Summary: Semipermeable membrane device (SPMDs) to assess potential fish PAH tissue concentrations in the North Saskatchewan River

Introduction

Semipermeable membrane devices (SPMDs) simulate exposure to and passive uptake of highly lipid soluble organic compounds (such as polyaromatic hydrocarbons, PAHs) by biological membranes. SPMDs consist of long strips of low-density polyethylene tubing filled with a thin film of purified lipids (e.g. triolein). They are a biomimetic technique that simulates a biological membrane e.g. fish gills, and can be used to assess theoretical fish PAH exposure. If organic contaminants in the water or on the sediment come into contact with the SPMD, they will transfer to their lipophilic matrix (fat friendly). The SPMDs act as a fish surrogate. This transfer would equate to water passing through the fish gills and transferring into the fish, potentially exposing the fish to contaminants.

Methodology

SPMDs were deployed into the North Saskatchewan River at a predetermined depth. SPMDs were deployed in two events, each lasting a month. Water flowed through the device capturing organic contaminants as they passed, mimicking the process of how a fish would uptake contaminants as they swim. In addition to locations in potentially impacted areas within the North Saskatchewan River, one location upstream of the spill site was chosen to assess the background PAH concentration within the river.

Conservative Assumptions

SPMDs provide an overestimate of PAH exposure for fish as SPMDs do not account for metabolism and assume that 100% of all PAHs are retained and transferred directly to muscle tissue; fish are known to metabolize PAHs efficiently. Previous studies have shown that SPMDs also show more efficient uptake of PAHs, therefore representing a more conservative estimate of exposure for the fish.

Findings

Chemistry Matters assessed theoretical fish PAH exposure from using SPMDs in the North Saskatchewan River and interpreted the results in a fisheries context. The calculated concentrations of PAHs in fish tissue are more than 50 times lower than potential screening guidelines for recreational fish consumption and more than 6 times lower than the guidelines for subsistence consumers. Additionally, the SPMD location upstream of the potentially impacted areas showed the highest potential for PAH concentration in fish tissue, and no increases in PAH concentration were seen downstream of the spill point based on the SPMD results.

Conclusion

The SPMD findings demonstrate that PAHs in the North Saskatchewan River do not pose a significant risk to human that may consume fish caught in the river, and support lifting the precautionary fish consumption advisory.