An Environmental Health Risk Assessment: Fish Consumption Among Southeast Asian Fishermen in Rhode Island and Risk from PCB Exposure

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Executive Summary

Fishing is an important activity in Rhode Island's inland and coastal waters. Among the benefits provided by fishing are recreational opportunities, direct and indirect input to the local economy, food for recreational and subsistence anglers, and food for the commercial marketplace. In recent years, however, there has been growing concern regarding the presence of chemical contaminants in the flesh of fish taken from Rhode Island waters and the resulting health risks to anglers and their families who consume their catch. This study looks at one particular pollutant—polychlorinated biphenyls (PCBs).

PCBs are persistent organic pollutants, and pose a significant risk to human health. PCBs have been found to cause cancer in several organs, as well as effects on the immune, reproductive, nervous, and endocrine systems. There are 209 different types of PCBs, each called a congener. Humans are exposed to PCBs through ingestion, inhalation, and dermal exposure, with ingestion of seafood being a major source. The goal of this study is to perform a human health risk assessment, asking the question: does exposure to PCBs through fish consumption pose a significant health risk? This assessment investigates both cancer and non-cancer effects. The results are intended to inform decisions concerning fish consumption advisories and regulations.

The study population is Southeast Asian anglers in Rhode Island and the surrounding area. This study population was chosen for two reasons— firstly, there is a large population of Southeast Asians in Rhode Island (1%) and it is rapidly growing (245.6% increase in 10 years); secondly, Southeast Asians consume more fish than the average citizen, putting them at increased risk. Specifically, this study looked at Hmong, Laotians, and Cambodians.

The Southeast Asian anglers in Rhode Island were interviewed to determine their fish consumption rates. The participants were recruited through local organizations. The study found a mean consumption rate of 4.5 g/kg/day (3.5 g/kg/day for Hmong, 2.2 g/kg/day for Laotians, and 7.6 g/kg/day for Cambodians).

Fish were then collected from Narragansett Bay (a popular fishing location) and analyzed for PCB concentrations. Three species of fish were collected—scup, striped bass, and tautog. These species were chosen because they were the most commonly consumed species among the participants. The sample analysis was done by freeze-drying the fish, extracting them with an ASE, doing a sulfuric acid/water cleanup, and then running them through a GC/ECD. The study found a concentration of 123.6 ng of PCBs per gram of wet fish in scup, 126.7 ng/g in striped bass, and 62.8 ng/g in tautog.

The consumption rates and the concentration data were then combined to calculate the concentration of PCBs the participants are exposed to everyday, also known as the lifetime average daily dose (LADD). The study used a tiered approach, meaning that the dioxin-like and nondioxin-like PCBs are analyzed separately. For Hmong, the study found a LADD of 73.042-97.390 ng/kg/day for nondioxin-like congeners, and 0.0083-0.0110 ng/kg/day for dioxin-like congeners. For Laotians, the LADD was 46.848-62.464 ng/kg/day for nondioxin-like congeners, and 0.0049-0.0065 ng/kg/day for dioxin-like congeners. For Cambodians, the LADD was 154.250-205.666 ng/kg/day for nondioxin-like congeners, and 0.0183-0.0244 ng/kg/day for dioxin-like congeners. For all ethnicities combined, the LADD was 90.474-120.632 ng/kg/day for nondioxin-like congeners, and 0.0105-0.0140 ng/kg/day for dioxin-like congeners.

These LADDs were then used to calculate the cancer and non-cancer risks. Cancer risk was found to be 0.0014-0.0019 for Hmong, 0.0008-0.0011 for Laotians, and 0.0031-0.0041 for

Cambodians. The average cancer risk for all three ethnicities was 0.0018-0.0023. These values are unitless, with 0 meaning there is no risk, and 1 meaning cancer is inevitable. The EPA has set a risk of above 10^{-5} to be unacceptable. All of the values found in this study are above this limit, meaning that there is cancer risk for all ethnicities, with Cambodians at highest risk.

The non-cancer risks are calculated as hazard indexes, and were 4.1-5.4 for Hmong, 2.7-3.6 for Laotians, and 8.5-11.4 for Cambodians. The average hazard index for the three ethinicities was 5.0-6.7. These values are unitless as well, with 1 signifying no risk, and anything over 1 signifying risk. These non-cancer risks are fairly high, meaning there is significant non-cancer risk.

The purpose of performing this health risk analysis is to affect regulations and advisories. The high cancer and non-cancer risks found in this study indicate that both immediate and long-term remediation are needed. The goal of immediate remediation is to prevent any further harm. Three possibilities for immediate remediation are fencing and capping affected areas, posting warning signs, and launching an educational campaign. The goal of long-term remediation is to permanently reduce the levels of PCBs in the water and soil. Options for long-term remediation include dredging and bioremediation. When considering any of these remediation possibilities, it is important to remember to include the community in the decision-making process to produce a contextually relevant solution. These decisions will also have to be made with consideration of the widespread distribution and long half-life of PCBs: dredging and bioremediation may be plausible in some areas, and unhelpful in others.

While a lot of progress has been made in the last decade, there is still much more that needs to be done. More accurate data on PCB toxicity is needed, and a more consistent coherent national policy is needed to assess and manage PCB risk.