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Tuesday, Nov. 10
8:30 AM – 10:00 AM
SESSION 19: Impacts of Toxic Chemicals on Water Quality, Aquatic Biota, and Human Health

Patterns in Soil Contamination in King County - Lee Dorigan, Public Health - Seattle & King County, Seattle, WA

Since 1999, Public Health – Seattle & King County and the Washington State Department of Ecology (Ecology) have partnered to investigate the nature and extent of the contamination from the Asarco Smelter on King County. In King County, almost 7000 soil samples have been taken at more than 550 locations. More than half of the locations showed at least one soil sample with arsenic above the state cleanup level of 20 parts per million (ppm), and about 18% showed lead above the state cleanup level of 250 ppm. An area of highest concern is called the Soil Safety Program. The following are some patterns in soil contamination in King County:
- The closer to the smelter, the higher the likelihood of contamination.
- Undeveloped properties, such as old parks and forests, are more likely to have contamination than recently developed properties, due to length of exposure and lack of disturbance.
- Properties that were developed after the smelter closed in the mid-1980s are the less likely to have contamination.
- Southwest-facing slopes are more likely to have soil contamination (depending on direction from smelter and local wind patterns).
- There is less elevated lead compared to elevated arsenic as the plume gets the farther from the smelter.
- Arsenic and lead tend to stay in the top 6 inches of soil and be very low below 12 inches.
Surface water impacts from arsenic have been demonstrated by a USGS study. The most likely groundwater impacts would be to those waterfront Vashon-Maury Island residences which rely on springs systems. These systems have not been sampled for arsenic. Currently, the TSP group finished sampling child-use areas: 135 schools and 487 childcare centers. This focus on the most vulnerable has found 15 schools and 22 childcare centers with elevated levels of arsenic. Ecology has completed cleanups at six schools and will follow through until all schools and childcare centers are cleaned. An outreach group continues to work with residents using a set of materials developed by King County

Weathering the Storm: Copper Impacts Juvenile Coho Behaviour and Survival with Predators - Jenifer Mcintyre, University of Washington, Seattle, WA (co-authors: D.A. Beauchamp, D.H. Baldwin, N.L. Scholz)

Stormwater runoff is recognized as a major source of degraded water quality affecting lowland streams. Among the complex mixture of contaminants contributing to stormwater pollution, metals have long been of concern because they can be acutely neurotoxic to aquatic organisms at low concentrations. In fish, metals such as copper target peripheral sensory systems, including olfaction and mechanosensation. At environmentally relevant concentrations, copper damages receptors for these sensory systems with effects that cascade up to impacts on ecologically relevant behaviours. We tested whether exposure to dissolved copper can decrease the survival of juvenile coho salmon (Oncorhynchus kisutch) in encounters with cutthroat trout (Oncorhynchus clarki) predators. Copper-exposed coho were more active than controls when a predator was present upstream and we found significant reductions in time to attack and capture during staged encounters with predators at copper concentrations as low as 5 µg/L. This is the first research showing that acute exposures to environmentally relevant sublethal concentrations of copper can affect juvenile salmon survival.

An Integrated Assessment of the Occurrence and Effects of Endocrine Disruptors in Puget Sound. - Irvin Schultz, Battelle Marine Science Lab Pacific NW National Lab, Sequim, WA (co-authors: Elliot Walters, James Nagler)

The contamination of aquatic environments with endocrine disruptors (EDs) is highly variable dependent upon source input rates, natural degradation processes and local hydrologic conditions among other factors. This creates challenges for environmental monitoring programs, which need frequent sampling to adequately assess the occurrence and ecological impact of ED contamination. Thus, there is potential for underestimating the extent of ED contamination and its impact aquatic organisms. In this study, we monitored four different streams in the greater Puget Sound region for the occurrence of estrogenic contaminants and other select EDs and assessed whether exposure levels were sufficient to impact fish reproduction. Our experimental design used an integrated approach employing grab samples of water and passive sampling devices deployed for several weeks at each stream site. We also placed caged, sexually mature rainbow trout at each site. The trout were placed in the streams for up to eight weeks and then subsequently spawned to assess fertility and embryo survival. The latter has been demonstrated in past laboratory studies to be the most sensitive toxicological endpoint in fish exposed to estrogens. The results of this study will be presented and the significance towards monitoring efforts of contaminants in Puget Sound discussed.

The Synergistic Toxicity of Pesticide Mixtures to Juvenile Salmon - Cathy Laetz, NOAA Fisheries, NWFSC, Seattle, WA (co-authors: David Baldwin, Nathaniel Scholz)

Pesticides are pervasive chemicals that are commonly detected in freshwater habitats that support threatened and endangered species of Pacific salmon (Oncorhynchus sp.) in the Pacific Northwest. These chemicals can enter salmon habitat in stormwater runoff from urban, residential, and agricultural areas, usually as complex mixtures of multiple chemicals. Two classes of commonly detected pesticides, the organophosphates and carbamates, are known to inhibit the activity of the enzyme acetylcholinesterase (AChE). Enzyme inhibition disrupts normal nerve transmission as well as behaviors that may be essential for salmon survival. While the effects of single organophosphate pesticides on aquatic species have been well studied, the toxicity of mixtures, especially at environmentally relevant concentrations, is poorly understood. We measured brain AChE inhibition and spontaneous swimming speed in juvenile coho salmon (Oncorhynchus kisutch) exposed to sublethal concentrations of organophosphates (diazinon, malathion and chlorpyrifos) and carbamates (carbaryl and carbofuran) in binary combinations. AChE inhibition was greater than expected after exposure to mixtures, indicating synergistic (i.e., greater-than-additive) toxicity for many of the binary mixtures. Moreover, several mixtures containing organophosphates caused mortality at concentrations that were sublethal in single pesticide exposures. The greatest levels of synergism were observed in mixtures of diazinon and malathion, where AChE inhibitions greater than 90% were measured in coho at a mixture concentration of 2.2 and 1.1 µg/l, respectively. Spontaneous swimming speed at this same exposure concentration was significantly reduced by 30% to less than 1 cm/s. In summary, we observed that salmon exposed to pesticide mixtures showed either concentration-additive or synergistic neurotoxicity, altered behavior, as well as unexpected mortality. Therefore, pesticide mixtures at environmentally relevant concentrations may pose a significantly greater threat to salmon health than predicted by conventional risk assessments for single chemicals. Additionally, these chemicals may represent a more important recovery challenge for declining salmon populations than previously anticipated.