An Evaluation of Potential Impacts of Chemical Contaminants to Chinook Salmon in the Green-Duwamish Watershed

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Executive Summary

The 2005 Green-Duwamish Salmon Habitat Plan identified protection and improvement of sediment quality as a Tier 3 conservation hypothesis for salmon recovery. Although sediment clean-up was hypothesized to benefit Chinook salmon, limited scientific data were available on the potential impacts of sediment contamination on Chinook salmon productivity. Other habitat quality and quantity issues were more well-defined and identified as higher priority needs in the watershed. WRIA 9 commissioned this paper in 2017 – along with several other white papers – to address priority data gaps identified during the scoping of the 10-year update to the Salmon Plan. This paper summarizes research completed since the 2005 Plan was adopted on the potential impacts of chemical contaminants on Chinook salmon productivity in the Green-Duwamish watershed. The information is intended to inform identification and prioritization of recovery needs as WRIA 9 watershed partners update the 2005 Salmon Plan.

Contaminants are carried from sources to surface waters as well as within surface waters, by transport pathways. Contaminants can be carried to the Green-Duwamish receiving waters by point discharges (permitted industrial, stormwater and combined sewer overflows [CSOs] discharges), overland flow (stormwater runoff), groundwater, and direct atmospheric deposition, as well as by spills/leaks and bank erosion. Fish are exposed to chemicals through multiple routes including water passing through their gills and/or its ingestion, direct sediment contact and/or its ingestion, and/or through consumption of contaminated food. The importance of an exposure pathway to a fish is dependent on several variables primarily related to the chemical properties of the contaminant (e.g., hydrophilic, hydrophobic) and the ecology of the species of interest (e.g., diet, benthic or pelagic habits). Generally, water exposure and food consumption are the greatest exposure pathways to Chinook. Because juvenile Chinook spend a longer amount of time in the Green-Duwamish watershed than adult Chinook, their exposure to chemicals and risk of health impact are greater. In addition, juvenile Chinook are feeding during this period and consuming prey that are potentially contaminated.

Metals such as aluminum and selenium, have low toxicity under typical environmental conditions. Several other metals, such as copper, chromium, and lead, share similar acute symptoms resulting from disturbance of homeostasis. However, chronic exposure symptoms range widely from neurological and reproductive to sensory system and immune system impacts. Common classes of organic contaminants include pesticides, pharmaceuticals, phthalates, polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), and polybrominated diphenyl ethers (PBDEs). Three commonly detected organic chemical contaminants in the Puget Sound Region are PCBs, PAHs, and PBDEs. There is a wide variety of possible health effects in fish from organic chemical exposure.

The available ambient water, sediment, and Chinook salmon tissue chemistry and sediment bioassay data collected in the Green-Duwamish watershed and the ecological assessments that use these data are reviewed in this report. Key information found from this review includes:

Observations of potential impacts of contaminants

- Chinook salmon return rates are substantially lower in contaminated estuaries, like the Duwamish, compared to uncontaminated estuaries.

Tissue chemistry/biomarkers

- Lower Duwamish Waterway (LDW) and East Waterway (EW) risk assessments did not identify risk of impaired growth or survival for juvenile Chinook salmon. However, the LDW risk assessment noted reduced immunocompetence may occur in juvenile Chinook migrating through the LDW.
- Subsequent studies, using more conservative assumptions, concluded PCBs may be causing health impacts in Chinook salmon.
- The risks of impacts to Chinook salmon from Chemicals of Emerging Concern (CECs) are unknown although these chemicals are likely present in wastewater discharges, and to a lesser degree stormwater discharges to the Green/Duwamish watershed.
- Relatively little juvenile Chinook tissue data have been collected or evaluated in the Duwamish Estuary in the last 10 years, and less data are available for the Green River. Tissue chemistry data indicate juvenile Chinook salmon are bioaccumulating contaminants while in the Duwamish Estuary. Tissue assessments suggest that PCB exposure may be causing sublethal adverse effects to juvenile Chinook salmon.

Sediment

- In the most contaminated areas of the LDW and EW, contaminated sediments are potentially impacting benthic invertebrates which could reduce the quantity or quality of food for juvenile salmon.
- Juvenile Chinook salmon in the Duwamish Estuary are exposed to sediments contaminated with PCBs, PAHs, some metals and phthalates.
- In the Duwamish Estuary, PCBs are the most widespread sediment contaminant. Sediment contaminants in the Green River need more characterization. Based on existing data, sediment contamination is highest in Mill (in Kent) and Springbrook creeks and may be a concern to benthic invertebrates. Mill Creek (in Auburn) is less contaminated, and Jenkins, Newaukum, Covington or Big Soos creeks are of little concern. Arsenic and BEHP concentrations most frequently exceeded the no-effects benthic sediment cleanup level (SCO) in Green River tributaries.
- Superfund cleanup of contaminated sediments will be an important step in reducing the exposure of aquatic life including Chinook salmon to contaminants, particularly PCBs. Sediment recontamination will remain a risk from dredging activities during cleanup of the LDW and EW.

Water chemistry

- Several water quality assessments have not identified any chemicals that are presenting notable risk to aquatic life. Of the chemicals investigated, mercury in water may be a chronic exposure risk for juvenile Chinook salmon in the Green River.

While tracking the LDW cleanup schedule, it is recommended that further direct work on Duwamish Estuary Chinook salmon be supported by the WRIA 9 group. Work completed before cleanup begins on the LDW and EW will provide a foundation for comparison with future data to measure how juvenile Chinook health and contaminant impacts change over time. This work will be most efficiently directed at Chinook diet and tissue chemistry, biomarkers and sublethal effect measurement and improvement of Chinook-specific effect thresholds.

In addition to ongoing support for cleaning up contaminants in sediments and limiting future contaminant transport to surface waters, specific recommendations for future work include:

- Conduct studies that measure contaminants in juvenile Chinook tissues and stomach contents at different life stages or residence times. e.g., in rearing habitat for Chinook, in restored habitat project areas, and where tributaries enter the Green River. This work will strengthen the small dataset available for risk evaluation.
- Focus new studies on contaminants known to be elevated in the Duwamish Estuary and for which substantial effects data are published for some salmonids (PCBs, PAHs) and opportunistically explore CECs, such as pharmaceuticals, in water and Chinook salmon to build a chemistry database. CEC analysis is costly, effects analysis tools are lacking, and substantial new data are necessary to begin risk evaluation for Chinook. Therefore, prioritizing known contaminants first will optimize resources.
- Establish one or more new tissue effect thresholds for PCBs that are Chinook-specific. Effects thresholds are a tool that allow chemistry results to be placed into the context of toxicity. PCBs are the most widespread contaminant in the Duwamish Estuary. Outside of Superfund risk assessments, there is only one published PCB effect threshold that has been developed to assess Chinook in this region. Given the highly variable assumptions made in defining an effects threshold, developing one (or more) new PCB thresholds would provide a more stable foundation for evaluating how PCBs are affecting Chinook survival.
- Support studies that examine other effects evidence (e.g., juvenile Chinook bioassays with Duwamish sediments, biomarkers) by providing in-kind or financial assistance. In addition to the types of evidence recently collected for Chinook salmon (tissue and stomach content chemistry concentrations), work on other lines of evidence that can demonstrate occurrence of contaminant effects. For example, encourage National Oceanic and Atmospheric Administration or Washington Department of Fish and Wildlife to conduct laboratory exposure of salmon for PCB, PBDE, PAH effect endpoints using Duwamish sediments.
- Tease out cause(s) of lower smolt-to-adult return (SAR) by collecting juvenile salmon when they leave the Duwamish Estuary and measure body mass, nutrition and stomach contents and compare to mass of Chinook salmon at release from hatcheries. This would test if food quality (e.g., benthic invertebrates) between hatcheries and Duwamish Estuary mouth may be reducing juvenile health and decreasing SAR.