Toxic Chemical Contaminants and Puget Sound

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Background Puget Sound is unique among of our nation's estuaries in being a deep fjord-like structure (resulting from its formation by glaciers) that contains many urban areas within its drainage basin. Because there are several sills that restrict exchange with oceanic waters, Puget Sound is relatively poorly flushed compared to other urbanized estuaries of North America. Thus, toxic chemicals that enter Puget Sound have longer residence times within the system, and this entrainment of toxics can result in biota being exposed to increased levels of contaminants for a given input, compared to other large estuaries. This hydrologic isolation also puts the Puget Sound ecosystem at higher risk from other types of pollutants that enter the system, such as nutrients and pathogens. The problems in Puget Sound associated with contaminants are exacerbated by the added problem of biological isolation. Because Puget Sound is a deep, almost oceanic habitat, the tendency of a number of species to migrate outside of Puget Sound is limited relative to similar species in other large urban estuaries. This high degree of residency for many marine species, combined with the poor flushing of Puget Sound, results in a more protracted exposure to contaminants. It is this combination of hydrologic and biologic isolation that makes the Puget Sound ecosystem highly susceptible to inputs of toxic chemicals compared to other major estuarine ecosystems.

A disturbing indication of this sensitivity is found in Pacific herring, one of Puget Sound's keystone forage fish species. These fish spend almost all of their lives in pelagic waters, far removed from sediments, and so should be among the least contaminated of fish species. Surprisingly, however, recent monitoring has shown that herring from the main basins of Puget Sound have higher body burdens of persistent chemicals (e.g. PCBs) compared to herring from the severely contaminated Baltic Sea. Thus, the pelagic food web of Puget Sound appears to be more seriously contaminated than previously anticipated. Additionally, chinook salmon that are resident in Puget Sound (a result of hatchery practices as well as natural migration patterns) are several times more contaminated with persistent, bioaccumulative contaminants than more migratory Puget Sound salmon and other salmon populations along the West Coast. Because of associated human health concerns, fish consumption guidelines for Puget Sound salmon have been published by the Washington State Department of Health. Extremely high levels of chemical contaminants are also found in Puget Sound's top predators, including harbor seals and southern resident killer whales. In addition to carrying elevated loads of toxic chemicals in their tissues, Puget Sound's biota are also showing a wide range of adverse health outcomes associated with exposure to chemical contaminants. These include widespread cancer and reproductive impairment in bottomfish, increased susceptibility to disease in juvenile salmon, acute die-offs of adult salmon returning to spawn in urban watersheds, and egg and larval mortality in a variety of fish species. Moreover, because humans are inextricably linked to the Puget Sound ecosystem, pollution has become a concern for human health as well. Overall, chemical contaminants currently pose a significant risk to the long-term recovery and sustainability of the Puget Sound ecosystem. Given current regional projections for population growth and coastal development, the loadings of chemical contaminants to Puget Sound will increase dramatically in the years ahead, unless serious measures are taken to address this issue now.

What is needed Three specific types of actions are needed if we hope to reverse the current state of degradation in Puget Sound and protect the Sound's ecosystem from harmful effects of toxic chemical contaminants in the future.

First, we must comprehensively define the sources, and estimate the amounts, of chemical contaminants entering Puget Sound. This will not be a simple task—the term 'chemical contaminants' includes an enormous variety of chemicals, with different physical properties that affect how they move through the air and water of the Puget Sound Basin. This effort should include the many agencies and municipalities that actively keep track of chemical releases within the Puget Sound Basin, as well as academic institutions that develop overall models of contaminant fluxes. Washington State has recently initiated an effort to perform such a 'loadings estimate' for Puget Sound, led by the Washington State Department of Ecology. This effort should eventually include the participation of Agriculture, Transportation, Health, and other relevant state and local agencies. The federal effort could be led by the U.S. Environmental Protection Agency and would include the U.S. Geological Survey and other agencies that are involved in monitoring chemical contaminants in the Puget Sound Basin. This loading estimate will also highlight the large gaps in current monitoring efforts, and should lead to better measurements of contaminant inputs to the Sound.

Second, the policymakers of the region, in conjunction with the above agencies, should determine how much reduction can be realistically achieved for the major classes of contaminants entering Puget Sound. This should be a large number, on the order of 40% or more, for those contaminants that are already shown to be posing risks to both ecological and human health in Puget Sound, such as PAHs and PCBs. Specific recommendations for reductions, as well as ways for achieving reductions, would be a useful product from the Puget Sound Partnership. It is recognized that certain legacy contaminants, such as PCBs, may already be so entrained within Puget Sound that their levels can only be reduced over long periods of time. However, other emerging contaminants, such as PBDEs, are known to be persistent, toxic, and increasing in Puget Sound. As has been recently shown in Sweden, preventing the release of PBDEs can yield quick reductions of these chemicals in humans and wildlife.

Third, the resource agencies of the region (e.g. WA Department of Fish and Wildlife, NOAA Fisheries, US Fish and Wildlife) should continue to monitor and assess the levels of chemical contaminants in the biota of Puget Sound, as well as the effects of contaminant exposure. It has been through the work of these groups and others, such as Cascadia Research and Canada's Department of Fisheries and Oceans, that we have come to realize the severity of the problem. It is clear that the biota of the Sound tell us things about Puget Sound that we cannot learn from monitoring only the water, air, and sediments. Recent examples of how biologically based studies have highlighted unexpected problems include the pre-spawn mortality syndrome noted in coho salmon returning to Puget Sound urban streams, as well as the results from monitoring of forage fish, showing the unexpected contamination of the pelagic food web of the Sound. Continued biological monitoring and assessment, along with continued innovative research and technology development, will alert us to the aspects of this complex and challenging problem that we would otherwise inevitably overlook.

These three steps, namely source characterization and quantitation, source control and reduction, and biologically-based monitoring and assessment, are essential if we are to protect Puget Sound from the waste products of its surrounding, and growing, human population.

* The views and opinions expressed herein are solely those of the authors, and should not be taken or construed as positions or policy of their respective agencies.