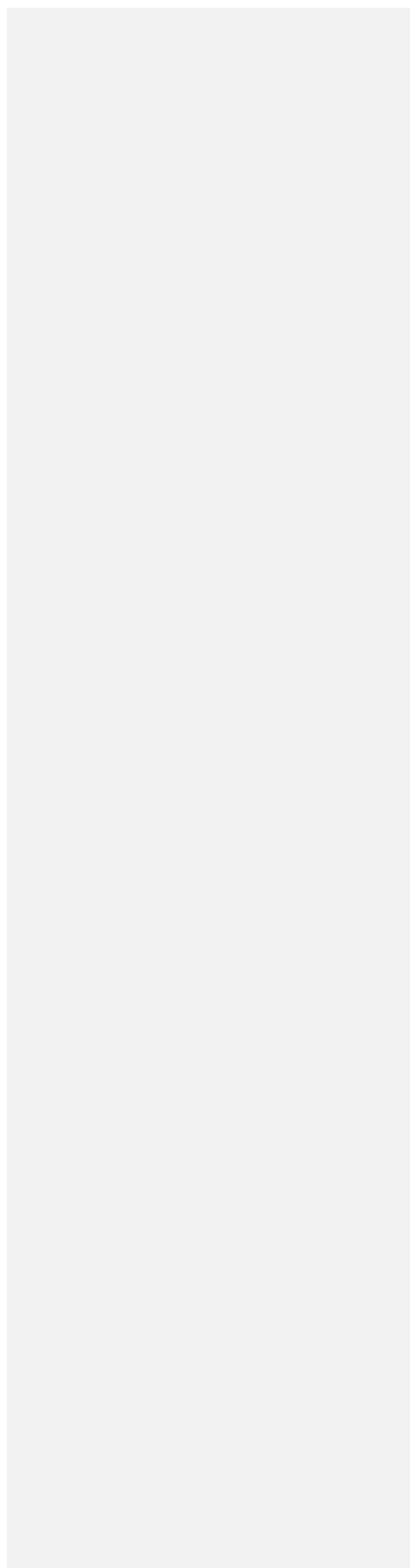
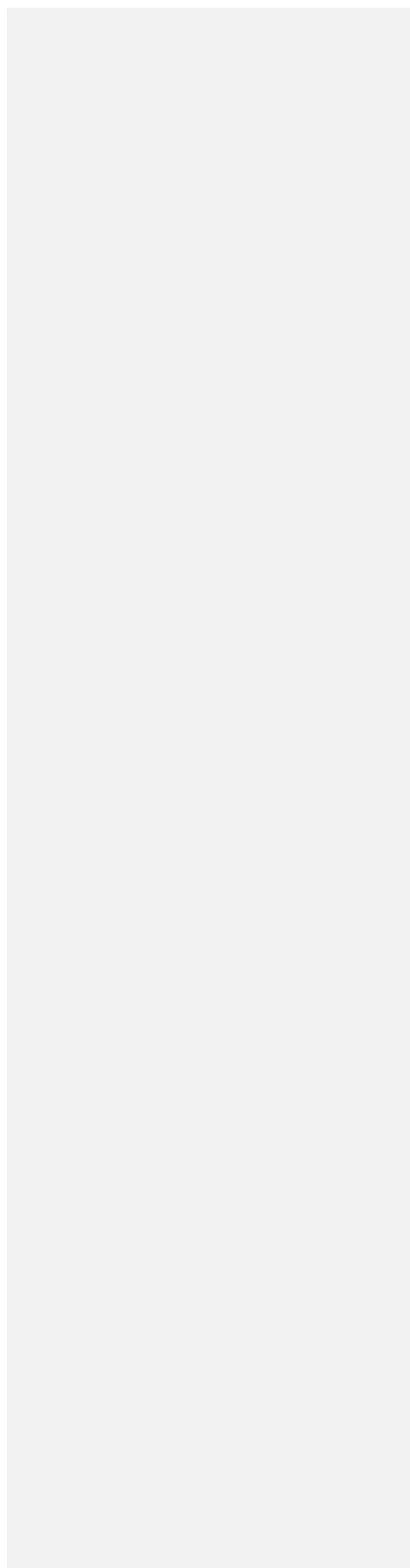


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Assessment of Mercury in Fish Tissue from Select Lakes of Northeastern Oregon

EPA Region 10 Report

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February 2012

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Acknowledgements

This project was *[acknowledge the input of the multiple agency team here]*.....

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ODFW provided field assistance and gear for fish collection at four of the sample lakes. We thank ODFW district biologists Nadine Craft and Ray Perkins for their help. Idaho Power provided gear and assistance for collections on the Powder Arm of Brownlee Reservoir. We thank Idaho Power biologist Tracy Richter for her assistance. Ken Lujan (USFWS), Leigh Woodruff (USEPA) and Michael McLeod and John Anderson (Idaho Power) also helped with fish collection. Jennifer Crawford and Don Matheny assisted with laboratory sample preparation and provided quality assurance technical support.

Abstract

The Environmental Protection Agency (EPA)

ADD AS LAST STEP

Introduction

Results from a recent EPA national modeling effort, REMSAD (REgional Modeling System for Aerosols and Deposition), predicted a significant mercury deposition area in northeastern Oregon (ICF, 2008). Currently, there is a general lack of fish tissue data from lakes and streams in this area. Given the potentially elevated level of mercury deposition and lack of fish tissue data, there is a need to measure mercury concentrations in fish to determine if there is a health risk.

To ensure the continued good health of its citizens, the State of Oregon issues fish consumption advisories for fish in waterbodies that exceed human health thresholds as identified by Oregon Department of Human Services, Oregon Health Authority (OHA, 2010). Fish consumption advisories may be issued to protect the general public or sensitive populations such as women of childbearing age, nursing mothers, pregnant women, and children.

The objective of this study is to determine whether people are at risk of health impacts due to elevated mercury from eating fish from this area and to communicate that information to state and local decision makers and the public. The project is not intended to investigate the sources of mercury in fish.

The main study questions are:

- What are mercury concentrations in the muscle tissue from commonly-consumed fish species in five sample waterbodies of NE Oregon?
- Do those mercury concentrations of mercury pose a human health risk to people who eat the fish?

Fish were collected from five reservoirs in northeastern Oregon in June, 2011, and the tissue was analyzed for mercury. The results from these measurements were determined to be of sufficient quality and quantity to be used in the evaluation of fish consumption advisories.

Study Area and Waterbody Selection

The study area is located in northeastern Oregon, within Union, Baker, and Malheur counties. Baker City and La Grande, along Interstate 84, are the largest towns in the area. Publicly-managed waterbodies within the study area were identified as candidates for sampling by EPA after consultation with ODFW and ODEQ. Criteria used to identify the final list were: 1) proximity to the high deposition zone identified by the REMSAD model, 2) high use by anglers, 3) high consumption of resident fish by anglers, and 4) availability/catchability of target species. After evaluating numerous waterbodies based on these criteria (see **Appendix 1**), five were selected for sampling:

- Balm Creek Reservoir,
- Bully Creek Reservoir,

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Northeast Oregon Lakes Mercury

- Phillips Reservoir,
- Powder Arm of Brownlee Reservoir,
- Thief Valley Reservoir.

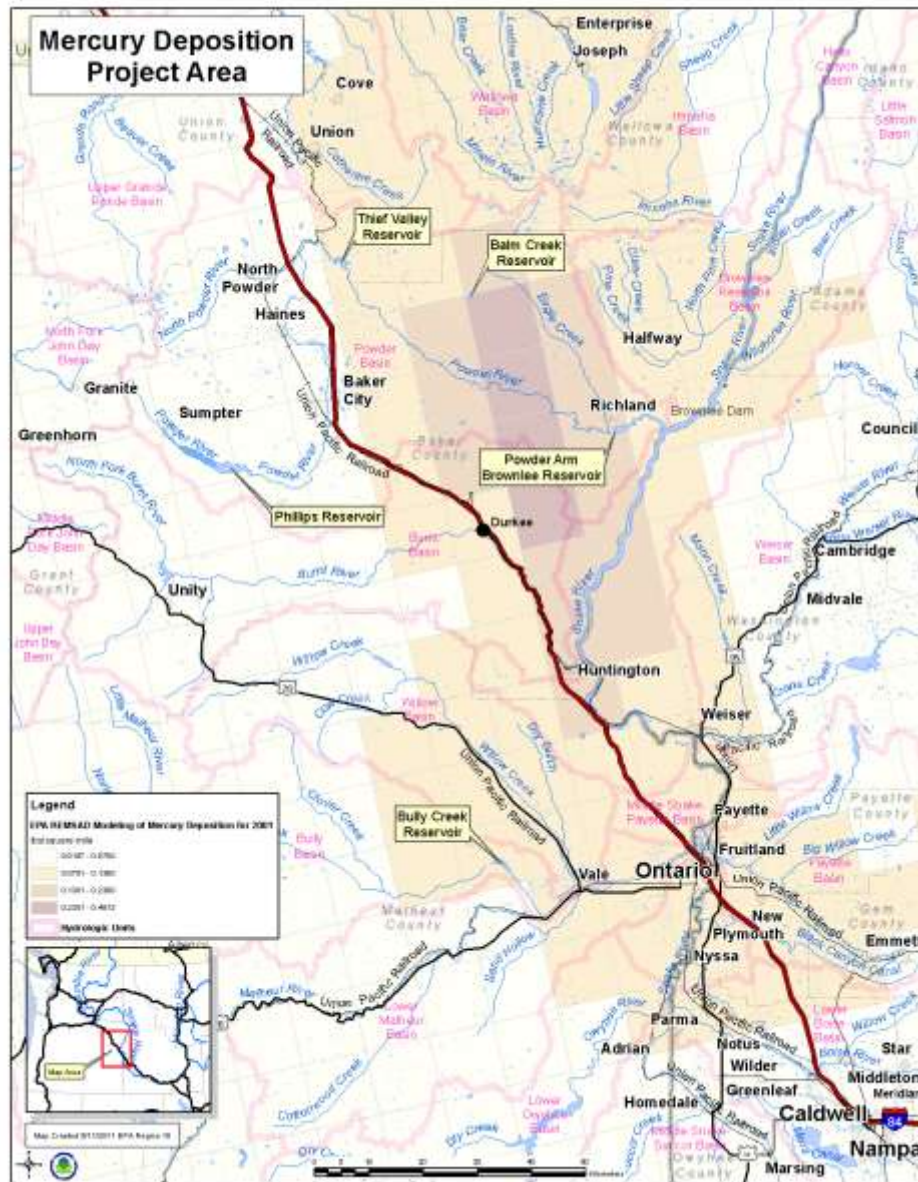
These waterbodies are described in **Table 1** and their locations are shown on **Map 1**. Map 1 also shows the area of estimated elevated mercury deposition from the REMSAD model. It is important to note that the REMSAD model was conducted on a national scale and was not corrected for factors such as local topography, which may affect wind direction. The smallest cell in the model results was 12 km².

Table 1. Location and description of sample lakes.

| Site Identification | County | Basin | Area Sqkm | Elev (ft) | Lat_DD | Long_DD |
|------------------------|-------------|--------------|-----------|-----------|-----------|-------------|
| Balm Creek Reservoir | Union | Powder River | 0.295 | 4529 | 44.970928 | -117.492410 |
| Bully Creek Reservoir | Malheur | Bully Creek | 2.474 | 2513 | 44.021791 | -117.401284 |
| Phillips Reservoir | Baker | Powder River | 9.510 | 4075 | 44.677331 | -118.007648 |
| Powder Arm Brownlee | Baker | Powder River | 5.202 | 2075 | 44.755474 | -117.131696 |
| Thief Valley Reservoir | Union/Baker | Powder River | 3.039 | 3140 | 45.025920 | -117.790134 |

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Northeast Oregon Lakes Mercury



Map 1. Northeastern Oregon Mercury Project Area showing model-predicted mercury deposition.

Target Species and Sample Hierarchy

In general, collecting fish for fish advisories involves targeting two fish species per waterbody (EPA, 2000). Sampling two species that occupy different trophic levels (for example, open-water predators plus bottom-dwellers) allows for a robust characterization of a chemical's presence in the fish population. Also, sampling species from multiple trophic levels allows for both human health and wildlife screening. This project is specifically focused on mercury that may be in fish consumed by humans, however, so only species that are known to be caught and consumed by anglers were targeted. Because mercury is known to bio-accumulate and reach higher concentrations in higher trophic level species (e.g. piscivores versus insectivores), predatory species were preferred. Only predator species that are resident (non-migratory) and are known to be caught and consumed were targeted for sampling. Collection of fish of a single species was considered the minimum sample with the option of sampling more than one predator species as available.

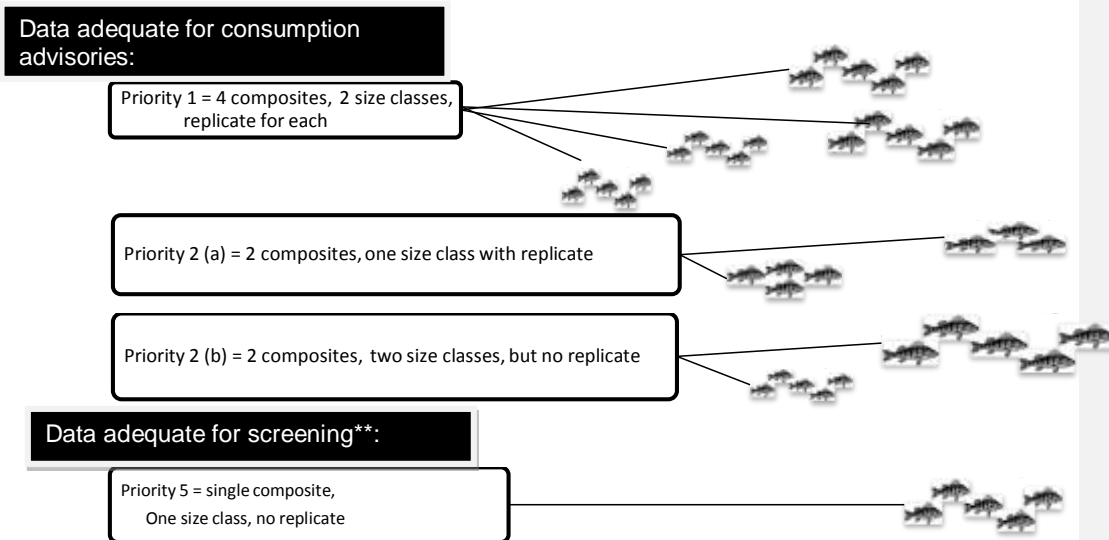
The predator species available for sampling varied by waterbody. In consultation with local biologists, the predator species that were considered the best targets were identified for each waterbody (See Appendix 1). Because these systems are dynamic, the relative abundance of the species that are dominant in angler's creels can vary depending on the year/water conditions. Most sites have more than one predator species that could be captured and still meet the sampling goal. The sampling goal at each lake was two composite samples of 3-5 fish per composite (of similar size) from each of two size classes of a single predator species (plus a replicate from each size class). Where the numbers and sizes of fish caught were inadequate, the hierarchy shown in **Figure 1** was used to determine the species and quantities that would make up the composite samples.

Adult fish that were within the length ranges typically consumed by anglers for each species and within the legal limits as stated by the State of Oregon Fishing regulations (ODFW, 2011) were eligible for inclusion in the sample. Inclusion of trout in the sampling was carefully considered by waterbody. Small lakes in Oregon are commonly stocked with fingerlings and sub-catchable sized trout. The study targeted only rainbow trout that had over-wintered at least once and were of catchable/consumable size. Practical considerations such as gear type, lake conditions, timing, and fish abundance dictated the species actually captured.

Comment [A1]: Can anyone make this more intelligible?

Northeast Oregon Lakes Mercury

Figure 1. Hierarchy for fish advisory for NE Oregon lake fish tissue study used to guide fish collection.



Hierarchy and data adequacy determinations were based on EPA guidance and are consistent with use in other West Coast States:

- USEPA Office of Water 2000, Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories
- California EPA 2005, General Protocol for Sport Fish Sampling and Analysis
- WA Dept of Health, draft 2004 "Protocol for Fish Consumption Advisories in Washington State"

*All composites will be made up of 3-5 individuals within a single size class (75% of length range)

**Screening data do not form an adequate basis for issuance of consumption advisories, but may indicate the need for additional sampling

Methods

The methods were designed to efficiently sample for total mercury to generate data useful for fish consumption advisories or screening level analysis (if inadequate numbers of fish are collected for advisories). Screening-level data, although not adequate for advisories, may indicate the need for additional sampling in the future.

Field Methods

All field sampling activities followed procedures in the project's QAPP (EPA 2011) with the objective of maintaining sample integrity from the time of fish collection through sample shipment to arrival at the laboratory. Fish were collected using gillnets at all waterbodies except the Powder Arm of Brownlee Reservoir where boat electrofishing was used. Fishing was a collaborative effort, with ODFW participating at four of the five waterbodies and Idaho Power Company (IPC) participating with fish collection on the Powder River Arm of Brownlee Reservoir. All sites were sampled between June 14th and 17th, 2011.

Captured fish were identified to species and measured for length. Individuals meeting the species and size criteria were retained. Each composite sample consists of similar sized fish (each fish within 75% of the length of the other individuals in the 3-5 fish sample). Whole fish were weighed, packaged, preserved on dry ice, and delivered to the EPA Region 10 Laboratory in Manchester Washington where they were stored at -20C.

Laboratory Fish Processing Methods

Initial processing was conducted in September 2011. Equal portions of muscle tissue (skinless) were removed from each fish so that individuals were equally represented in the composite sample. Tissues were then combined and homogenized in a mini-blender. A total of approximately 40 grams of tissue per fish was used for each composite sample. The homogenized samples were stored at -20C until final processing.

The chemical analysis was performed by EPA chemists following standard operating procedures for digestion and analysis in order to achieve the required measurement quality objectives. These are described in detail in the QAPP for this project (See Attachment 1). The wet tissue was digested and analyzed by EPA method 245.6 (USEPA 1991). The reporting limits for mercury were 0.0125 mg/kg.

Data Summary Methods

All results are reported separately for each species on a site by site basis. Since samples were analyzed as composites, only one value is reported per sample. In cases where there are replicate samples, data are reported as means of the two composites. To aid the reader in interpreting the concentrations, the data are compared to 1) threshold values used by Oregon Department of Health for fish advisory screening (OHA 2010), 2) other fish tissue mercury data that has been collected from these waterbodies, and 3) data from other lakes in the area.

Comment [A2]: Insert a sentence regarding national comparison?

Results

Sampling Results

Several fish species were captured, but no single species was captured consistently across all the sampled waterbodies. Of the fish captured and retained as samples, all were considered target species as they met the study criteria of resident predators within appropriate size specifications that represent fish commonly captured and consumed by anglers (see QAPP). A total of 19 samples were collected from the five waterbodies.

Sample results are shown in **Table 2**. Powder Arm of Brownlee Reservoir had the most species sampled with composites from four target species submitted. Three waterbodies, Balm Creek Reservoir, Bully Creek Reservoir, and Phillips Reservoir, had only one species sampled. An adequate number of individuals useable for fish advisory level evaluation was collected for a minimum of one species at each of the four waterbodies. At Bully Creek Reservoir, only two channel catfish were captured. These two fish were analyzed as individuals (not composited) because only two fish would be an inadequate composite and they would be more valuable for screening level analysis for this reservoir as individual samples.

Analysis Results

Mercury analysis results were generated for all 19 samples. Replicate samples were collected for eight of the species/size/waterbody combinations. These are presented as mean values in Table 2. Quality assurance review was conducted on all samples plus two duplicates and one rinsate. All measures of quality control met the laboratory/QAPP criteria (US EPA Region 10, 2011).

Northeast Oregon Lakes Mercury

Table 2. Northeast Oregon fish sampling results.

| Waterbody | Fish Species | Fish per sample | Length Range (mm) | Hg conc. Wet wt. (mg/kg) | Species Mean | Size Class Mean | Size | Sample (n) |
|--------------|--------------------|-----------------|-------------------|--------------------------|--------------|-----------------|-------|------------|
| Balm Cr. | rainbow trout (sm) | 4 | 270-306 | 0.099 | 0.123 | 0.099 | small | 1 |
| Balm Cr. | rainbow trout (lg) | 3 | 345-392 | 0.131 | | 0.135 | large | 2 |
| Balm Cr. | rainbow trout (lg) | 4 | 335-398 | 0.139 | | | | |
| Bully Cr. | channel catfish | 1 | 470 | 0.207 | 0.248 | 0.248 | all | 2 |
| Bully Cr. | channel catfish | 1 | 356 | 0.288 | | | | |
| Phillips R. | yellow perch | 5 | 195-208 | 0.558 | 0.581 | 0.581 | all | 2 |
| Phillips R. | yellow perch | 5 | 193-230 | 0.604 | | | | |
| Powder Arm | black crappie | 5 | 242-263 | 0.380 | 0.395 | 0.395 | all | 2 |
| Powder Arm | black crappie | 5 | 240-265 | 0.410 | | | | |
| Powder Arm | bluegill (sm) | 5 | 173-184 | 0.122 | 0.196 | 0.130 | small | 2 |
| Powder Arm | bluegill (sm) | 5 | 171-183 | 0.137 | | | | |
| Powder Arm | bluegill (lg) | 3 | 220-233 | 0.329 | | 0.329 | large | 1 |
| Powder Arm | smallmouth bass | 4 | 305-355 | 0.287 | 0.316 | 0.316 | all | 2 |
| Powder Arm | smallmouth bass | 4 | 306-344 | 0.344 | | | | |
| Powder Arm | white crappie | 4 | 266-282 | 0.325 | 0.339 | 0.339 | all | 2 |
| Powder Arm | white crappie | 4 | 282-316 | 0.353 | | | | |
| Thief Valley | bluegill | 5 | 140-170 | 0.247 | 0.247 | 0.247 | all | 1 |
| Thief Valley | rainbow trout | 3 | 283-295 | 0.053 | 0.061 | 0.061 | all | 2 |
| Thief Valley | rainbow trout | 4 | 300-325 | 0.069 | | | | |

Total mercury concentration (expressed as wet weight) ranged from a mean low of 0.061 mg/kg in rainbow trout of Thief Valley Reservoir to a mean high of 0.581 mg/kg in yellow perch of Phillips Reservoir (Table 2). Rainbow trout collected in both Balm Creek Reservoir and Thief Valley Reservoir had relatively low total mercury concentrations compared with other species (Figure 2). The small-sized bluegill collected in Powder Arm of Brownlee Reservoir also had low total mercury concentration (mean 0.130 mg/kg). The highest concentration was found in the yellow perch from Phillips Reservoir (mean 0.581 mg/kg).

Comment [A3]: Lil, check my change per Leigh's comment

Northeast Oregon Lakes Mercury

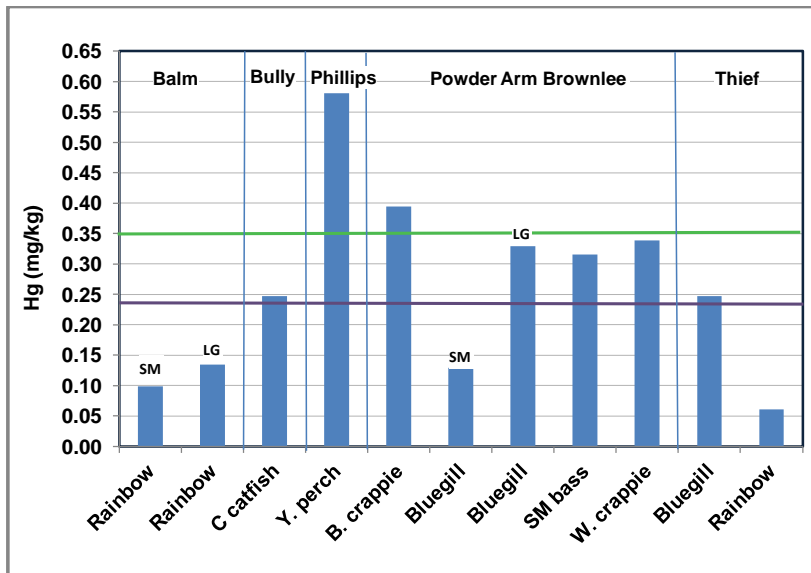


Figure 2. Graph of mercury concentration in fish species by water body. Where replicate samples were collected, data are presented as mean values as show on Table 1.

Discussion

A. Thresholds for evaluating need for fish advisories

The screening level thresholds for mercury depend on the fish consumption rate used. The more fish consumed, the lower the screening level. Oregon Health Authority currently uses a level of 0.23 ppm of Hg, which assumes up to 4 meals per month of fish for an adult female. This calculation is based on the method in EPA's Fish Advisory Guidance (USEPA 2000). There may be local anglers that consume more than one meal of fish per week, and therefore a fish advisory calculated for only four meals per month may not be protective of those individuals. However, health agencies also consider the benefits of fish consumption, so they do not want to express advisories in a way that is overly cautious and may discourage people from consuming fish at all.

Comment [A4]: Verify with OHA. Didn't Barbara say their number was derived based on body weight of adult male?

B. Relevance to Fish Advisories

Phillips Reservoir

Northeast Oregon Lakes Mercury

Based on these 2011 sample results, Phillips Reservoir is a candidate for development of a fish advisory for consumption of yellow perch. The mean of two samples was 0.605 mg/kg, substantially higher than the 0.35 mg/kg threshold. These results confirm previous data collected from Phillips in 1994, which showed that mercury concentrations were elevated above threshold levels in both smallmouth bass and black crappie (**Table 3**). Like yellow perch, both of these species are consumed by anglers. Although this is a limited dataset, it does show that elevated concentrations of mercury were present in fish tissue almost two decades ago.

Table 3. Data collected from Phillips Reservoir on September 27, 1994 from the deepest part of the lake (unpublished data provided by OHR).

| Species | Hg (mg/kg) | age | length | wt grams | mean |
|-----------------|------------|-----|--------|----------|-------------|
| smallmouth bass | 0.27 | 3 | 250 | 185 | 0.37 |
| smallmouth bass | 0.39 | 4 | 250 | 185 | |
| smallmouth bass | 0.39 | 3 | 220 | 120 | |
| smallmouth bass | 0.40 | 3 | 235 | 155 | |
| smallmouth bass | 0.41 | 3 | 265 | 235 | |
| black crappie | 0.35 | 3 | 205 | 125 | 0.37 |
| black crappie | 0.39 | 5 | 250 | 205 | |
| rainbow trout | 0.14 | 1 | 230 | 95 | 0.15 |
| rainbow trout | 0.15 | 1 | 225 | 95 | |
| rainbow trout | 0.16 | 1 | 220 | 95 | |

Powder Arm of Brownlee Reservoir

A fish advisory for sport fish has been in effect in for Brownlee Reservoir since 1997 (OHR,1997). This advisory states that fish mercury concentrations of 0.41 mg/kg prompted the advisory, as this level exceeds the threshold of 0.35 mg/kg used at the time. Species specific levels were not presented. The 2011 results from the Powder Arm of Brownlee Reservoir tend to support what has been found in past data. White crappie, smallmouth bass, and large-sized bluegill samples exceeded 0.30 mg/kg and black crappie exceeded 0.40 ppm.

Did not find any data specific to brownlee in the EPA-Helen dataset. Maybe under Snake river site name?(LGH comment)

C. Other data of interest from the area waterbodies

Insert very brief comparisons here, include national study

Recommendations

- Provide these data to OHA to use along with past data to support development of a fish advisory on Phillips Reservoir for yellow perch.
- Verify mercury concentrations in Bully Creek and Thief Valley Reservoirs. Screening level sampling at Bully Creek and sampling of only one centrarchid species in Thief Valley Reservoir yielded results just above the threshold value of 0.23, suggesting that more sampling would be warranted. [add species](#)
- Provide these data to OHA to use to revisit the 1997 advisory for Powder Arm of Brownlee Reservoir. These data provide more clarity on specific species that are of concern there and this new information could be used to make the advisory more species-specific, which would be useful to the public.
- Evaluate the REMSAD model's 'significant deposition area' to identify other waterbodies that have substantial use by anglers yet lack data on mercury concentrations. If candidate waterbodies meet criteria, consider a second phase of sampling.

Should we say anything about evaluating the use of these waterbodies by subsistence fishers and that this should be a consideration in setting thresholds for fish advisories? (LON?)

Leigh's suggested wording: Consider what advice to provide to subsistence fishers (those consuming more than 4 meals/month) for waterbodies below the 0.23 mg/kg threshold

-

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Northeast Oregon Lakes Mercury

U.S. EPA Region 10. 2011. Quality Assurance Memorandum for Inorganic Chemical Analysis: Quality Assurance Review of NE Oregon Mercury in Fish Tissue for Mercury November 22,2011 to L. Herger and L. Edmond From K. Adams Office of Environmental Assessment, US EPA Region 10 Laboratory. Project Code: ESD-218A.

Northeast Oregon Lakes Mercury

Appendix 1. List of lakes considered for sampling in northeastern Oregon.

| Waterbody | Deposition Zone Prox. | Possible target species | Other species | Fish consumption | Methylation potential | Condition Comments | Draft Recommendation for Inclusion in Sampling |
|---------------------------|-----------------------|--------------------------------------|---|----------------------------|-----------------------|-----------------------------|---|
| Powder Arm, Brownlee Res. | high | bass, crappie, catfish | | high | high | eutrophic | Y -- Both ODEQ and ODFW have highlighted this area |
| Highway 203 Pond | high | bass (small), bluegill (small) | trout (catchable-size stocked) | high trout; low bass | unk. | | Probably N -- stocked trout not likely to substantially accumulate Hg; bass & bluegill very small |
| Burnt River | high | bass, trout (natural) | trout (catchable-size stocked) | low | unk. | low gradient | Y-- bass available |
| Catherine Cr. | high | carp, trout | | low (some trout) | unk. | | Maybe -- may be info on GR Basin |
| Powder River | high | adult trout below Thief Valley Resr. | trout (catchable-size stocked) | medium | unk. | | Probably N-- Thief Valley and Brownlee Arm part of Powder R. |
| Bully Cr Res. | med | bass, crappie | | high | high | Elev fluctuates; eutrophic | Y |
| Phillips Res. | med | perch, bass, crappie, | trout (fingerlings and sub-catchables stocked), suckers | high | unk. | Elev.fluctuates | Y |
| Thief Valley Res. | med | trout (fingerlings stocked), perch | | high (mostly trout) | high | Elev. fluctuates; eutrophic | Y |
| Pilcher Res. | med | crappie | trout (fingerlings stocked) | high trout; med. crappie | unk. | | Maybe |
| Malheur Res. | med | trout (fingerlings stocked) | | medium | med | Elev. fluctuates | Maybe -- Only trout caught (But premier trout fishing spot) |
| Balm Cr Res. | med | bass, crappie | trout (fingerlings stocked) | medium with high potential | unk. | Elev. fluctuates | Maybe -- Close proximity to yellow zone. |
| Unity Res. | low | bass, crappie | trout (fingerlings stocked), | high | unk. | Elev. fluctuates | Maybe, but more distant |
| Grande Ronde | low | Bass,, trout | | low | high /unk | low gradient | Fairly Distant -- |
| Beulah Resr | low | trout | | unk. | unk. | | N due to distance and species |
| Warm Springs Resr | low | bass,perch,trout crappie, catfish | | unk. | unk. | | Fairly Distant --> Maybe Later if Subsequent Sampling |
| Pole Cr Resr | low | trout | | unk. | unk. | | Need to verify exact location |
| Wolf Cr. Res. | med | crappie | trout (fingerlings stocked) | sometimes high | unk. | | Maybe |

Proximity to REMSAD zones (map 1): H=in red or yellow; M=within 24km of red/yellow; L > 24 km from red/yellow

Northeast Oregon Lakes Mercury

North east C

Select photos



Tissue extraction



homogenization



North east C



Fish for sample



electrofishing

North east C



gillnetting



kids fishing at Brownlee