

September 2022

>> Consumption
Advisory for
Lamprey: Columbia
River and its Oregon
Tributaries

Technical Report

Oregon
Health
Authority

PUBLIC HEALTH DIVISION
Environmental Public Health Section

Acknowledgments

The Oregon Health Authority, Public Health Division, Environmental Public Health Section prepared this publication.

For more information, contact:

David Farrer, Public Health Toxicologist

Email: david.g.farrer@oha.oregon.gov

Phone: 971-673-0440

Please cite this publication as follows:

Oregon Health Authority, Public Health Division, Environmental Public Health Section. Consumption Advisory for Lamprey: Columbia River and its Oregon Tributaries Technical Report. Portland, OR. 2022 July.

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Overview

The Oregon Health Authority (OHA) issues fish advisories with meal recommendations for people to limit or avoid eating certain fish or shellfish to reduce exposure to contaminants like polychlorinated biphenyls (PCBs), mercury, dioxins and furans* and others. OHA issues advisories based on data about contaminants in fish or shellfish tissue from state and federal environmental agencies, the Tribes, fishing commissions and environmental organizations.

Before issuing an advisory OHA prepares a technical report. This report:

- Summarizes available fish or shellfish tissue data
- Describes assumptions about exposure to contaminants, and
- Provides information that supports the development of an advisory.

OHA evaluated the need for a consumption advisory for lampreys from the Columbia River and its Oregon tributaries. The findings of this technical report support issuance of such an advisory.

The Columbia River and its tributaries contain culturally significant habitats and spawning areas for lampreys. Willamette Falls is one of the last major lamprey harvest sites left in the Columbia River Basin. Although numbers are not as robust as they were historically, lampreys still provide Tribes in Oregon, Washington and Idaho the ability to continue culturally significant harvesting practices of this important first food. Tribal restoration activities such as adult transport and translocation collections occurring at dams including Bonneville, The Dalles and John Day are helping to restore lamprey populations in the Columbia Basin depleted by these structures, shrinking habitats, reduced water flows and other human impacts.

* Dioxins and furans are very similar classes of chemicals. Therefore, we like to analyze and talk about them as a group.

Species range, background, habitat and lifecycle

Range

The Pacific lamprey is the most widely distributed lamprey species on the West Coast of the United States. They have been found in streams from Hokkaido, Japan and around the Pacific Rim including Alaska, Canada (British Columbia), Washington, Oregon, Idaho and California to Baja Mexico. Their distribution includes major river systems such as the Fraser, Columbia, Klamath, Trinity, Eel and Sacramento-San Joaquin. Pacific lamprey distribution patterns are like those of anadromous salmonids.

Background

Pacific lampreys have historically provided a high lipid and high energy food source for Tribes who lived and fished along rivers during cold winter months when salmon were not running. Lampreys have five times the lipid content of salmon. Lampreys provide higher caloric value per unit of weight and have the highest Omega 3 fatty acid content of any seafood. This high lipid content, however, makes lamprey tissue more vulnerable to the bioaccumulation of lipophilic (fat-loving) contaminants like PCBs.

Habitat and lifecycle

Like salmon and sturgeon, Pacific lamprey are anadromous. Once hatched, lamprey ammocoetes (larvae) drift downstream and burrow into the fine substrate or muddy areas of backwater pools, eddies and stream banks where water velocity is low. Larvae are filter feeders, filtering mud and water for microscopic detritus, algae and invertebrates. This stage of their life is unusually variable compared to other migratory species, as it can last from four to seven years.

Lampreys undergo a radical metamorphosis from larvae to juveniles. Juveniles spend about a year completing their transformation which includes regulating their bodies to adjust to life in saltwater. Their migration to the ocean happens in the winter and spring. During this transformation, they move to silt-covered gravel in a moderate current. They develop eyes and teeth. When fully transformed they are found in gravel or boulder substrate where the current is moderate to strong. It's then easier for them to migrate downstream to the estuary.

In the estuary, they enter a free-swimming stage using sucker-like discs to attach to marine fish and mammals. They use their bony tongue to drill into scales and flesh, feeding as ectoparasites on the hosts' blood and fluids. Juvenile lampreys initially target smaller size fish in the estuary or tidal waters. They then shift to larger and larger hosts as they grow. Because they are opportunistic and not selective of their host species, they will target whatever species of fish or mammal are the most abundant. According to Columbia River Inter-Tribal Fish Commission (CRITFC) experts, lampreys tend to focus more on bottom-dwelling fish such as Pacific hake, cod, sole, halibut and rockfish, as well as sharks and whales. They feed less on salmon as these fish inhabit the mid-water column. Juvenile lampreys have been observed attached to salmonids in both fresh and varying concentrations of salt water. While feeding on a host, a lamprey can grow 16 to 27 inches.

CRITFC studies on parentage genetics and sibling analysis have found that lampreys likely spend five to six years in the ocean. They then detach from the host fish; cease feeding and migrate to freshwater in the spring during which time they become sexually mature. Most are thought to overwinter and remain in freshwater habitats for at least a year before spawning. During this overwintering, lampreys may shrink in size up to 20 percent.

Spawning

Spawning usually occurs in early spring through mid-summer depending on the geographic location of their native range. Low-gradient streams and gravel at the tailouts of pools and riffles are ideal locations. Rocky areas within the lower Willamette River, the Deschutes River at Sherars Falls and the Columbia River near the locks at John Day Dam create a suitable habitat where lampreys migrate to spawn. In the same way salmon and steelhead spawn and lay eggs, lampreys construct nests or redds in small gravel substrate. Females can lay more than 100,000 eggs in a redd fertilized externally by the male. Like spawning salmon, lampreys do not feed during this time. Spawning ends in death for these adults typically within three to 36 days.

The degree of homing during the spawning season is unknown. However, scientists believe adult lampreys navigate to upriver spawning grounds by following pheromone trails secreted by the digestive tracts of larval lampreys. Unlike salmon, Pacific lampreys do not necessarily return to their natal streams. The theory behind this strategy is twofold:

1. If the habitat is healthy enough to support larvae, it must be suitable for spawning.
2. Adult Pacific lampreys are attached to their hosts whose travel makes it hard for them to swim potentially hundreds of miles back to their natal river once they enter the reproductive stage.

Harvesting

Harvest season

Harvest season varies by location. At Willamette and Sherars Falls fresh migrant runs are typically harvested between June and September. At other sites, the primary focus can be overwintered runs which usually occur from March through June or July with some overlap. According to the Confederated Tribes and Bands of the Yakama Nation, most of the catch of lampreys in the Columbia River are overwintered lampreys. Lampreys collected near dams such as Bonneville, the Dalles and John Day are mostly translocated to enhance lamprey populations where they are unable to migrate through fish ladders.

Harvesting by Tribes in Oregon, Washington and Idaho

The four Columbia River Treaty Tribes (Confederated Tribes and Bands of the Yakama Nation, Confederated Tribes of the Umatilla Indian Reservation, Confederated Tribes of Warm Springs and Nez Perce Tribe) that created CRITFC use off-reservation fishing and hunting rights by treaty with the United States and have repeatedly affirmed these rights.

Tribes who do not have reserved rights to manage fish and wildlife may have Tribal harvest rights limited to areas within their reservation boundaries. Those who do not possess Tribally reserved rights to manage fish and wildlife must hunt and fish per the state's fish and wildlife regulations.

The four CRITFC member Tribes separately determine the time, harvest area and method of the take for their members. Conservation is key in the decision-making process for Tribal managers. Each Tribe will then draft resolutions to adopt into regulations that govern their members' actions. The four Tribes coordinate the mainstem Columbia River fisheries to ensure regulations are consistent among fisheries, especially commercial fishing activities for other species.

Members from Tribes who do not have reserved fishing and hunting rights and non-Tribal members need a permit to harvest lampreys at Willamette Falls from the Oregon Department of Fish and Wildlife (ODFW). They must harvest per state regulation in [OAR 635-044-0130](#). This is the only location Tribes allow without reserved rights and non-Tribal lamprey harvest, consistent with ODFW regulations.

Lamprey collection and tissue analysis

To determine the level of contaminants in lampreys harvested and eaten by Tribal members, CRITFC collected lampreys in 2009 from the following areas:

- Willamette River at Willamette Falls directly downstream from the locks
- Columbia River at the John Day Dam lamprey collection box near the exit to the John Day pool
- Deschutes River at Sherars Falls fish ladder

The Oregon Department of Environmental Quality (DEQ) lab and the United States Geological Survey (USGS) analyzed lamprey whole body composite* samples from each location. DEQ and USGS completed this analysis in 2011 and provided the data to CRITFC. CRITFC submitted the 2011 data to OHA for review in 2012. Table 1 shows the breakdown of composite samples by location.

Table 1. Breakdown of composite samples by collection site

Collection site	Number of composite samples	Number of lampreys in each composite			Total number of lampreys collected
Willamette Falls	3	2	5	5	12
John Day Dam	3	5	5	6	16
Sherars Falls	1	5			5

2012 analysis

OHA completed an initial evaluation of the lamprey data in 2012. OHA then determined an advisory with meal recommendations for lamprey was not necessary based on the review methodology in place at that time. Between 2013 and 2015, OHA made changes to the methods used to calculate meal recommendations from fish tissue data. That methodology is described in our standard operating guidance (SOG), which OHA has been using with minor changes since 2015. Important changes to the SOG since 2012 included:

- Considering the cumulative effects of multiple contaminants with similar health effects, such as mercury and PCBs.
- Developing different levels for distinguishing harmful levels from exposure of sensitive populations (children, pregnant people) as compared to general populations.

* Lampreys in composite samples were not eviscerated.

In addition to these changes to the SOG, OHA has in recent years developed a more comprehensive Tribal consultation policy and communications plan. This policy and plan prompted OHA to review past advisories for fish species that are particularly important to Tribes. OHA determined available lamprey data would benefit from an updated analysis since the last updates to the SOG were in 2012.

2021 analysis

Lamprey tissue data indicated mercury is a health concern for vulnerable populations.* However, PCBs are the primary contributor to the health risks of consuming lamprey from all three collection sites for both general and vulnerable populations. PCBs are the primary contaminant because of the high lipid content of lamprey tissue. Dioxins were found to pose a low-level health risk compared to the risks posed by PCBs and mercury in tissue. Findings were similar across collection sites as shown in Table 2.

Table 2. Mean tissue concentrations for each collection site

Collection site	Contaminant	Mean total – by location (mg/kg)	Total number of lampreys collected
Willamette Falls (Willamette River)	PCBs	0.036	12
	Mercury	0.19	
	Dioxins and furans (ng/kg)	0.17	
John Day Dam (Columbia River)	PCBs	0.038	16
	Mercury	0.24	
	Dioxins and furans (ng/kg)	0.58	
Sherars Fall (Deschutes River)	PCBs	0.045	5
	Mercury	0.25	
	Dioxins and furans (ng/kg)	0.28	

Meals in Table 3 were calculated using the mean total data by contaminant and location from Table 2. OHA calculates recommended monthly meal recommendations for single contaminants alone and for multiple contaminants together when they have similar health effects. The equation for a single contaminant is found in [Section 2.6.1 of OHA’s SOG](#). When data are available for multiple contaminants with additive toxicity and health effects, OHA uses the discrete equation in [Section 2.6.2 of the SOG](#).

* Pregnant women, nursing mothers and children

Table 3: Lamprey meal calculation results by area and contaminant

Whole-body* meals† per month by area and contaminant						
Contaminant	Sherars Falls		Willamette Falls		John Day Dam	
	General Pop	Vulnerable Pop	General Pop	Vulnerable Pop	General Pop	Vulnerable Pop
PCBs	4		5		5	
Mercury (Hg)‡	11	4	15	5	12	4
PCBs+Hg‡	3	2	4	3	3	2
Dioxins and furans	23		39		11	

Table 3 shows PCBs are the main contaminant of concern for lamprey consumption. While mercury, dioxins and furans are contaminants of concern, people could eat many more meals if those were the only contaminants in lamprey tissue. Looking just at PCBs, the monthly meal recommendations are within a narrow range of four to five fish at all three sites. When adding the risk from mercury, the meal recommended number is lower. It is within a narrow range of three to four meals per month for the general population and two to three for vulnerable populations. This similarity in meals among all three sites justifies combining the data for all locations when calculating meal recommendations for lamprey.

The following statement from CRITFC explains why OHA is using the combined data from these three collection sites (Table 4) to inform an advisory for all of the Columbia River that touches Oregon and all of its Oregon tributaries. “Although our contaminants results were based on adult Pacific Lamprey collected from three specific Oregon tributaries in the Columbia River, we feel that based on the following two major reasons that it is justified to consider these results to be applicable to a broader region that encompasses the entire Columbia River Basin: 1) a population of Pacific Lamprey has been characterized to include the entire Columbia River Basin as well as portions of the U.S. West Coast range of this species (Hess et al. 2013), 2) the observed trait variation exhibited by this species in the Columbia River Basin (i.e., timing of maturation and body size) is effectively captured by including the spawning segments at Willamette Falls and those upstream of Bonneville Dam (Hess et al. 2020). Because Willamette Falls represents a diversity of trait variation in

* OHA did not convert whole-body data to fillet-only data due to the physical characteristics of lamprey such as a high lipid content and a high percentage of body weight that is edible.

† A meal is about the size and thickness of you or your child’s hand. Adults = about 8 oz and a child = about 4 oz.

‡ OHA always calculates the effects of Hg on general and vulnerable populations. OHA also calculates the additive effects of mercury and PCBs because they have similar health effects.

this species and the contaminant results at Willamette Falls compared to upstream sites were similar, we have an expectation that these contaminant results apply to a geographic region that is similar to the extent of the population that resides in the Columbia River Basin.”*† Oregon is limiting the boundaries for this advisory to the portions of the Columbia River Basin that are located within the state of Oregon because Oregon does not have authority to issue fish advisories that apply to waters in other states. This means the boundary of this advisory is the portion of the Columbia River that touches Oregon plus all tributaries to the Columbia River in Oregon.

Table 4. The concentration of contaminants of concern in lamprey tissue (All collection sites combined)

Tissue type	Contaminant	Mean (mg/kg)	Standard dev (mg/kg)	Total number of lampreys (all composites)
Whole body	PCBs	0.038	0.006	33
	Mercury	0.22	0.02	
	Dioxins and furans (ng/kg)	0.39	2.6	

* Hess, J. E., Campbell, N. R., Close, D. A., Docker, M. F., & Narum, S. R. (2013). Population genomics of Pacific lamprey: adaptive variation in a highly dispersive species. *Molecular Ecology*, 22(11), 2898-2916.

† Hess, J. E., Smith, J. J., Timoshevskaya, N., Baker, C., Caudill, C. C., Graves, D., ... & Narum, S. R. (2020). Genomic islands of divergence infer a phenotypic landscape in Pacific lamprey. *Molecular ecology*, 29(20), 3841-3856.

Meal recommendations

Combined data vs. separate location data

To calculate meal recommendations, OHA used the combined mean concentration for PCBs and mercury across all collection sites as shown in Table 4, instead of the mean data for each collection site as shown in Table 2.

OHA calculated meal recommendations using data from across all collection sites because:

- Lampreys parasitize fish and mammals in the estuary and ocean for several years. Therefore, OHA believes most of the contaminant burden in adult lampreys comes from these hosts; not from river habitats where they live as ammocoetes or juveniles or where they are harvested as adults.
- Combining the data does not significantly change the calculated number of lamprey meals a person can safely eat.
- Using one set of meal recommendations for all of the area covered by the fish advisory is a more well-defined and effective message that harvesters can use regardless of where in the Oregon portion of the Columbia River Basin the lampreys are harvested.

Whole-body vs. fillet meal recommendations

Typically, when whole-body data only are available for lipophilic contaminants such as PCBs, OHA will apply an adjustment factor to convert whole-body data to fillet data (whole-body data is divided by a factor of 2). OHA uses this converted data to calculate meals for fillet-only because many people eat only the fillet and not the whole body.

OHA did not use this adjustment factor and did not calculate meal recommendations for lamprey fillets because:

- Lampreys have a high percentage of body fat in their tissue where lipophilic contaminants accumulate.
- Tribal members, the most prolific consumers of lamprey, report they customarily eat most of the lamprey (including the organs) because lampreys are considered a delicacy. They do not wish to waste any of the edible portions.

Based on available data and the decisions outlined above, the advisory meal recommendations in Table 5 represent the most consistent health-protective approach possible for lampreys while encouraging the use of the fishery for its cultural, spiritual and health benefits. **As illustrated in Table 5 the advisory meal recommendations in the portion of the Columbia River touching Oregon and tributaries to the Columbia River in Oregon are:**

- **Four meals per month for the general population, and**
- **Two meals per month for the vulnerable population.**

These meal recommendations will remain valid until more current data become available that may result in changes to the recommendations or removal of the advisory.

Table 5. Recommended meals for lamprey advisory: Portions of Columbia River touching Oregon and tributaries to the Columbia River in Oregon

Whole-body* meals per month recommended consumption rates†			
All collection sites	Contaminant	General population (Men, women beyond childbearing age)	Vulnerable population (Pregnant women, nursing mothers, children)
<ul style="list-style-type: none"> • Willamette Falls downstream of locks • John Day Dam lamprey collection box near the exit to John Day pool • Deschutes River at Sherars Falls fish ladder 	PCBs		5
	Mercury (Hg)‡	13	4
	PCBs + Hg‡	4	2
	Dioxins and furans		17

Methods like smoking, drying or grilling can significantly reduce PCB concentrations in lamprey tissue because the oil can drip from the lamprey and not be consumed. Based on the information from Tribal Fisheries staff several preparation methods are used and most of the lamprey is eaten:

- “Lamprey[s] are fried, grilled or cooked over a fire, but baking seems to be the most common method of preparation.”
- “Lamprey[s] are considered a delicacy and a high percentage of their body weight is edible and eaten by tribal members.”

A lamprey can lose up to 20 percent of its weight when spawning. This should naturally reduce their body burden of PCBs before being harvested. However, PCBs can further be reduced depending on preparation methods. Recommendations for reducing exposure to PCBs can be found on OHA’s website. These are similar to those used by the tribal members: <https://www.oregon.gov/oha/PH/HEALTHYENVIRONMENTS/RECREATION/FISHCONSUMPTION/Pages/Fish-and-PCBs.aspx>

* OHA did not convert whole-body data to fillet-only data due to the physical characteristics of lamprey such as a high lipid content and a high percentage of body weight that is edible.

† A meal is about the size and thickness of you or your child’s hand. Adults = about 8 oz and a child = about 4 oz.

‡ OHA always calculates the effects of Hg on general and vulnerable populations. OHA also calculates the additive effects of mercury and PCBs because they have similar health effects.

Advisory focus

This advisory and technical report applies only to the harvesting of lampreys.

OHA advises fishers of the Columbia River touching Oregon and tributaries to the Columbia River in Oregon to go the OHA fish advisory webpage for advisories about other fish. That webpage is HealthOregon.org/fishadv.

For advice on the types of fish people can purchase and eat to reduce their exposure to contaminants, refer to EPA's Choose Fish and Shellfish Wisely webpage: http://water.epa.gov/scitech/swguidance/fishshellfish/outreach/advice_index.cfm.

Limitations

There is very little, if any, information available about the difference in tissue concentrations in non-overwintered lamprey versus overwintered lamprey. The difference in the amount of contamination in these two groups could be significant since overwintered lamprey can lose as much as 20 percent of their weight (including shrinkage of organs before harvesting). The data available from CRITFC did not distinguish between non-overwintered lamprey and overwintered adults. OHA assumes that composite samples included a random distribution of both. If that is the case, then the meal recommendations in this advisory are protective if harvesters also eat a random distribution of fresh non-overwintered and overwintered lamprey. OHA is less certain if these recommendations are protective if harvesters preferentially and consistently eat one type or the other throughout their lives.

Adjustments for meal preparation methods

OHA did not adjust PCB concentrations to account for meal preparation methods or the removal of organs that can reduce the amount of PCBs consumed. This is because, according to CRITFC fisheries staff, 90-95 percent of the lamprey (body and organs) is eaten. Also, baking seems to be the most common method of preparation. Therefore, this makes meals calculated using this adjustment an underestimate of exposure.



PUBLIC HEALTH DIVISION
Environmental Public Health Section
800 NE Oregon Street, Suite 640
Portland, OR 97232
ehap.info@dhsoha.state.or.us
971-673-0440

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