Contaminants in Stillaguamish Watershed
Fish and Shellfish

The greater Port Susan area of Central Puget Sound, Washington, is home to the usual and accustomed (U&A) hunting and fishing areas for the Stillaguamish Tribe and a popular sport and commercial fishing area for the public. Large shellfish beds lie in the Port Susan and Stillaguamish estuary and various Pacific salmon return to the Stillaguamish River and Tulalip fishery every year. Both species are a local and consumable resource for Stillaguamish Tribal members and the public. The health and presence of these species are vital to much more than the Tribe’s sustenance, but its culture and traditional knowledge systems as well. The Stillaguamish Tribe and its membership have relied on local seafood for millennia.

As urbanization has increased and is predicted to continue in western Washington, concern over pollution impacts to fish and shellfish have grown. In 2016-1718, the Stillaguamish Tribe, in partnership with the US Geological Survey and the Washington Department of Health, conducted a study to determine the risk, if any, to human health from consuming locally caught Chinook salmon and eastern softshell clams harvested from Port Susan Bay.

The Stillaguamish Tribe, Snohomish County, the Tulalip Tribes, the USGS and others have conducted baseline monitoring in the Stillaguamish watershed and the Port Susan estuary for several years. However, there are limited data for the occurrence of contaminants in the foods collected in this area. The Stillaguamish River and watershed is considered a relatively pristine area, with primarily forest and agricultural land uses, with low but measurable levels of contaminants reported (Wagner 2017). Legacy contaminants and mercury, which can also be accumulated in the Pacific Ocean, may pose a risk to Tribal members or the public from local harvest of these resources. This Fact Sheet summarizes the concentrations and risk associated with polychlorinated biphenyl chemicals (PCBs), and other contaminants such as Chlordane, DDTs (both pesticides) and mercury in tissues of adult, returning Pacific Chinook salmon and Eastern softshell clams collected in 2016 and 2017.

Figure 1. Location of sampling collections. Stillaguamish Tribe is headquartered in Arlington, WA.
Where do these Pollutants come from?

The chemicals evaluated here (Organochlorine Pesticides, PCBs and Mercury), primarily come from industrial activities that release them into the air or water. Organochlorine pesticides are an older class of pesticides, no longer applied, that were used to control pests in agriculture or, in the case of DDT, used to control pests such as mosquitoes, in urban areas. PCBs were used in hydraulic fluids, electrical devices, and in paints and dyes. Mercury is both a naturally occurring element, often released from volcanos or certain minerals, and a major contaminant from combustion of coal and waste streams. These three classes of pollutants have common chemical properties that give them persistence in the environment, a tendency to bioaccumulate, and are known to be toxic to animals, including orcas and humans. While there has been a history of control and regulation to remove or decrease these current sources, they are still present and still released into the air or water. These three pollutants also have a ‘Global Distribution’ in the atmosphere where sources long distances away can deliver them to Puget Sound via atmospheric transport.

Why should we worry about pollutants in seafood?

Each of these pollutants, organochlorine pesticides, PCBs and mercury, are known to have adverse health effects when too much is consumed. Effects are more common from long-term, repeated exposures to low or moderate levels of the chemical. Those most at risk are fetal and newborn children who receive, relatively, a higher dose per body weight than adult consumers. Exposure to high levels of methyl mercury in the diet are known to cause neurological and immune system disorders (Mercury 1997, Transdane et al. 2005). Chlordanes are known immune suppressants (Tryphonas et al. 2003, Rough 1999) and DDT breakdown products are known endocrine disruptors (Bouwman et al. 2011). Much of the literature on PCB toxicity describes its effects on the immune system.
Are Organochlorines in our diet a concern?

Like Mercury and Polychlorinated Biphenyls, Organochlorine pesticides such as Chlordanes and DDT are known to have adverse health effects at high enough doses. They were used as pesticides in agriculture and termite control (chlordane) and for mosquito control (DDT) in the United States, until 1988 and 1973, respectively. They ‘bioaccumulate’ through the marine food web and can reach high concentrations in some marine organisms. Chlordane has known human health effects in humans and is classified as a Class 2 human carcinogen (ASTDR 2018). The human toxicology data on DDT is more limited but it is generally considered less toxic than chlordane and is classified as a ‘Probable’ human carcinogen (ASTDR 2002). They were measured in this study as a part of routine testing of tissues. The concentrations measured here are well below the levels were consumption advisories would be warranted.

<table>
<thead>
<tr>
<th>Sample Description</th>
<th>Total Chlordanes</th>
<th>Total DDT</th>
<th>Total PCB</th>
<th>Total Hg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clams, eastern softshell A</td>
<td>N.D.</td>
<td>N.D.</td>
<td>N.D.</td>
<td>30.0</td>
</tr>
<tr>
<td>Clams, eastern softshell B</td>
<td>N.D.</td>
<td>N.D.</td>
<td>N.D.</td>
<td>24.0</td>
</tr>
<tr>
<td>Clams, eastern softshell C</td>
<td>N.D.</td>
<td>N.D.</td>
<td>N.D.</td>
<td>20.0</td>
</tr>
<tr>
<td>Clams, eastern softshell D</td>
<td>N.D.</td>
<td>N.D.</td>
<td>N.D.</td>
<td>26.0</td>
</tr>
<tr>
<td>Clams, eastern softshell_E</td>
<td>N.D.</td>
<td>N.D.</td>
<td>N.D.</td>
<td>16.0</td>
</tr>
<tr>
<td>Chinook salmon_6</td>
<td>3.4</td>
<td>19.3</td>
<td>68.9</td>
<td>N.M.</td>
</tr>
<tr>
<td>Chinook salmon_7</td>
<td>4.3</td>
<td>28.1</td>
<td>68.4</td>
<td>N.M.</td>
</tr>
<tr>
<td>Chinook salmon_8</td>
<td>1.5</td>
<td>9.1</td>
<td>22.1</td>
<td>N.M.</td>
</tr>
<tr>
<td>Chinook salmon_9</td>
<td>1.5</td>
<td>11.6</td>
<td>23.3</td>
<td>N.M.</td>
</tr>
<tr>
<td>Chinook salmon_10</td>
<td>2.8</td>
<td>21.2</td>
<td>39.6</td>
<td>N.M.</td>
</tr>
<tr>
<td>Chinook salmon_11</td>
<td>2.6</td>
<td>17.4</td>
<td>25.1</td>
<td>N.M.</td>
</tr>
<tr>
<td>Chinook salmon_12</td>
<td>5.2</td>
<td>26.7</td>
<td>63.8</td>
<td>N.M.</td>
</tr>
<tr>
<td>Chinook salmon_13</td>
<td>5.4</td>
<td>28.4</td>
<td>33.2</td>
<td>N.M.</td>
</tr>
<tr>
<td>Chinook salmon_14</td>
<td>0.8</td>
<td>7.3</td>
<td>15.2</td>
<td>N.M.</td>
</tr>
<tr>
<td>Chinook salmon_15</td>
<td>2.2</td>
<td>15.7</td>
<td>44.8</td>
<td>N.M.</td>
</tr>
<tr>
<td>Chinook salmon_16</td>
<td>5.9</td>
<td>33.0</td>
<td>63.6</td>
<td>N.M.</td>
</tr>
<tr>
<td>Chinook salmon_17</td>
<td>3.5</td>
<td>16.8</td>
<td>16.3</td>
<td>N.M.</td>
</tr>
<tr>
<td>Chinook salmon_18</td>
<td>3.2</td>
<td>18.2</td>
<td>35.9</td>
<td>N.M.</td>
</tr>
<tr>
<td>Median in ppb</td>
<td>3.19</td>
<td>18.17</td>
<td>35.90</td>
<td>20.00</td>
</tr>
<tr>
<td>+/- 95 Confidence Interval</td>
<td>0.94</td>
<td>5.21</td>
<td>13.85</td>
<td>11.11</td>
</tr>
</tbody>
</table>

N.D. indicates pollutant not detected in sample. N. M. indicates pollutant not measured in laboratory.
Summary of Findings

Contaminant concentrations in all samples in this study were low. These concentrations measured are consistent with other reports of fish tissue concentrations from the Puget Sound region (West 2017). The Total concentrations of the major chemical groups, i.e. sum of Chlordanes, total DDTs, total PCBS and Mercury, while often present, were below levels that warrant new consumption advisories beyond those already in place. Current consumption advisories for Chinook salmon in Puget Sound, available here: www.doh.wa.gov/CommunityandEnvironment/Food/Fish, recommend a limit of 2 meals per month for Blackmouth (young, resident Chinook that have spent most of their life in Puget Sound) salmon and 4 meals per month for mature Chinook salmon from the open ocean. Unique to this study, was the measurement of 180 PCB chemicals (i.e. congeners). One of these PCB chemicals, PCB 126, is particularly potent in its dioxin-like toxicity. This one PCB 126, detected in 7 of the 15 Chinook fillets, but not in the clams, has the potential to elevate a consumer’s risk of dioxin-like disease. See Page 4- Washington Department of Health-

Washington Department of Health (DOH) works to protect and improve the health of people in Washington State. Part of this mission is to reduce or eliminate exposures to health hazards in the environment. Health’s Office of Environmental Public Health Sciences (OEPHS) evaluates chemical hazards in the environment, develops strategies to reduce exposure to environmental contaminants, and provides education and outreach to communities to help minimize impacts to the public. One focus of OEPHS is on human health impacts from consuming contaminated seafood.

The PCB Cycle

The mercury cycle

In collaboration with The U.S. Geographical Survey and the Stillaguamish Tribe, Chinook salmon and clam tissues were analyzed for organochlorine pesticides, polychlorinated biphenyls (PCBs) and mercury. PCBs were analyzed by measuring all 209 congeners including the dozen dioxin-like PCBs. To determine whether Chinook salmon and softshell clams collected as part of this study are safe to consume, DOH compared contaminant concentrations found in the tissue of these two species with health based screening levels established by DOH. Screening levels for both the general population and high consumers were used for comparison based on 8 and 23 8-ounce meals per month, respectively. Allowable meal consumption rates were also calculated to provide safe meal limits to Chinook and softshell clam consumers. Based on cultural considerations on how Chinook salmon are consumed with skin on fillets, no reductions in contaminants were calculated to account for reductions of organic contaminant loads by cleaning and cooking techniques. Similarly, reductions in contaminants were not considered for softshell clam tissue samples.

Softshell Clam Results

Due in part to the relatively low amount of fat in the tissue of shellfish, the concentrations of organic compounds including organochlorine pesticides, PCBs, and mercury were not detected above levels of concern. Most of the time, PCBs and organochlorine pesticides were not detected in shellfish. Calculated safe meal limits for all organochlorine pesticides contaminants were greater than five hundred meals per month reflecting the very low concentrations in the clam tissue. Total PCB concentrations were below one part per billion, allowing for over two hundred 8-ounce meals per month. Mercury concentrations resulted in 47 meals per month, well above DOH’s cut off of eight meals per month when issuing an advisory to the general public or 23 meals per month for high consuming populations.
Chinook Salmon Results

While contaminant levels for all organochlorine pesticides were higher than those seen in the clam tissues, concentrations did not exceed screening levels based on general population or high consumer consumption rates. With the exception of total DDT, organochlorine pesticide concentrations allow for greater than 500 meals per month. DDT concentrations were also low and resulted in calculated meal limits of over 200 meals per month. Total PCB concentrations (average of 47 ppb) from fillets are slightly lower than PCB concentrations previous reported in Puget Sound Chinook salmon (average of 54 ppb) but slightly higher than coastal Chinook from the Pacific Northwest. Calculated meal limits allow for 4 meals per month, consistent with the current consumption advisory of 4 meals per month for non-resident Chinook salmon in Puget Sound. Removing skin and belly fat and cooking to reduce fats can reduce PCB concentrations, allowing for 8 meals per month. Mercury was not measured in Chinook salmon tissue, however, previous analysis of mercury in Puget Sound salmon would suggest that it is not of concern as well.

For more information on the Department of Health’s fish advisories for Puget Sound, visit: www.doh.wa.gov/fishmap

Future Assessment

DOH, with consultation with the Washington State Department of Fish and Wildlife and the Washington State Department of Ecology will evaluate the results of the dioxin-like PCB concentrations measured in this study to determine if any further advice is warranted.

Eat Fish, Be Smart, Choose Wisely

DOH encourages all Washingtonians to eat at least two fish meals per week as part of a heart healthy diet in accordance with American Heart Association (AHA) recommendations. People may eat fish more than two times weekly, but such frequent consumers should take steps to reduce exposure to contaminants in the fish that they eat by following some general advice.

• Eat a variety of fish that are low in contaminants according to guidance provided on the DOH website at http://www.doh.wa.gov/fish/.
• Follow advice provided by DOH and other local health agencies on water bodies to fish.
• Young children and small adults should eat proportionally smaller meal sizes.
• Eat fillets without the skin.
• Consume younger, smaller fish (within legal limits). These fish typically contain lower levels of accumulative contaminants like PCBs and mercury than older, larger fish.
• When cleaning fish, remove the skin, fat, and internal organs before cooking; this will help to reduce the amount of some contaminants.
• Grill, bake, or broil fish so that fat drips off while cooking.
• Smoking fish greatly increases the cancer risk due to the introduction of a large dose of Polyaromatic Hydrocarbons (PAHs) during smoking.
References


D. McBride DOH OEPHS

Author:
Patrick W. Moran

For more information:
Director, Washington Water Science Center, U.S. Geological Survey
934 Broadway, Suite 300, Tacoma, Washington 98402
http://alaska.usgs.gov

Project web page at:
https://www.doh.wa.gov/DataandStatisticalReports/HealthDataVisualization/fishadvisory

Publishing support provided by the U.S. Geological Survey, Tacoma Publishing Service Center

ISSN 2327-6916 (print)
ISSN 2327-6932 (online)
https://doi.org/10.3133/fsxxxxxxxx