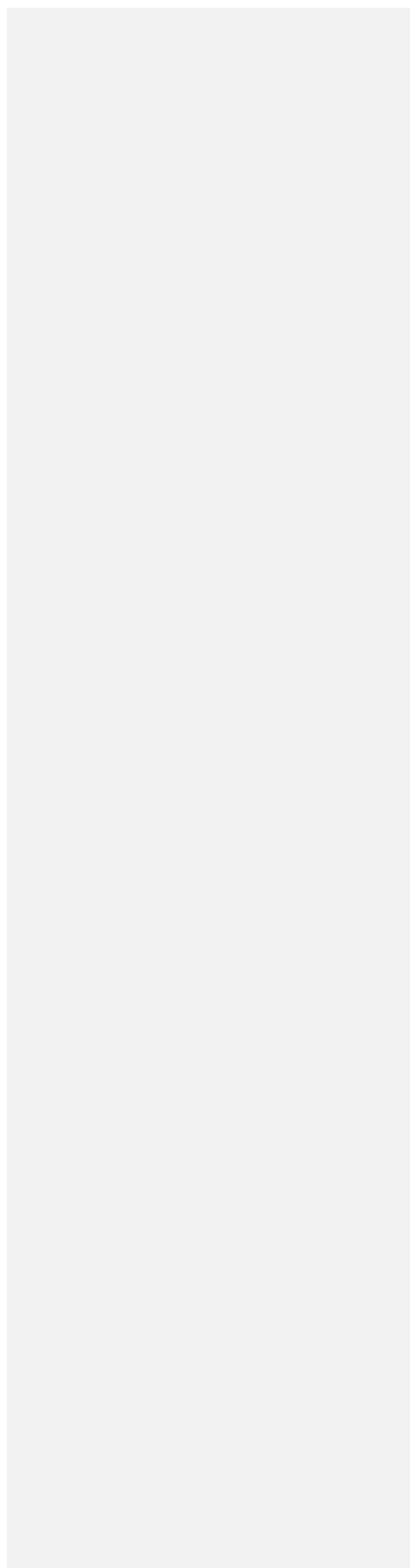
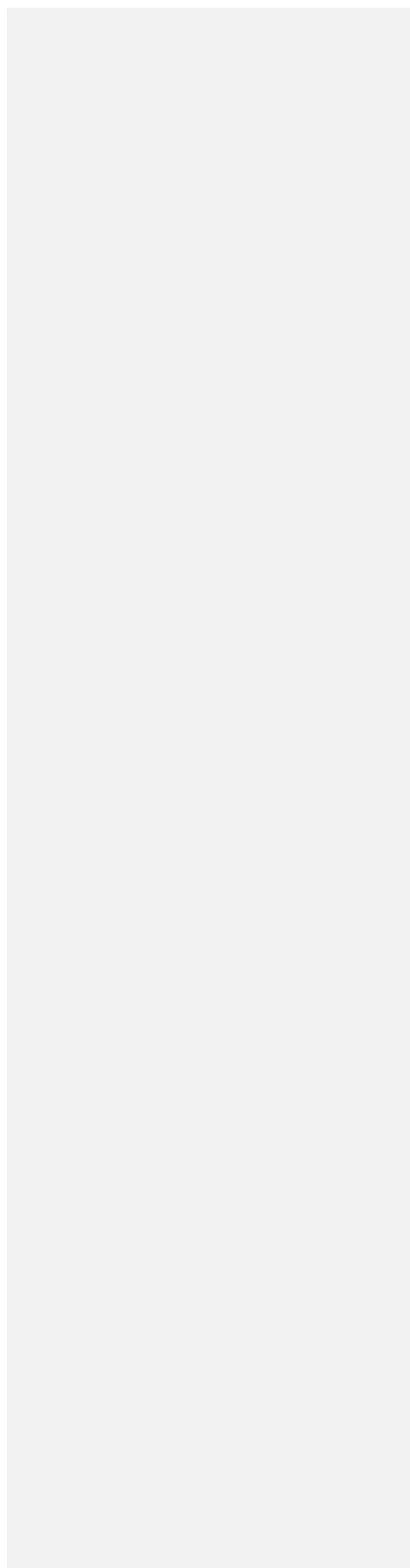


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Assessment of Mercury in Fish Tissue from Select Lakes of Northeastern Oregon

EPA Region 10 Report

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February 2012

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Publication Number: EPA-910-R-XX-XXX

Suggested Citation:

Herger, L.G. and L. Edmond. 2011. Assessment of mercury in fish tissue from selected lakes in northeastern Oregon EPA Region 10 Report. Report Number EPA-910-R-10-XXX. U.S. Environmental Protection Agency, Region 10, Seattle, Washington.

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Acknowledgements

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

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 Metheny 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. This predicted deposition indicated a need to assess whether mercury is bioaccumulating in local fish that are consumed by humans. ~~Currently, there is a general lack of fish tissue data from lakes and streams in this area. Given the elevated level of potential mercury deposition, it is important to conduct a screening assessment to measure the concentrations of mercury in fish tissue in the surrounding waterbodies.~~

The objective of the 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.

To ensure the continued good health of its citizens, the State of Oregon issues fish consumption advisories for specific fish species in waterbodies that exceed human health criteria 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 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 objective was to establish whether mercury levels in fish are elevated and warrant fish consumption advisories to the public for these waterbodies.

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

Comment [A1]: I would leave this general, since OHA is considering a "warmwater" advisory which is not species specific.

Comment [A2]: I think the term to use here and elsewhere is "threshold" since criteria denote a WQS, which these are not.

Northeast Oregon Lakes Mercury

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, Phillips Reservoir, Powder Arm of Brownlee Reservoir, and 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



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.

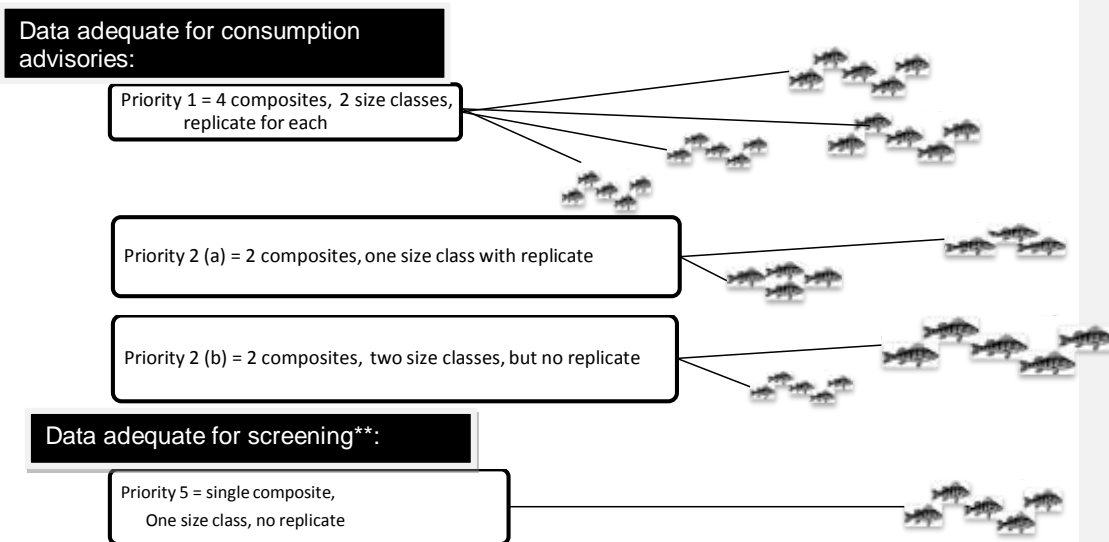
The predator species available for sampling varied by waterbody. In consultation with local biologists, the predator species that were considered the best targets were identified for each waterbody (See Appendix 1). Because these systems are dynamic, the relative abundance of the species that are dominant in angler's creels can vary depending on the year/water conditions. Most sites have more than one predator species that we could capture 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, we used the hierarchy shown in Figure 1 ~~Figure 4~~ 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.

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Northeast Oregon Lakes Mercury

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



Comment [A3]: I like using a graph rather than a table, as it adds a little graphic life to the report.

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 ~~in~~-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. The tissue was 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 [A4]: I think it would be useful to compare results to the national survey findings by species also, to put these Regional levels in a larger context.

Results

Sampling Results

A variety of fish species were captured, but no 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 were collected for at least one species at four of the waterbodies. At Bully Creek Reservoir, only two channel catfish were captured. These two fish were analyzed as individuals (not composited) ~~as-only~~since 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 wgt. (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	264-332	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				

Comment [A5]: Lil – is this size range right? Seems high to me, the upper end being 13" which is a huge bluegill. I recall them being nice size, but not quite that big.

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 high of 0.604 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 [A6]: I think it would be more appropriate to cite the size class mean of 0.581 for perch, since the 0.604 value is just one of the 2 samples for the same size class. Would also make it more consistent with the statement in the last sentence in this para.

Northeast Oregon Lakes Mercury

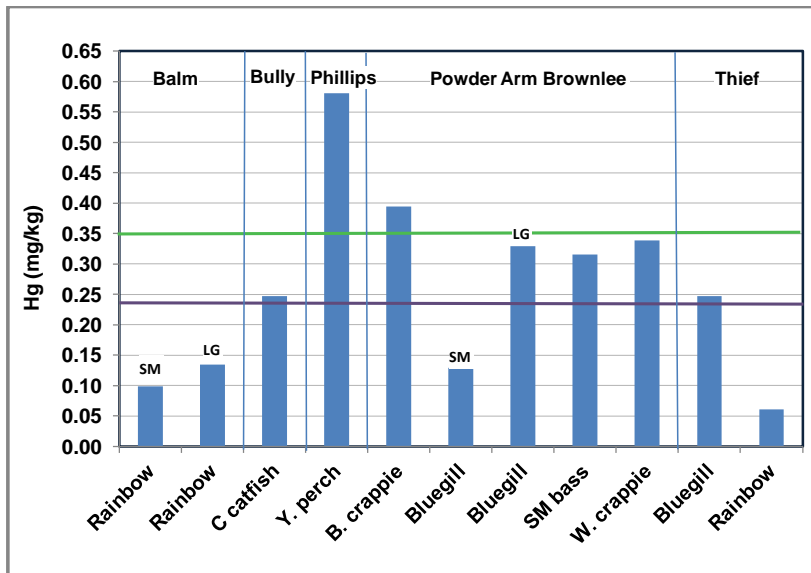


Figure 2. Graph of mercury concentration in fish species by water body. Where replicate samples were collected, data are presented as mean values as show on Table 1.

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 Department of Health 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). Similarly, a concentration of 0.35 corresponds to a consumption rate of two 8- oz meals per month. This is a screening level that was used in the past for ??? (citation for this). 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 [A7]: On our call with OHA, Barbara Stifel indicated they use a 70 kg male in deriving this threshold. I mentally questioned whether that was appropriate, since females would be more sensitive, and slightly lighter weight. We should probably confirm one way or the other what they really used.

Comment [A8]: I think reference to the historic 0.35 ppm screening level can be deleted, since neither we nor OHA use it any longer, and leaving it in this document may be confusing to readers.

Northeast Oregon Lakes Mercury

B. Relevance to Fish Advisories

Phillips Reservoir

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 ~~both the 0.35 and 0.23 mg/kg thresholds~~. These results confirm previous data collected from Phillips in 1994, which showed that mercury concentrations were elevated above ~~both threshold levelss~~ in both smallmouth bass and black crappie (~~Table 3~~**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.

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Comment [A9]: Again, I think it's a little confusing to use the old threshold values, and would suggest deleting reference to them here.

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.

Comment [A10]: I think this reference to the old threshold is okay.

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? Yes or no?

I would say yes, and also comparisons to the most recent national study, for perspective. If I recall, I don't think these results are too far from the norm, except for yellow perch, and I think its valuable to see that these depart from typical national levels.

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.
- 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?

• 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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Comment [A11]: I think we should say something about developing advice to the higher end or subsistence consumers. Here is my suggested wording

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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