2019

Columbia Slough Fish Advisory

Technical Report

Oregon Health Authority
PUBLIC HEALTH DIVISION
Environmental Public Health

Contents

Water body background

The historical Columbia Slough (slough) watershed contained a vast system of side channels, lakes, ponds and wetlands that covered a floodplain of the Columbia River between the mouths of the Sandy River and the Willamette River. Water seasonally inundated the floodplain, cutting new channels and depositing sediment. Native Americans, including the Yakama Tribe, the Nez Perce Tribe and the nine recognized tribes in Oregon used these waterways and uplands for fishing, hunting and gathering food. Subsequent industrialization by white settlers drastically altered the watershed. Levees were built in the early 1900's to provide flood protection, wetlands were drained and filled, waterways channelized, and streams diverted to underground pipes. Today the 19-mile-long slough is an extensively managed channel that parallels the Columbia River with a dozen miles of side channels. The levee system reduces the river's connection to the slough, except for the lower slough which is directly connected to the Willamette and Columbia Rivers. The lower slough provides refugia habitat for federally listed salmon and is critical habitat for Chinook and steelhead under the Endangered Species Act.

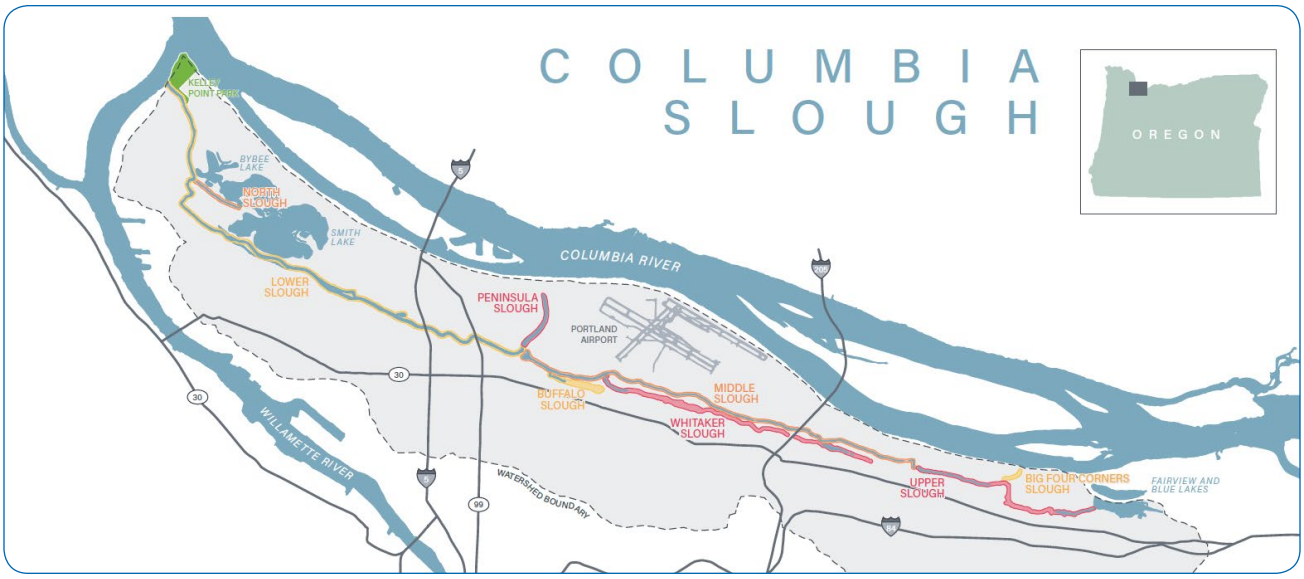
The slough is divided into three major sections based on hydraulic characteristics:

- The upper slough, contained within the levee system, starts in Fairview, Oregon at the mouth of Fairview Lake and extends downstream to the mid-dike levee at NE 142nd Avenue,
- The middle slough, also contained within the levee system, starts at the mid-dike levee at NE 142nd Avenue in Northeast Portland and extends down to the Peninsula Drainage District No. 2 (Pen 2) levee near NE 18th Avenue, and
- The lower slough in Northeast and North Portland, which extends from the Pen 2 levee 8.5 miles to the Willamette River.

Lowlands in the lower slough are subject to flooding because they are not protected by levees. Without levees, water flow and water levels in the lower slough are affected primarily by the Columbia and Willamette Rivers and Pacific Ocean tides.

The watershed includes various types of land uses such as residential, agricultural, commercial and industrial in addition to an airport, interstate highway system and railroad corridors. Some of these uses over time have damaged watershed health and contributed to chemical contamination of water, sediment and fish in area waterways.

Map of the Columbia Slough



Major species in the Columbia Slough

The slough is home to many resident fish (i.e., fish who live most of their life in the slough). The most abundant species are carp, largescale sucker, crayfish, black crappie, bluegill, largemouth bass and sunfish. Crayfish are also found in the Slough.

The Oregon Department of Environmental Quality (DEQ) and the City of Portland Bureau of Environmental Services (BES) have been investigating and overseeing environmental cleanup actions over the 19-mile length of the slough over the past 25 years and using their respective regulatory authorities to control contaminant sources. The results of BES fish tissue and sediment testing in 2015 and 2017 indicate conditions in the slough are improving and contaminant levels are decreasing. However, DEQ, the city and private parties recognize the need for continued action to further reduce contaminants in the slough to levels that are protective of human health and the environment.

Ingestion of fish by wildlife and humans is the primary risk pathway of concern for contaminants identified in the Columbia Slough Record of Decision (ROD) issued by the DEQ in 2005.[1] In 2015, BES performed a fish tissue study to:

1. Determine if concentrations in fish tissue exceed DEQ's acceptable tissue levels for human health
2. Assess whether levels of contaminants in fish tissue are declining over time, and
3. Evaluate whether fish advisories can be modified or removed.

BES analyzed carp and largescale sucker because these species tend to accumulate the highest concentrations of lipophilic (concentrate in fat tissue) contaminants like polychlorinated biphenyls (PCBs) and dioxins and furans due to their high fat content

and their proximity to the sediment. Because PCBs and dioxins and furans are the primary contaminants of concern, using this data across all species and habitats is likely to provide the most human health protective fish consumption advisory for the slough.

Fish tissue studies and advisories

BES conducted a number of fish tissue studies as part of the slough-wide remedial investigation (RI); screening level risk assessment (SLRA); feasibility study; and under long-term monitoring plan (plan) implemented as a requirement of the 2005 Record of Decision for Columbia Slough Sediment issued by DEQ. These include:

- 1993 Fish Tissue Study
- 1994 Columbia Slough screening level risk assessment
- 1995 Buffalo Slough fish tissue sampling
- 2005 Columbia Slough fish tissue sampling
- 2015 Columbia Slough fish tissue sampling (e.g., carp and largescale sucker fish tissue sampling

As these data became available, Oregon Health Authority (OHA) issued or updated the Columbia Slough fish advisory in:

- 1994
- 2010 (updated based on 2005 fish tissue sampling results)
- 2019 (updated based on 2015 fish tissue sampling results)

OHA generally receives data three to five years after originally collected by natural resource agencies or local partners, reflecting time needed to perform quality control, internal review and management approval.

Analysis of sediment, fish tissue samples and other environmental data assists in tracking the environmental quality of the slough over time. Fish tissue analysis provides a direct measurement of the health of the slough because bioaccumulation (an organism absorbing and retaining a substance), is an indirect way to determine if persistent, bioaccumulative toxics are present that are not readily measurable in water or sediment. Fish tissue studies also help inform fish advisories for the slough. OHA used fish tissue data from past BES studies (pre-2015) to calculate the current fish consumption advisory. OHA used data BES collected in 2015 to determine whether the current fish advisory needed modification.

Risk factors

The primary risk pathway of concern for human health from the slough is the ingestion of fish that have accumulated contaminants in their tissue from exposure to sediments, water and food.

BES' 2015 data report (published in 2018) concluded that:

- Measured fish tissue concentrations represent fish collected across a wide area of the Slough over a prolonged period.
- Contaminants of concern in fish tissue remain consistent across all studies, with some change in the amounts detected over time.
  - » PCBs (primary human health risk driver) – Fish tissue levels appear to be generally stable over time.
  - » Dioxins and furans – Fish tissue levels appear to be generally stable over time.
  - » Pesticides – Fish tissue levels appear to be decreasing over time.
  - » Metals – Fish tissue levels appear to be decreasing over time.

When people consume fish with tissue concentrations of PCBs that are too high, the PCBs can impair reproduction, cause neurobehavioral and developmental deficits in children, impair immune system and thyroid function and increase lifetime cancer risk.

In 1994, DEQ placed the Columbia Slough on the state's Clean Water Act 303(d) list of impaired waters as "water-quality limited" for bacteria, phosphorus, dissolved oxygen, chlorophyll a, toxics (DDT, DDE, dieldrin, dioxins, PCBs and lead), pH and temperature. The high level of PCBs, a toxic industrial compound, was a main cause of the listing.

Sources and environmental pathways of slough contaminants

PCBs and dioxins and furans are prevalent in waterways of formerly industrial areas. These contaminants are persistent in the environment and can accumulate within individual species, eventually moving up through the food chain. Thus, it is common to find higher levels of PCBs and dioxins and furans in fish species that are highly predatory or bottom feeders. Top predators, such as bass, yellow perch and walleye tend to live a long time and accumulate contaminants over the course of their lives eating other contaminated fish and invertebrates. Bottom feeders, such as carp, largescale sucker and brown bullhead tend to live closer to contaminated sediment

and eat prey located on the river bottom. Bottom feeders also tend to have a high fat content where lipophilic (those that are bound up in fatty tissue) contaminants such as PCBs can accumulate.

Mercury is also persistent in the environment. However, unlike PCBs and dioxins and furans, mercury can be naturally occurring from eroding native soil as well as an industrial byproduct. Mercury accumulates in fish tissue mainly in the form of methylmercury. Methylmercury biomagnifies up the food chain so that fish at the top of the chain have the highest levels of mercury. Unlike PCBs and dioxins and furans methylmercury accumulates mainly in the muscle tissue rather than the fat of fish.

2015 Sampling overview

The BES 2015 Fish tissue sampling program included all major reaches of the slough; lower slough, North Slough, middle slough, upper slough, Big Four Corners (east) Slough, Peninsula Drainage Canal, Buffalo Slough, and Whitaker Slough.

According to the 2015 tissue data and plan, PCBs and dioxins and furans are the contaminants of concern for people consuming fish from the slough. Because carp and largescale sucker tend to carry a higher body burden of lipophilic contaminants, they were collected as an appropriate and conservative representative of all resident fish in the slough. Largescale suckers were selected as an alternative species when carp could not be collected at a planned sample location. At the time BES developed its fish sampling plan, largescale suckers were assumed to be comparable to carp because they are bottom-feeders, have similar foraging habits and are thought to have similar home ranges. However, once BES had the samples analyzed, significant variation in contaminant concentrations were observed in largescale sucker tissue samples collected from the same locations as carp. This suggests that largescale suckers may migrate or have larger home ranges than previously thought. (Note: This information allowed OHA to develop a fish meal recommendation for largescale sucker fish separate from the recommendation for carp and all other resident fish, as presented in Table 4 below.)

The 2015 fish tissue study involved collecting a total of 59 carp and largescale sucker samples for analysis. Most fish were caught in the lower and middle slough and between three and seven fish were caught in all other Slough segments (See Table 1). Forty-nine of the 59 fish tissue samples were whole body and 10 were analyzed as fillet and remainders*. In these 10 cases, the fish was filleted and separated from the remainder of the fish (head, tail, viscera, etc.). Both fillets and remainders were analyzed as discreet samples. BES had all fish tissue samples analyzed for total metals, PCB Aroclors, and organochlorine pesticides; a subset was analyzed for PCB congeners, dioxins and furans, arsenic speciation, and methyl mercury.

* Remainders are pieces of fish left over after the fish has been filleted. In this study these pieces were analyzed separately from the fillet.

In preparing meal recommendations, OHA chose to analyze data from whole-body tissue samples as well as fish fillets to provide a protective estimate of the potential contaminant exposure based on consumption practices. People who fish in the slough come from many diverse ethnicities and cultures with different practices associated with the preparation, cooking and consumption of fish. Some cultural practices involve eating most of the fish, making stews and soups in which all but the viscera are eaten. Note: OHA did not use remainder data in any of the recommended meal calculations, only whole body and fillet data. If used, remainder data would have caused double counting.

Currently, the slough is posted with educational materials describing how to prepare harvested fish to minimize the amount of contaminant ingested.

Results for resident fish

Table 1 lists the number of carp and largescale sucker caught in each Slough section.

Table 1. Number of fish collected per Slough section in 2015

Lower slough	North Slough	Middle slough	Peninsula Drainage Canal	Buffalo Slough	Whitaker Slough	Upper slough	Big Four Corners (east) Slough
18	4	14	3	4	5	7	4

Fish tissue concentrations indicate that PCBs and dioxins and furans dominate the risk profile for people consuming fish from the slough. Although mercury was not dominant, when combined with PCBs to calculate meal recommendations for general and vulnerable populations, the inclusion of mercury resulted in more restrictive meal recommendations. Mercury and PCBs are combined because health risks associated with the two contaminants are additive. Both PCBs and mercury have similar neurological effects on fetuses and young children.

Mean tissue concentrations for each species are in Tables 2 and 3. All data have been rounded.

Table 2. Mean tissue concentrations of contaminants of concern in carp – 2015

Analyte	Tissue type	No. of samples	Mean (mg/kg)	Minimum (mg/kg)‡	Maximum (mg/kg)‡	Standard deviation (mg/kg)‡
Mercury	Whole body	30	0.07†	0.01	0.14	0.04
	Fillet	8				
Total PCB Congeners	Whole body	5	0.27	0.01	0.33	0.10
	Fillet	8	0.12			
Dioxins and furans Toxic equivalency	Whole body	5	2.83E-06	6.95E-07	2.43E-06	7.33E-07
	Fillet	5 Converted from whole body data*	1.42E-06			

* For dioxins and furans, only whole-body analysis was performed on both carp and largescale sucker
† Mean for mercury is calculated for all data reported (whole body and fillet combined)
‡ Minimum, maximum and standard deviation were calculated for whole body and fillet combined

Table 3. Mean tissue concentrations of contaminants of concern in large scale sucker – 2015

Analyte	Tissue type	No. of samples	Mean (mg/kg)	Minimum (mg/kg)‡	Maximum (mg/kg)‡	Standard Deviation (mg/kg)‡
Mercury	Whole body	19	0.06†	0.009	0.14	0.04
	Fillet	2				
Total PCB Congeners	Whole body	5	0.13	0.04	0.14	0.04
	Fillet	2	0.08			
Dioxins and furans Toxic equivalency	Whole body	5	1.85E-06	8.10E-07	3.33E-06	9.14E-07
	Fillet	5 Converted from whole body data*	9.26E-07			

* For dioxins and furans, only whole-body analysis was performed on both carp and largescale sucker
† Mean for mercury is calculated for all data reported (whole body and fillet combined)
‡ Minimum, maximum and standard deviation were calculated for whole body and fillet combined

Meal recommendations

Meal recommendations were calculated for resident fish only. Migratory fish like salmon and steelhead are not considered resident fish and are not covered by this advisory. These species accumulate much less contamination than resident fish species. These and other migratory fish are considered a healthy choice when looking for additional fish meals to consume. It should be noted that salmon and steelhead have not been identified in the middle or upper slough due to the levees in place and BES does not believe adult salmon or steelhead are present in the lower slough. For advice on the types of fish people should purchase and consume to reduce their exposure to contaminants in fish, refer to EPA's "Choose Fish and Shellfish Wisely" webpage: http://water.epa.gov/scitech/swguidance/fishshellfish/outreach/advice_index.cfm

Summary

Although OHA's maximum meal recommendations in Table 4 cover the species of fish for which data were available, OHA's fish advisory protocol dictates following these recommendations for other resident fish species in the slough. As mentioned earlier the major species found in the slough include carp, largescale sucker, crayfish, black crappie, bluegill, largemouth bass and sunfish.

Based on the available data, the advisory outlined in Table 4 represents the most consistent health protective approach possible while encouraging people to eat fish for its health benefits. As more fish tissue data from the Columbia Slough become available in the future, OHA will evaluate those data and update this advisory as warranted.

The recommendations in Table 4 are the number of meals per month everyone should follow.

Table 4. Recommended meals per month for resident fish

River zone	Fish species	Meals per month recommended consumption rates		Risk-driving contaminant	Comments
		Fillet	Whole body		
Columbia Slough	Carp and all resident fish except large scale sucker	1	0	**PCBs**	Meal recommendations are for **all** populations
	Large scale sucker	2	1		

When eating other resident fish from the slough besides carp and largescale sucker, people should follow the recommended number of meals per month calculated for carp.

If people eat the maximum amount of recommended fish in a month, they should not consume any other resident fish from the slough during that month. People can also average the recommended fish meals per month across several weeks. For example, if they eat a lot of fish one week, they can cut back for the next week or two.

Recommendations for reducing exposure to PCBs can be found on OHA's website: https://www.oregon.gov/oha/ph/healthyenvironments/recreation/fishconsumption/pages/fish-and-pcbs.aspx

Limitations

Some uncertainty comes from applying an advisory to all resident species in the same waterbody based on samples taken from a few individual species. It is possible that one species of fish accumulates more or less of a contaminant than another, even though both species are piscivorous (prey on other fish), top predators, bottom feeders, or have more fat content. However, data is not available for every species that an angler could potentially catch in any given waterbody. Therefore, the prudent and health protective course is to assume that the species of fish caught in a given waterbody will accumulate contaminants in a way similar to the fish for which OHA has data (carp and largescale sucker), although the specific type of contaminant the fish are exposed to and where in the fish the contaminant will accumulate may be differ.

OHA's use of the arithmetic mean in calculating meal recommendations assumes that fishers, over a lifetime, will catch a random distribution of fish over the entire distance of the Columbia Slough covered by this advisory. This may or may not reflect the actual practice of fishers along the slough. It is possible that a person regularly fishing in one spot over a lifetime could get fish that are consistently higher or lower than the mean used to calculate this advisory. PCB concentrations are higher starting in the lower reaches of the slough and generally decrease with distance upstream from the confluence of the slough with the Willamette River. This may be due to several factors including that there was more industrial development in the lower slough than in the middle and upper slough during the first half of the 20th century.

Endnotes

1 Oregon Department of Environmental Quality, Northwest Region. Office Record of Decision Remedial Action Approach for Columbia Slough Sediment Portland, Oregon 2005 [cited 2019 Nov 7]. Available from: https://www.deq.state.or.us/Webdocs/Controls/Output/PdfHandler.ashx?p=80616036-1b29-45ab-9024-ad9fcacbe06f.pdf&s=ROD%20for%20Columbia%20Slough,%20July%202005.pdf

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