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Technical Report:

Oregon Statewide Bass Fish Consumption Advisory Due to Mercury Contamination

Oregon Health Authority

PUBLIC HEALTH DIVISION

Acknowledgments

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Background

Currently, the Oregon Health Authority (OHA) has mercury advisories in place for 16 water bodies in Oregon, 15 of which have resident largemouth (LMB) and/or smallmouth (SMB) bass populations with some of the highest mercury concentrations. Bass fishing across Oregon is a popular recreational activity. In addition to recreational fishers, many subsistence fishers eat bass on a regular basis. LMB and SMB can live a long time, which equates to a longer-term exposure to contaminants present in the water, including mercury. They are also considered a top predator, eating other mercury-contaminated fish within the ecosystem. The longer they live, the more mercury they accumulate. Top predators such as bass, yellow perch and northern pike minnow tend to be much higher in mercury content than other, less predatory fish.

OHA is concerned about mercury found in water because microorganisms in aquatic systems convert inorganic mercury into methyl mercury (MeHg). MeHg is a known neurotoxicant that bioaccumulates in fish tissue and over time has the potential to cause adverse human health effects such as damage to organs, the nervous system and reproductive system. MeHg is likely present in all water bodies in Oregon, and an estimated 90% of mercury in fish tissue is MeHg.(1,2) This is the reason total mercury in fish tissue is used as a surrogate for MeHg when calculating health risks associated with consumption of mercury-contaminated fish and in the development of fish advisories for mercury. OHA believes using total mercury is necessary to provide the level of confidence needed to protect public health, especially among infants, women of childbearing age, those who are pregnant or breastfeeding, and children who may be at higher risk of the health effects.

Fish consumption advisories are issued when fish tissue data collected and analyzed verifies a particular contaminant, in this case MeHg, is over Oregon's target analyte screening value. This means this contaminant is high enough to be of concern to human health if fish contaminated with MeHg are not consumed in moderation. Table 1 displays the screening values used by OHA when determining if the concentration of MeHg found in fish tissue is a health risk.

Table 1. OHA standard operating guidance - Target analytes for Oregon's fish advisory program

Circumstance	Form	Oral reference dose1 (mg/kg-day)	Screening value (mg/kg fish tissue)
Metals		**Used in calculating meal recommendations**	
Mercury (at-risk population)[2]	MeHg	0.0001	0.2
Mercury (general public)[3]	MeHg	0.0003[4]	0.6

[1] Unless otherwise noted, all oral reference doses are from EPA's Integrated Risk Information System (www.epa.gov/IRIS/)
[2] At-risk population: infants, children, and pregnant or breastfeeding women
[3] General public excluding at-risk population (defined above)
[4] This value is based on an older IRIS value for MeHg based on studies in otherwise healthy adults. This value is used by fish advisory programs in California, Washington and Idaho.

Screening values were developed from the listed RfD assuming 4 eight-ounce fish meals per month using the equation below:

$$SV = \frac{RfD \times BW}{IR \times CF}$$

Where:

SV = Screening value (mg/kg)
RfD = Oral reference dose (mg/kg-day)
BW = Body weight (70 kg for all but mercury which used 60 kg for pregnant women)
IR = Intake rate of fish (30 grams per day)
CF = Unitless conversion factor (0.001) to convert grams of fish to kilograms of fish

Rationale for statewide advisory

OHA is issuing a statewide advisory for mercury in bass because environmental conditions are such that MeHg is certainly present in recreational waters across the state and can therefore bioaccumulate in the fish that live in these waters. Bass is a predatory species that prey on other fish in the same environment. This predatory behavior can increase the amount of mercury bass are exposed to and bioaccumulate in their tissue. This bioaccumulation can cause an increase in mercury in bass above that of other non-predatory fish species. Bass is also the target fish for this advisory because they are found across the state in many popular fishing waters and the available data for mercury in bass was adequate enough to issue an advisory. This advisory, once issued, will provide health protection for bass fishers and the public on all water bodies, including those that have not been monitored and do not have a specific advisory.

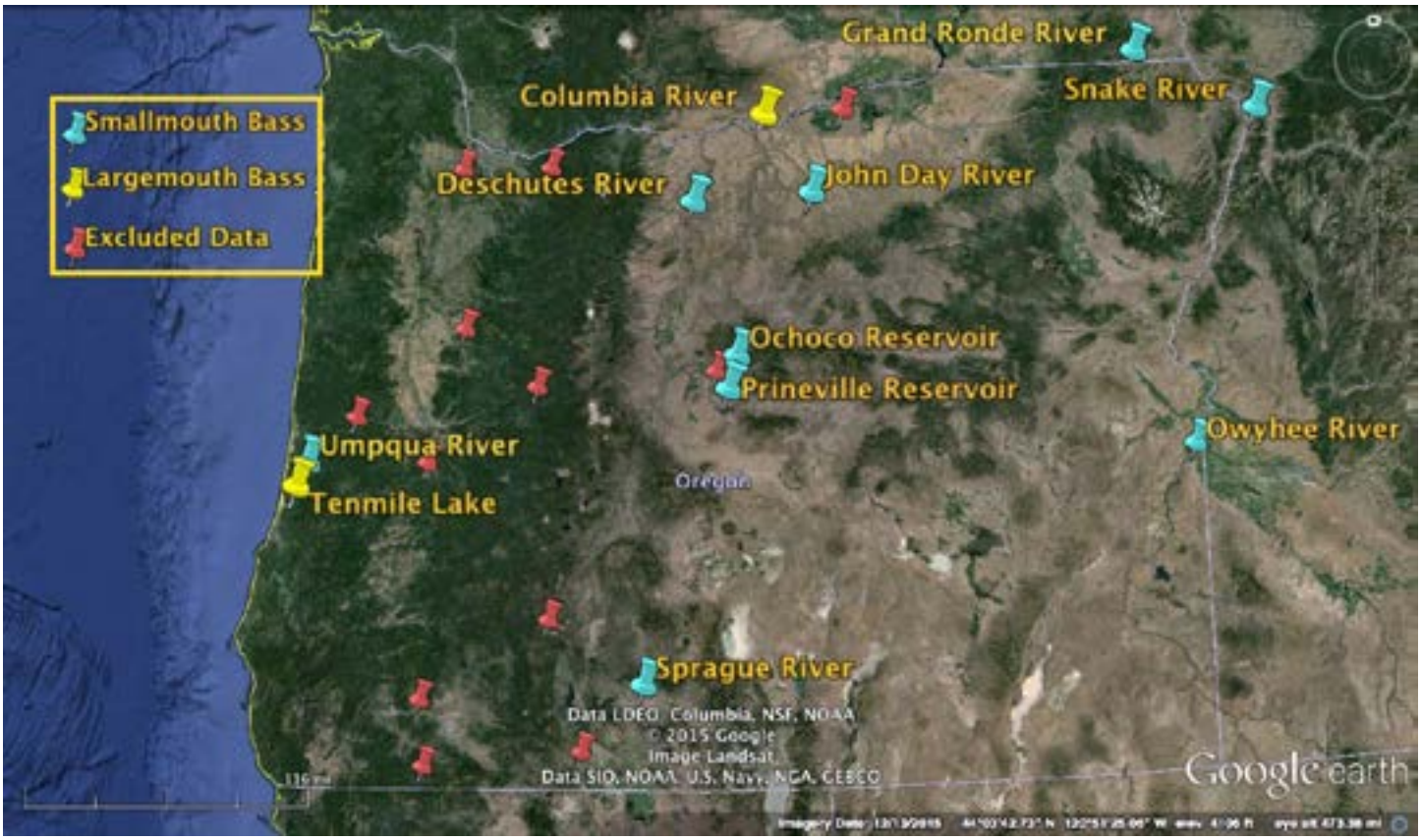
OHA's responsibility when data is available is to evaluate contaminant concentrations in fish tissue, to calculate the number of meals per month that can safely be consumed and to provide information to the public through an advisory. This advisory is not a rule or law, therefore meal recommendations are not mandatory and OHA does not have the authority to require the public consume only those levels calculated. We provide the best information currently available that people need to reduce their exposure to a given contaminant, and rely on the public to use the information when consuming fish listed in an advisory. If people choose to eat more than the recommended meal amounts listed, that is their individual choice.

Assessment

Data compilation

The Oregon Department of Environmental Quality (ODEQ), the U.S. Environmental Protection Agency (EPA) and the National Parks Service (NPS) supplied data sets on mercury concentrations in fish tissue. Most of the data used for this advisory were originally collected for DEQ's Toxics Monitoring Program (3) and EPA's National Rivers and Streams Assessment.(4) Sampling events ranged from 2008–2014 and included the following water bodies for the combined data set of LMB and SMB: Ten Mile Lakes, the Columbia, Umpqua, Snake, Sprague, John Day, Owyhee, and Grand Ronde rivers, and Ochoco and Prineville reservoirs (see Figure 1 for locations). Quality assurance project protocols (QAPP) were required for each data set to justify their use in the statewide fish advisory. These QAPPs include sampling protocols, quality assurance and control procedures, and data code definitions and qualifiers. Data sets without QAPPs were not used because they lacked some of the following information: species identification, sampling protocol, sample type, sample tissue matrix, and units or sampling locations. Contacts at the Oregon DEQ and EPA supplied QAPPs for those data sets used.

Figure 1. Sampling locations. Yellow pins represent LMB, light blue SMB and red excluded data



Note: Sampling locations and events were mapped regionally using latitude and longitude when available and a pin dropped to mark the site. This is especially important for rivers where fish populations can migrate greater distances. For lakes, sampling events without coordinates were approximated based on the location of the water body.

Data analysis

Mercury concentrations in SMB and LMB from 2008 to 2014 were analyzed. Sixty-two data sets comprised the entire data set used for the consumption advisory (46 from SMB and 16 from LMB). SMB sampling occurred primarily in Eastern Oregon (Snake, Sprague, John Day, Owyhee, Grande Ronde and Umpqua rivers, and Ochoco Reservoir). LMB sampling occurred in Western Oregon (Ten Mile lakes and the Columbia and Umpqua rivers). Total mercury data reported from the National Rivers and Streams Assessment was measured for composite samples and adjusted in the data set to reflect the number of fish in the composite. The remainder of the samples analyzed from all other data sets were individual fish.

OHA calculated the mean concentrations of mercury in two ways as per the methods used by Idaho and Washington for their respective advisories.(5,6) OHA calculated the average of all data sets combined using the Idaho method, giving more weight to water bodies with more data. OHA used the Washington method to incorporate the average mercury concentrations in fish tissue by water body first, then averaged those data to get a statewide average. OHA used both methods in their calculations of the average total mercury concentration per fish, compared the average concentration using each method and used the higher (more restrictive) estimate when calculating the recommended number of meals per month for the statewide advisory. This was done to provide a meals-per-month recommendation that would be maximally protective of public health. These averages are listed in Table 2.

Future testing data will be integrated into the existing dataset as more fish tissue data become available. Although OHA focused on bass for this advisory, compiled data on other fish species could be used for individual advisories, as data and topographical characteristics warrant.

Table 2. Average total Hg concentration per fish, by water body, Oregon, 2008–2014

Species	Water body	Average total mercury concentration per fish (mg/kg)	Number of fish sampled
SMB	1	0.63	10
SMB	2	0.08	4
SMB	3	0.30	13
SMB	4	0.67	10
SMB	5	0.33	2
SMB	6	0.47	2
SMB	7	0.26	1
SMB	8	0.47	4
SMB	AVG by water body (Washington method)	0.40	46
SMB	AVG of all data (Idaho method)	0.46	46
LMB	8	0.46	4
LMB	9	0.86	10
LMB	10	0.46	2
LMB	AVG by water body (Washington method)	0.59	16
LMB	AVG of all data (Idaho method)	0.36	16
SMB and LMB	AVG by water body (Washington method)	0.50	62
SMB and LMB	AVG of all data (Idaho method)	0.41	62

Note: Values rounded to second post-decimal, non-zero digit. All digits used in calculations.
SMB = Small-mouthed bass; LMB = Large-mouthed bass

Calculation of meal recommendations for statewide fish consumption advisory

Mercury comes from both natural and manmade sources and is found in most water bodies in Oregon. Because unsafe levels of mercury have been found in fish tissue from numerous water bodies where fish have been sampled, OHA determined a statewide fish advisory was appropriate and necessary to be protective of public health. Fish are a nutritious food source, but bass and fish of similar trophic levell across the state have accumulated enough mercury to be harmful to health if not eaten in moderation. The statewide advisory is limited to bass because it is the only species for which there are adequate data from across the state to inform such an advisory. **Babies and children are most at risk. It is especially important that children, women who are or might become pregnant and nursing mothers follow advice for higher risk populations.**

Following is the equation used to calculate the number of meals per month that can be safely consumed, based on mercury data from Table 1.

$$\text{Meals per month} = \frac{BW \times 30.44\ days/month}{0.227kg\ fish/meal} \times \frac{RfD}{C_{Hg}}$$

Table 3. Description of values used in equation

RfD	Oral reference dose, the maximum estimated oral dose of mercury that is likely to be without an appreciable risk of deleterious effects (mg/kgBW-day*). The RfD value for mercury is 0.0003 mg/kgBW per day for the general population and 0.0001 mg/kgBW per day for higher risk populations.
BW	Person's body weight (kg); Assumed to be 70 kg
C_{hug}	Concentration of mercury, in mg/kg fish tissue, wet weight

Results

Using mercury concentration averages from Table 1, OHA calculated statewide recommendations for the maximum number of meals per month for the general public, and for higher risk populations, including infants, children, and pregnant or breastfeeding women. These recommendations were calculated in two ways:

1. Averaging meal limit data from each body of water; and
2. Averaging all the available statewide meal limit data.

The final meal limit recommendation was based on the most health-protective of these estimates. The average by water body for LMB and SMB was therefore used for the advisory. The statewide bass consumption advisory, based on this method, is six meals per month for the general public and two meals per month for higher risk populations. (See Table 4).

Oregon's meal recommendations are consistent with both the current Idaho and Washington advisories referenced.

Table 4. Maximum meals per month recommendations

Species	Water body	Maximum meals per month	
		General public	Infants, children, and pregnant or breastfeeding women
SMB	1	4	1
SMB	2	35	12
SMB	3	9	3
SMB	4	4	1
SMB	5	9	3
SMB	6	6	2
SMB	7	11	4
SMB	8	6	2
SMB	AVG by water body (Washington method)	7	2
SMB	AVG of all data (Idaho method)	6	2
LMB	8	6	2
LMB	9	3	1
LMB	10	6	2
LMB	AVG by water body (Washington method)	5	2
LMB	AVG of all data (Idaho method)	8	3
SMB and LMB	AVG by water body (Washington method)	6	2
SMB and LMB	AVG of all data (Idaho method)	7	2

Note: Values rounded to nearest whole number for communication purposes. All digits used in calculations. Same body weight (70kg), reference doses and guidance used to calculate allowable consumption rates. A meal = 8 ounces (0.227 kg).

Dealing with differences in per month meal recommendations

Differing meal recommendations on water bodies is not unusual since both environmental conditions and fish species differ across the state. In the case of mercury, some water bodies are affected by local and regional sources of mercury, while others are not, but both are equally affected by the global emission of mercury.

The statewide advisory and recommended meal allowances cover those water bodies that do not currently have an individual advisory in place for resident fish, to include bass. For a water body with an existing advisory you need to refer to the advisory table located at http://HealthOregon.org/fishadv. The recommended meal allowances for these individual water bodies should be followed in place of the statewide meal allowance of six and two.

Limitations

Several data sets reviewed for this advisory were excluded from the analysis due to missing or non-existent QAPPs, incomplete information or more than 20 years passed since data were collected. Some of the applied data sets were very small and below the number of fish that could be used for individual advisories. These data sets were combined with other data in calculating meal recommendations for bass statewide. The smaller sets could have affected the overall meal allowance recommendation by increasing the number of recommended meals. However, since the recommendations are within the average range of current advisories for other water bodies and fish, OHA is confident they are protective of human health.

Our use of the arithmetic mean assumes that fishers, over a lifetime, will catch a random distribution of fish across an entire water body covered by an advisory, or in this case across the entire state. This may or may not reflect the actual practice of fishers on a given water body or at multiple water bodies, as when fishing on multiple rivers. It is possible that a fisher consistently fishing in one particular spot or on one particular water body over a lifetime could get fish consistently higher or lower than the mean used to calculate this advisory.

Discussion

The available data sets used for the advisory maximum meal recommendations of six per month for the general public and two per month for higher risk populations as outlined in Table 3 above represent the most consistent health-protective recommendations possible. OHA will evaluate those data and update this advisory, as necessary should more mercury data from across the state become available in the future.

Future advisories and data

QAPPs are available for the data used in this advisory. Quality control will remain consistent and QAPPs will be obtained for sampling data added to the existing data set in the future. It was not always possible to obtain QAPPs with older data sets. Because QAPPs were not always available, fewer data sets were available when calculating Oregon's statewide consumption values than those in Washington and Idaho to inform their advisories. Washington and Idaho had approximately 180–200 data sets across the state, while Oregon could only rely on 62.

Fish tissue data on several water bodies in parts of Oregon were not used in meal consumption calculations, as they did not meet the data quality criteria developed even though those data showed levels of mercury of concern to human health (see Figure 1). This unused data did support a statewide advisory to reduce exposure to mercury on all water bodies across the state where mercury is certainly present.

More data need to be collected and analyzed to improve the reliability of human health recommendations. OHA does not have the expertise to conduct fish tissue sampling and must rely on other state and federal agencies and groups to provide data to inform advisories or to update those already in place. OHA has begun and will continue to make every effort to coordinate with agencies so when fish tissue sampling plans are developed and monitoring is performed, the data collected and analyses will be more representative of how contaminants of concern will affect human health. It will be an integral part of the process to justify integration of the data into any new consumption advisories or updates to existing advisories as the program moves forward.

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www.usbr.gov/mp/ccao/newmelones/planning-visit/fish.html

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