune systems, Keller says that we also may be at risk for the same health problems as the loggerheads from exposure to PFCs.

Gender Bending can Impact Aquatic Food Webs

Chemicals are ending up in aquatic ecosystems in part because many municipal wastewater treatment plants do not filter out chemicals completely, including the estrogen women excrete in their urine after taking birth control medications. Karen Kidd of the University of New Brunswick is testing the effects of estrogen on aquatic life in a laboratory a bit larger than usual—a lake in northwestern Ontario.

After Kidd and her colleagues with Fisheries and Oceans Canada added estrogen to the lake in 2001, male fish in this lake started producing eggs or egg proteins and female fish produced up to 115 times more estrogen than normal. During the next summer, the fathead minnow, the shortest-lived fish species in the lake, stopped reproducing until more than 99 percent of its population was lost. This has impacts all through the food chain, ultimately hitting top predators and the entire lake ecosystem. In the next two years, she saw depletions in longer-lived species: the pearl dace declined 86 percent and trout, 30 percent.

But Kidd also has some good news: “Once you take the estrogen out of the system, given enough time, the fish return to their original abundance.” By 2006, three years after the scientists ceased adding estrogen to the water, the fathead minnow began to repopulate the lake. This suggests that if treatment plants could remove such chemicals from municipal wastewaters before they enter the environment, affected ecosystems could rebound.

Dilution Not the Solution

Steven Bay at the Southern California Coastal Water Research Project in Costa Mesa, Calif., has seen evidence of altered hormone levels in marine fish. The hornyhead turbot, a common flatfish in the coastal

waters of Southern California, hangs out on the seafloor where it can be exposed to a chemical cocktail discharged from nearby wastewater pipes. These chemicals range from industrial compounds to pharmaceuticals, some of which could contain substances that interfere with the fish's hormone system.

Bay found that up to 90 percent of the male hornyhead turbot tested at some locations had produced egg yolk proteins. They also had estrogen levels as high as females and low thyroid hormone and cortisol levels. Thyroid hormone manages growth, so development of the fish embryos could be impaired. And as cortisol is produced in response to stress, the low levels could actually mean the fish might be overstressed and "worn out," leaving them vulnerable to disease. Most of these responses in the fish were widespread and not confined to the areas around the discharge pipes, so their precise cause and source remain a mystery.

While you might think that the vast ocean could dissipate these chemicals, Bay says dilution is not the solution: "More than a billion gallons of treated municipal wastewater are discharged into Southern California coastal waters every day. Our study shows that some of these contaminants can be detected in sediments and water, even though the effluent is immediately diluted at least one hundredfold upon discharge."

Because most municipal treatment plants do not completely remove chemicals from wastewater, this study could have implications for groundwater and surface water. Treated wastewater effluent is sometimes discharged into rivers and used to replenish groundwater or to irrigate landscapes. If these chemicals are not filtered out through natural processes, they could end up in our drinking water supplies.

Carolyn Sotka, a contractor who is a senior science policy analyst at NOAA's Oceans and Human Health Initiative, says, "It's ironic that although we use drugs and products to benefit our health and well-being,

we can sometimes in turn hurt our environment and ourselves. Studies such as these force us to see the whole picture, to make the connection not only between land and sea, but also how what we put in or on our bodies or use in our homes can affect our world." Sotka says a better understanding of the impacts of emerging contaminants will lead to improved management decisions for the environment, especially coastal ecosystems that are already battling such a multitude of stresses.

Source: SeaWeb