Fish Consumption Advisory Standard Operating Guidance (SOG)
Oregon Health Authority (OHA) Fish Advisory Program

Goal

The goal of Oregon Health Authority's Fish Advisory Program is to provide information to people who eat fish from local waterbodies. The information enables people to enjoy the health benefits of eating fish in amounts that protect them from harm due to environmental contaminants in the fish. OHA strives to provide this information in ways that are accessible, culturally sensitive and tailored to the communities that need it most.

Purpose

Fish study specialists will use this guidance when evaluating fish tissue contaminant data, making advisory decisions, and communicating health risks associated with consumption of fish contaminated with environmental toxicants. OHA does not collect or analyze fish tissue samples, however, we often receive fish tissue contaminant data from partner agencies that collect and analyze these types of samples.

This guidance protocol outlines the steps to follow when evaluating fish tissue contaminant data to determine potential risks to human health and the need for fish consumption advisories that address safe eating guidelines. Other guidance used in creating fish consumption advisories include the Fish Monitoring SOG (Appendix A) and *Target Analytes for Oregon's Fish Advisory Program* (Appendix B).

The following steps will ensure that the fish study specialist addresses each advisory meal recommendation using the best technical knowledge available along with the combined expertise of the fish advisory team.

1. **Sampling and fish Tissue analyses**

    1.1 Obtain fish tissue data from program partners, published data, and other sources.
    1.2 Review data to ensure fish collection and analysis procedures were followed in accordance with the Fish Monitoring SOG (Appendix A) and/or EPA guidelines (http://water.epa.gov/scitech/swguidance/fishshellfish/techguidance/risk/volume2_index.cfm).

1.3 For each fish species studied, run a basic statistical analysis (min, max, mean, median, and standard deviation) on each contaminant for each discreet geographic location (lake or defined stretch of river).

1.3.1 Individual fish sample datasets (whole or fillet):

1.3.1.1 Calculate the arithmetic mean.

$$Arithmentic\ mean\ = \frac{\sum measured\ concentrations\ (c)}{number\ of\ fish\ (N)}$$

1.3.1.2 Calculate Standard Deviation.

$$Standard\ Deviation\ = \sqrt{\frac{\sum(c - mean)^2}{N - 1}}$$

Or use STDEV function in Excel or equivalent function in statistical software

1.3.1.3 Chart fish size vs. contaminant concentration

1.3.2 Composite samples (whole body or fillet) or data sets with a mixture of composite samples and results for individual fish samples:

1.3.2.1 Calculate a grouped mean. Multiply the concentration of each sample (c) by the number of fish in the composite (n). When individual fish samples are included in the dataset, (n) = 1 for those individual samples. Then sum (∑) all multiplied composite (and/or individual) values and divide by the total number of fish in the dataset (N) (not the number of composite samples). *This method gives more weight to composite samples that contain more fish*.

$$Grouped\ mean\ = \frac{\sum cn}{N}$$

1.3.2.2 Calculate standard deviation:

$$Standard\ Deviation\ = \sqrt{\frac{\sum c^2 n - (\sum(cn)^2)/N}{(N - 1)}}$$

2 Risk Assessment

Limit advisories to non-cancer health effects as cancer risk models are more likely to over-estimate risk. Over estimating risk causes consumers to unnecessarily forgo the health benefits of eating fish. When calculating risk and meal consumption limit calculations, use toxicity values from Target Analytes for Oregon's Fish Advisory Program (Appendix B).

2.1 Identify fish species (native and non-native) found in the water body. Differentiate hatchery raised fish (stocked by ODFW) from native fish of the same species, using ODFW identifiers (mainly adipose fin clipping).

2.2 Determine if migratory fish are land locked (i.e., by a dam or other structure). If so, they are considered resident fish.

2.3 Compare mean concentration for each contaminant and fish species with its screening value from the *Target Analytes for Oregon's Fish Advisory Program* document (Appendix B). Consult a toxicologist about contaminants not included in the *Target Analytes* document.

2.4 Identify target populations if known (i.e., who is likely to be catching and eating the fish? Who are the most vulnerable?)

2.5 Use body weights of target populations in calculations if known (if unknown use default values from EPA guidance [70 kg])

2.6 Calculating recommended monthly meal limits for single or multiple contaminants with mean concentrations within a factor of 10 of the screening values.

2.6.1 Equation for use with a single contaminant:

$$Meals\ per\ month\ = \left(\frac{BW \times 30.44 \frac{days}{month}}{0.227\ \frac{kg\ fish}{meal}} \right) \times \frac{RfD}{C}$$

Where:

RfD = Oral reference dose or other toxicity value from the *Target Analytes for Oregon's Fish Advisory Program* document (Appendix B) (milligrams contaminant per kilogram body weight per day [mg/kg-day])

BW = Body weight (kg); assume 70 kg if site-specific information is not available

C = Mean concentration of contaminant, measured as mg contaminant per kg fish tissue (wet weight) (mg/kg)

2.6.2 Equation for use with multiple contaminants: This equation accounts for additive toxicity of multiple contaminants for each fish species and size class.

$$Meals\ per\ month = \left(\frac{BW \times 30.44\ days/month}{0.277\ kg\ fish/meal}\right) \times \frac{1}{\sum_{m=1}^{x} \frac{C_m}{RfD_m}}$$

Where:
RfD_m = Reference dose or toxicity value for contaminant *m*
C_m = Mean concentration of contaminant *m*
BW = same as above

Note: *Toxicity from multiple contaminants should only be added together if the contaminants target the same organ system or have similar health effect (e.g.: toxicity from PCBs and mercury can be added together because both target fetal brain development. Toxicity from individual PFAS chemicals should also be added).*
If unsure about a specific combination of contaminants, consult a toxicologist or look up the endpoint used in the critical study for a given contaminant in EPA's Integrated Risk Information System (www.epa.gov/IRIS).

2.7 Round to nearest whole meal when post-decimal digit is 5: if the second digit is an odd number (i.e., 2.53) round up, if it is an even number (i.e., 2.54) round down.

2.8 Identify risk-driving contaminant or risk driving combination of contaminants (this is the contaminant associated with most restrictive recommended meal limit)

2.9 Whenever mercury is among the risk-driving contaminants, two sets of meal recommendations should be calculated – one for vulnerable populations and one for everyone else. Use the two RfDs listed for mercury in the *Target Analytes for Oregon's Fish Advisory Program* document (Appendix B) as the basis for the different meal limits and refer to the guidance document *Technical Memo on the Use of an Alternate Toxicity Value for Methylmercury Applied to Healthy Adults* (Appendix C)

2.10 Lipophilic contaminants like PCBs, dioxins/furans, and organochlorine pesticides primarily accumulate in the fatty portions of the fish. Studies have shown that removal of skin and internal

organs can reduce the concentration of lipophilic contaminants measured in the whole body of the fish by 50%. If the fish tissue data used were analyzed as whole-body, then prior to calculating recommended meal limits the mean concentrations of lipophilic contaminants should be divided by 2. This will account for the fact that most people remove internal organs when preparing fish to eat. Support for this approach can be found here: (https://www.fish.state.pa.us/images/fisheries/fcs/pcb_fishtech.pdf) and in Appendix C of EPA's Guidance on Chemical Contaminant Data for Use in Fish Advisories Volume 2 (http://water.epa.gov/scitech/swguidance/fishshellfish/techguidance/risk/volume2_index.cfm).
Hardcopies of these documents can be found by asking a toxicologist. In addition to the support from these two documents, the Washington Department of Health also applies this 50% reduction factor to whole-body data for lipophilic contaminants.

2.11 If the recommended meal limit for the risk-driving contaminant or combination of contaminants is five or less 8-ounce meals per month, consider issuing an advisory following guidance in section 3.0. If it is more, meal limits can be added to the Safe Eating Guidelines following the guidance in section 4.0. If the advisory is for a species of particular significance, OHA may decide to issue an advisory regardless of the meal limits unless the number of meals is sizable.

2.12 Make general meal limit recommendations across species of similar trophic levels (e.g., recommended meal limits for smallmouth bass should be used for all top predator, non-migratory, warm water fish such as largemouth bass, northern pike minnow, yellow perch, etc.).

Note: *Based on data from Phillips Reservoir and information from ODFW biologist Dan Van Dyke, yellow perch likely have mercury concentrations as high as bass if not higher due to this species predatory nature. Therefore, yellow perch should be evaluated on the same trophic level as bass whenever both species are present in the same water body and bass have been sampled.*

Bluegill and crappie are considered "panfish" and are mid-low level predators. They typically have significantly lower mercury levels than bass and other high level predator species.

3 Fish Consumption Advisories

When the calculated meal limit is 5 meals/month or less a health advisory is issued, and the following actions taken:

- 3.1 Summarize recommendations in a technical report
  - 3.1.1 Date
  - 3.1.2 Title with type of fish, geographic location and risk-driving contaminants identified
  - 3.1.3 Water body background information – include formal and common water body names, location with respect to nearest municipality or commonly recognized landmark, county/counties of locale, fishery information (including native and non-native species present and stocking information from ODFW), information on why the study was conducted and by which agencies
  - 3.1.4 Assessment
    - 3.1.4.1 Sample collection summary – include the number and type of samples (composite vs. individuals), sample matrix (fillet, whole fish, etc.), species of fish, size classes, sample locations and sample collection dates
    - 3.1.4.2 Results of statistical analysis in section 1.3
    - 3.1.4.3 Risk assessment summary from sections 2.1 – 2.11
    - 3.1.4.4 Results- include the proposed allowable daily and monthly meal limits for each affected population associated with each fish species and size class and for each specified risk-driving contaminant (from section 2.8)
    - 3.1.4.5 Discussion and summary – include meal limit recommendations in a narrative, or in tabular format if there are multiple recommendations. Discuss data limitations and recommendations for improving future studies. Always highlight potential policy implications
- 3.2 Compile stakeholder list – Name, phone number and email of contacts if possible (separate document from the rest of the technical memo). List should include at a minimum:
  - 3.2.1 Media
  - 3.2.2 Technical contacts, to include other state or federal agencies with an interest in the advisory

3.2.3 County health department(s) responsible for the area(s) covered by the advisory
3.2.4 Tribes with fishing rights in the area
3.2.5 Any local fishing organizations known to fish in the area

3.3 Technical report feedback and action

3.3.1 Solicit feedback from internal and external program partners.
3.3.2 Incorporate feedback, as applicable and document actions to be taken in the Technical Report.
3.3.3 Submit report to section manager for approval and to others as necessary.

3.4 Risk and Tribal Communications

3.4.1 Follow the steps outlined in the Fish Advisory Procedures Checklist to ensure necessary risk and Tribal communications are performed. The checklist will guarantee that key internal and external stakeholders, the nine federally recognized Tribes in Oregon, and the Tribes and Tribal Nations in Washington and Idaho have an opportunity to review documents and participate in the process. The checklist also outlines the steps OHA takes to inform the public of important information on fish consumption that can help to reduce exposure to contaminants in fish and shellfish, when data is available.
3.4.2 Discuss with local water body managers recommendations for sign posting. Work with the manager to develop and create signage that would alert fishers to an applicable advisory and where to go to get additional information about species and meal consumption recommendations.

4 Safe Eating Guidelines

When the calculated meal limit is between 6 and 22 meals/month, a safe eating guideline is developed, and the following actions taken:

4.1 Summarize recommendations in a Technical Report according to 3.1
4.2 Incorporate feedback and take necessary action related to the technical report according to 3.2 – 3.3)
4.3 Post safe eating guidelines on website within table to ensure public risk communication occurs

5 Lifting an Advisory

If new data indicate that an advisory can be lifted, reclassify the advisory as

a safe eating guideline. Follow the steps described in section 3 including the Risk Communication section described in section 3.4.

Note: *More than 22 meals/month is considered "unlimited" and no number is associated with this amount.*

Revision summary:

December 2014 revisions are most apparent in Sections 1.3, 2.3, and 2.6. Revisions included addition of equations for calculation of means, variance, and standard deviation for different types of data sets including those that contain composite samples. December revisions also included addition of guidance for accounting for additive toxicity among mixtures of contaminants in fish tissue when calculating recommended meal limits.

November 2021 revisions are most apparent in Section 3.4 and Appendix B. Revisions included:

- A rewrite of section 3.4 that directs staff to the Fish Advisory Procedures Checklist where a complete list of steps involved in risk and Tribal communications are outlined.
- Appendix B revision to include congener specific analysis of per- and polyfluoroalkyl (PFAS) substances to the list of target analytes with reference doses and screening levels.

Appendix A

FISH MONITORING STANDARD OPERATING GUIDANCE (SOG)
Guidance for the Oregon Health Authority (OHA) and its partners.

October 11, 2010

This document will guide the OHA fish advisory program and its partners in designing and implementing fish tissue studies that generate data appropriate for use in developing human health fish consumption advisories. We encourage our partners to consult with us before and during the study design processes. However, this SOG may also be used by monitoring crews on site to alter or add to the fish study design based on the lack of/or availability of various fish species.

1. Select **waterbody sites** for fish sampling based on the following factors.

    1.1. *Contaminant(s) of concern* known or suspected in the waterbody.

    1.2. Prior sampling found fish tissue with *contaminant(s) of concern* at, or above screening values (SVs) as established according to the *Fish Consumption Advisory SOG.*

    1.3. Waterbody is heavily fished.

    1.4. Possible changes in fish contaminant levels in a waterbody through time may change advisory status.

    1.5. Need additional data for waterbodies where no contaminant concentrations exceeded the SVs to establish areas of unrestricted fish consumption or “green areas.”

2. Maintain continuity and uniformity in the fish **sample species** collected for fish consumption studies.

    2.1.The EPA recommends that studies collect one bottom-feeding fish species and one predator fish species at each site.

        2.1.1. Examples of bottom-feeding fish include carp, catfish, and sucker.

        2.1.2. Predator fish preferring warm water habitats include large/smallmouth bass, crappie, walleye and sunfish.

2.2. Salmonids prefer relatively cold-water environs and are used infrequently in Oregon fish studies. Anadromous fish such as salmon, steelhead, lamprey, smelt and shad do not reflect local contamination as they spend very little time in local streams and only during spawning.

2.3. Consult ODFW and/or the reservoir manager for known species of fish caught and consumed from each waterbody.

3. The **size of fish** collected for analyses should reflect the size of fish caught and subsequently eaten from each waterbody.

4. **Analyses of fish** should reflect the type of tissue considered to be most healthful for human consumption.

   4.1. Prepare composite fillet samples (skin on, belly flap included) for each target fish species. For scaleless species, use skin-off fillets.

   4.2. A composite sample of five fish in each of three size ranges is desirable. ODFW and/or other fishery management may be able to provide the size range of fish found in the waterbody. The smallest fish in each composite should not be more than 25% shorter than the largest in the composite and must meet ODFW's minimum size requirement for the waterbody. If possible, collect at least one replicate sample for each target species.

5. Request a **Quality Assurance Project Plan** (QAPP) for the fish collection and analyses from the partner(s) providing this work. It should cover the following standard field work.

   5.1. Sample collection procedures,

   5.2. Recordkeeping and chain of custody, and

   5.3. Sample processing, preservation, and shipping

   5.4. The QAPP should also identify technically sound analytical methods and QA and QC procedures including

      5.4.1. Detection limits capable of measuring tissue concentrations at or below SVs (OHA will make these numbers available to the participating laboratory.

5.4.2. Procedures for data analysis and reporting of fish contamination data (i.e., wet weight for mercury concentrations).

Appendix B

Target Analytes for Oregon's Fish Advisory Program

Chemical	Form	Oral Reference Dose[1] (mg/kg-day)	Screening Value (mg/kg fish tissue)
Metals			
Arsenic	Inorganic	0.0003	0.7
Cadmium		0.001	2.3
Mercury (Vulnerable Populations)[2]	Methylmercury	0.0001	0.2
Mercury (General population)[3]	Methylmercury	0.0003[4]	0.6
Selenium		0.005	11.7
Tributyltin		0.0003	0.7
Organochlorine Pesticides			
Aldrin		0.00003	0.07
Chlordane	total (cis- and trans-chlordane, cis- and trans-nonachlor, oxychlordane)	0.0005	1.2
DDT	total (2,4'-DDD, 4,4'-DDD, 2,4'-DDE, 4,4'-DDE, 2,4'-DDT, 4,4'-DDT)	0.0005	1.2
Dicofol		0.0004	0.9
Dieldrin		0.00005	0.1
Endosulfan	I and II	0.006	14
Endrin		0.0003	0.7
Heptachlor Epoxide		0.00001	0.03
Hexachlorobenzene		0.0008	1.9
Lindane	γ-hexachlorocyclohexane; γ-HCH	0.0003	0.7
Methoxychlor		0.005	11.7
Mirex		0.0002	0.5

[1] Unless otherwise noted, all oral reference doses are from EPA's IRIS program (http://www.epa.gov/IRIS/)
[2] Vulnerable populations are children and women of childbearing age
[3] General public excluding vulnerable populations (defined above)
[4] This value is based on an older IRIS value for methylmercury, which was based on studies in otherwise healthy adults. This value is used in this way by state fish advisory programs in California, Washington, and Idaho. See Technical Memo on the Use of an Alternate Toxicity Value for Methylmercury Applied to Healthy Adults.

Chemical	Form	Oral Reference Dose[1] (mg/kg-day)	Screening Value (mg/kg fish tissue)
Toxaphene[5]		0.002	4.7
Organophosphate Pesticides			
Chlorpyrifos		0.0003	0.7
Diazinon		0.0007	1.6
Disulfoton		0.00004	0.09
Ethion		0.0005	1.2
Terbufos		0.00002	0.05
Chlorophenoxy herbicides			
Oxyfluorofen		0.003	7
Polychlorinated biphenyls (PCBs)	Total (sum of congeners)	0.00002	0.05
Dioxins/furans	TEQ	0.0000000007	1.6 (ng/kg)
Brominated flame retardants	Congener-specific analysis		
BDE-47		0.0001	0.2
BDE-99		0.0001	0.2
BDE-153		0.0002	0.5
BDE-209		0.007	16.3
Per- and polyfluoroalkyl substances (PFAS)	Congener-specific analysis		
Perfluorooctane sulfonic acid (PFOS)[6]		0.0000041	0.01
Perfluorooctanoic Acid (PFOA)[6]		0.000017	0.04
Perfluorononanoic Acid (PFNA)[6]		0.0000034	0.008
Perfluorohexane sulfonic acid (PFHxS)[6]		0.0000057	0.013
Perfluorobutanoic acid (PFBA)		0.001	2.3
Perfluorobutane sulfonic acid (PFBS)		0.0003	0.7
GenX – hexafluoropropylene oxide (HFPO)		0.000003	0.007

[5] ATSDR's Intermediate Oral Minimal Risk Level (http://www.atsdr.cdc.gov/toxprofiles/tp94-a.pdf); no IRIS value

[6] Oregon Health Authority Provisional Reference Dose, September 2021

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 = Bodyweight (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

Appendix C

Technical Memo on the Use of an Alternate Toxicity Value for Methylmercury Applied to Healthy Adults

December 30, 2013
Approved 1.10.14 by Curtis Cude

Background

Different states use different toxicity values to calculate fish advisories where methylmercury is the risk driving contaminant. The Environmental Protection Agency's (EPA) Integrated Risk Information System (IRIS) provides an oral reference dose (RfD) for methylmercury (0.0001 mg/kg-day) that is based on studies in humans who were exposed to methylmercury by eating contaminated fish. These studies identified the most sensitive human health endpoint as observed impairments in fetal neurodevelopment leading to lifelong cognitive deficits in affected children. However, fish consumption itself confers many health benefits. To allow as much fish consumption as possible, states neighboring Oregon (e.g. Washington, California, and Idaho) use a less restrictive RfD for healthy adults where fetal neurodevelopment is not at risk.

Proposed Change to Toxicity Value Used for Methylmercury in Oregon Fish Advisories

Because the current RfD is based on toxicity studies that are so relevant to fish advisories for children and women of childbearing age, the current RfD of 0.0001 mg/kg-day should be used to calculate fish advisories for these vulnerable populations.

Prior to 1995, EPA's RfD for methylmercury was 0.0003 mg/kg-day (three times higher than it is today). This older value was based on toxicity endpoints relevant to otherwise healthy adults instead of fetal developmental endpoints [as reviewed in (CalEPA, 2008)]. This makes the older RfD more relevant for healthy adults not carrying developing fetuses and the current RfD more relevant for children and women of childbearing age where neurodevelopment may still be ongoing (CalEPA, 2008). California, Washington, and Idaho state fish advisory programs all use this old RfD for adult men and women beyond childbearing years.

In practice, this will mean that all fish advisories where methylmercury is the risk-driving contaminant will have two fish consumption recommendations. One recommendation will be for children and women of childbearing years and will be calculated using the current RfD that is based on fetal

neurodevelopment as the toxic endpoint. The second recommendation will be for adult men and women older than childbearing age, and this recommendation will be calculated using the older (pre-1995) RfD of 0.0003 mg/kg-day which is based on toxicity in adults. This change in practice acknowledges that adults have higher tolerance for methylmercury than children and developing fetuses and allows more adults to continue to enjoy the health benefits of fish consumption.

Summary

Toxicity value for vulnerable populations (children and women of childbearing age): 0.0001 mg/kg-day [current RfD]
Toxicity value for adult men and women beyond childbearing years: 0.0003 mg/kg-day [pre-1995 RfD]

Reference

CalEPA (2008). Development of Fish Contaminant Goals and Advisory Tissue Levels for Common Contaminants in California Sport Fish. Available at http://oehha.ca.gov/fish/gtlsv/pdf/FCGsATLs27June2008.pdf