

Prepared in cooperation with the City of Boise

Mercury Concentrations in Water, and Mercury and Selenium Concentrations in Fish from Brownlee Reservoir and Selected Sites in Boise and Snake Rivers, Idaho and Oregon, 2013

Open-File Report 2014–1099

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By Dorene E. MacCoy

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Conversion Factors and Datum

Conversion Factors

SI to Inch/Pound

Multiply	By	To obtain
	Length	
centimeter (cm)	0.3937	inch (in.)
millimeter (mm)	0.03937	inch (in.)
	Volume	
milliliter (mL)	0.03381	ounce, fluid (fl. oz)
	Mass	
gram (g)	0.03527	ounce, avoirdupois (oz)
kilogram (kg)	2.205	pound avoirdupois (lb)
milligram (mg)	0.000035	ounce, avoirdupois (oz)
nanogram (ng)	3.5×10^{-11}	ounce, avoirdupois (oz)

Concentrations of chemical constituents in water are given in micrograms per liter ($\mu\text{g/L}$), equivalent to part per billion; nanograms per liter (ng/L), equivalent to part per trillion; nanograms per gram (ng/g), equivalent to part per billion; and milligrams per kilogram (mg/kg), equivalent to part per million.

Datum

Horizontal coordinate information is referenced to the North American Datum of 1983 (NAD 83).

Mercury Concentrations in Water, and Mercury and Selenium Concentrations in Fish from Brownlee Reservoir and Selected Sites in Boise and Snake Rivers, Idaho and Oregon, 2013

By Dorene E. MacCoy

Abstract

Mercury (Hg) analyses were conducted on samples of sport fish and water collected from six sampling sites in the Boise and Snake Rivers, and Brownlee Reservoir to meet National Pollution Discharge and Elimination System (NPDES) permit requirements for the City of Boise, Idaho. A water sample was collected from each site during October and November 2013 by the City of Boise personnel and was analyzed by the Boise City Public Works Water Quality Laboratory. Total Hg concentrations in unfiltered water samples ranged from 0.73 to 1.21 nanograms per liter (ng/L) at five river sites; total Hg concentration was highest (8.78 ng/L) in a water sample from Brownlee Reservoir. All Hg concentrations in water samples were less than the EPA Hg chronic aquatic life criterion in Idaho (12 ng/L).

The EPA recommended a water-quality criterion of 0.30 milligrams per kilogram (mg/kg) methylmercury (MeHg) expressed as a fish-tissue residue value (wet-weight MeHg in fish tissue). MeHg residue in fish tissue is considered to be equivalent to total Hg in fish muscle tissue and is referred to as Hg in this report. The Idaho Department of Environmental Quality adopted the EPA's fish-tissue criterion and a reasonable potential to exceed (RPTE) threshold 20 percent lower than the criterion or greater than 0.24 mg/kg based on an average concentration of 10 fish from a receiving waterbody. NPDES permitted discharge to waters with fish having Hg concentrations exceeding 0.24 mg/kg are said to have a reasonable potential to exceed the water-quality criterion and thus are subject to additional permit obligations, such as requirements for increased monitoring and the development of a Hg minimization plan. The Idaho Fish Consumption Advisory Program (IFCAP) issues fish advisories to protect general and sensitive populations of fish consumers and has developed an action level of 0.22 mg/kg wet weight Hg in fish tissue. Fish consumption advisories are water body- and species-specific and are used to advise of allowable fish consumption from specific water bodies. The geometric mean Hg concentration of 10 fish of a single species collected from a single water body (lake or stream) in Idaho is compared to the action level to determine if a fish consumption advisory should be issued.

The U.S. Geological Survey collected and analyzed individual fillets of mountain whitefish (*Prosopium williamsoni*), smallmouth bass (*Micropterus dolomieu*), and channel catfish (*Ictalurus punctatus*) for Hg. The median Hg concentration of 0.32 mg/kg exceeded the Idaho water-quality criterion at the site in Brownlee Reservoir. Average Hg concentrations from Brownlee Reservoir (0.32 mg/kg) and the Boise River at mouth (0.33 mg/kg) exceeded the Hg RPTE threshold (>0.24 mg/kg). IFCAP action levels also were exceeded at the sites on Brownlee Reservoir and at the mouth of the Boise River. Median Hg concentrations in fish at the remaining four river sites were less than 0.20 mg/kg with average concentrations ranging from 0.14 to 0.21 mg/kg Hg.

Selenium (Se) analysis also was conducted on one composite fish tissue sample per site to screen for general concentrations and to provide information for future risk assessments. Concentrations of Se ranged from 0.07 to 0.49 mg/kg wet weight; average concentrations were highest in smallmouth bass (0.40 mg/kg) and lowest in mountain whitefish (0.12 mg/kg).

Introduction

Mercury (Hg) is a global pollutant that ultimately makes its way into every aquatic ecosystem through the hydrologic cycle. Atmospheric deposition of inorganic Hg contributes the vast majority of Hg to aquatic systems, although geologic sources and point-source pollution also may contribute to Hg loading. Once it is in aquatic systems, inorganic Hg may become methylated through microbial sulfate reduction (Fitzgerald and Lamborg, 2007). Methylmercury (MeHg) is by far the more bioavailable and toxic form of Hg; and, once Hg has moved through aquatic food chains into predatory fish, almost all Hg present in fish tissue is MeHg. In turn, sport fish that are most commonly caught and consumed by subsistence or recreational anglers tend to be predatory fish. As a result of these dynamics, risks of MeHg exposure to humans are almost exclusively through consumption of fish (U.S. Environmental Protection Agency, 2001).

The U.S. Environmental Protection Agency (EPA) recommended water-quality criterion for MeHg is expressed as a fish-tissue residue value (wet-weight MeHg in fish tissue). The MeHg criterion is based on fresh weight, appropriately reflecting the nature of fish destined for human consumption. The Idaho Department of Environmental Quality (IDEQ) adopted EPA's fish-tissue criterion as the Idaho MeHg water-quality criterion and published implementation guidance for the Idaho Hg water-quality standard (Idaho Department of Environmental Quality, 2005). The criterion of 0.3 milligram MeHg per kilogram (mg/kg) of wet weight fish is based on protecting an adult consumer who eats an average of 17.5 g of fish per day—this is equivalent to about one, 8-ounce serving every other week (U.S. Environmental Protection Agency, 2001; Idaho Department of Environmental Quality, 2005). Total Hg is analyzed in place of MeHg in fish tissue for two reasons: (1) total Hg is easier and less costly for laboratories to determine than MeHg, and (2) nearly all Hg present in fish muscle tissue is MeHg (Bloom, 1992; Hammerschmidt and others, 1999; Harris and others, 2003). Interpretation of total Hg analysis as MeHg will likely bias high the results as MeHg in fish on the order of less than 1.01–1.05 based on comparisons shown by Bloom (1992) and by Hammerschmidt and others (1999). This magnitude of potential bias is well within the range of expected analytical variability. In comparing fish-tissue results with the criterion, the analytical results for total Hg in the fish tissue should be interpreted as 100 percent MeHg. For the remainder of this report, total Hg analyzed in both water and fish tissue will be referred to as Hg.

The Idaho implementation guidance describes two scales of monitoring for Hg in fish tissue: (1) statewide ambient monitoring and (2) facility/source monitoring. The Idaho Statewide Ambient Monitoring Program was designed to monitor concentrations of Hg in fish tissue that represent an integrated exposure to Hg throughout a water body over time (Idaho Department of Environmental Quality, 2005). The Idaho Statewide Ambient Monitoring Program began collecting fish tissue in 2004 and was discontinued in 2009 because of funding constraints (Essig and Kosterman, 2008; Essig, 2010). The facility/source monitoring is targeted at potential local sources. The EPA Office of Wastewater Management in partnership with the State of Idaho manages the National Pollution Discharge and Elimination System (NPDES) to help track and manage permits for point-source dischargers (U.S. Environmental Protection Agency, 2012a). Certain NPDES permittees are required to analyze for Hg in effluent and in fish that inhabit the receiving waterbodies (Idaho Department of Environmental Quality, 2005).

The 2005 IDEQ implementation guidance document requires NPDES permittees to provide data for Hg in fish tissue under the Reasonable Potential To Exceed (RPTE) process (Idaho Department of Environmental Quality, 2005). The RPTE threshold is designed to protect people that consume fish and is based on an average Hg concentration from 10 fish not to exceed 80 percent of the 0.3 mg/kg Idaho criterion or greater than 0.24 mg/kg wet weight Hg in fish from the receiving water body. The IDEQ guidance recommends additional pollution prevention and sampling actions if the RPTE threshold is exceeded. The EPA has included numerical Hg limitations, Hg minimization plan development, watershed based fish tissue and water Hg sampling, and annual reporting requirements in the City of Boise's two effluent permits for the Lander Street and the West Boise Wastewater Treatment Facilities (U.S. Environmental Protection Agency, 2012b, 2012c).

The Idaho Fish Consumption Advisory Program (IFCAP) issues fish advisories to protect fish consumers and has developed an action level of 0.22 mg/kg wet weight Hg in fish tissue. Fish consumption advisories are water body- and species-specific and are used to advise general and sensitive populations of the allowable consumption of fish obtained from Idaho waters. The geometric mean Hg concentration of 10 fish of a single species collected from a single water body (lake or stream) in Idaho is compared to the action level to determine if a consumption advisory should be issued.

EPA considers a total recoverable mercury concentration of 12 ng/L to be the effective chronic aquatic life criterion in Idaho for the purposes of the Clear Water Act (Idaho Department of Environmental Quality, 2014, referred to as EPA aquatic life criteria in this report). The City of Boise's NPDES permits require a minimum detection level for Hg of 0.5 ng/L, sufficiently low enough to compare to EPA criteria.

The implicit purpose of collecting data on Hg in water and fish tissue at the same location is to facilitate developing fish bioaccumulation factors, which are ratios of tissue and water Hg concentrations. Bioaccumulation factors (BAFs) can be useful for water-quality management, such as site-specific implementation targets of the fish-tissue based MeHg water-quality criteria, and total maximum daily load target development (Idaho Department of Environmental Quality, 2005; U.S. Environmental Protection Agency, 2010). For developing BAFs, it is not essential that the water and fish samples are collected at the same time. Riva-Murray and others (2012) reported that, in streams in Oregon and New York, the best BAF estimates came from sampling MeHg in water during the July to September growing season, regardless of when the fish were collected. In related analyses with fish, the optimal approach for estimating BAFs is to use Hg concentration data from at least 10 adult fish of a single species and similar length (Barbara Scudder Eikenberry, U.S. Geological Survey, written commun., 2013). BAFs are currently not calculated using the data published in this report. It is the intent that this data will be combined with future data-collection efforts for calculations of BAFs.

The City of Boise in cooperation with U.S. Geological Survey (USGS) developed a multiyear water and fish tissue Hg monitoring plan (Mebane and MacCoy, 2013) in the Snake and Boise Rivers and Brownlee Reservoir to satisfy the watershed based fish-tissue sampling requirements contained in the city permits. The IDEQ implementation guidance (Idaho Department of Environmental Quality, 2005) encourages municipal dischargers to establish monitoring cooperatives to help fund watershed-based statewide monitoring for Hg in fish tissue. The EPA further recommended that the permitting authority (which is the EPA in Idaho) require only one study per water body (U.S. Environmental Protection Agency, 2010). The multiyear water and fish tissue Hg monitoring plan (Mebane and MacCoy, 2013) was developed and intended to provide a framework for a cooperative Hg sampling program.

Although selenium (Se) analysis is not required for NPDES permit compliance, analysis of composite samples of fish tissue for Se was done to provide information for future risk assessments. The potential for Hg toxicity reduction in the presence of certain concentrations of Se has not been considered in fish consumption advisories or in comparing to criteria for the protection of human health but may be important in the future (U.S. Environment Protection Agency, 2001; Idaho Department of Environmental Quality, 2005).

Purpose and Scope

This report contains water-quality and fish-tissue data that meet the requirements of the first year (2013) of the implementation of the Hg monitoring plan in the Boise and Snake Rivers and Brownlee Reservoir (Mebane and MacCoy, 2013). The data contained in this report will provide a reference to which future determinations of Hg in water and fish can be compared.

This report contains Hg in water data collected by City of Boise personnel and Hg and Se in fish tissue collected by the USGS as described in the Hg monitoring plan (Mebane and MacCoy, 2013). Data collected by both agencies are reported here to meet the City of Boise NPDES permit requirements. Water samples and fish samples were collected at the same locations, near but not on the same dates.

Site Locations

Six sampling sites (table 1) were selected to meet specific requirements for the City of Boise NPDES permits (U.S. Environmental Protection Agency, 2012b, 2012c). Site locations (fig. 1) were required to be upstream (Eckert) and downstream (Middleton) of the city's two wastewater facilities at Lander Street and West Boise on the Boise River, near the middle of the lower Boise River watershed (Middleton), at the mouth of the Boise River (Boise mouth), in the Snake River upstream (Murphy) and downstream (Nyssa) of the mouth of the Boise River, and in the impounded section of the Snake River downstream of the Boise River confluence (Brownlee). The site downstream of both wastewater facilities, Middleton, also was used to meet the middle of the lower Boise River watershed site requirement.

Information for multiple years of sampling is provided in the Hg monitoring plan (Mebane and MacCoy, 2013). In 2013, water and fish were collected at all six sampling sites (table 1, fig. 1). The sites were selected to meet specific NPDES requirements and to try to isolate the fish populations being sampled. There are no natural fish passage barriers between sampling sites to prevent fish migration. There are manmade diversions in the Boise River between Eckert and Middleton that act as fish passage barriers.

Targeted Fish Species

The targeted fish species were based on the Idaho Department of Environmental Quality (2005) recommendation that fish tissue samples should be representative of the Hg exposures likely encountered from recreational or subsistence fishing, and upon previous fish sampling at selected locations in the Boise and Snake Rivers and Brownlee Reservoir (table 2; Clark and Maret, 1998; Richter and Chandler, 2003; MacCoy, 2006).

Targeting specific fish species is inherently difficult because of fish movement and sample timing; the sampling crew in 2013 was fortunate to collect 10 individuals of a targeted fish species of edible size at each site. Sampling at Murphy provided an opportunity to collect samples of two targeted fish species, smallmouth bass and channel catfish. Smallmouth bass and channel catfish are important sport fish in the Snake River and these samples will provide a much needed comparison of Hg in fish tissue between species and sites (fig. 2).

Field Sampling Procedures

Water samples were collected by City of Boise personnel using low-level Hg surface-water sampling protocols (City of Boise, Public Works field standard operating procedures, written commun., March 12, 2014) following collection and quality-control procedures similar to those described in Lewis and Brigham (2004) and Essig (2010). Precleaned 200 mL glass bottles were used to collect dip water samples. Samples were placed on ice and delivered to the Boise City Public Works Water Quality Laboratory, within the same day. One field blank was used for quality control for each sampling site trip as described in Wilde (2006, section 4.3 "Quality-Control Samples").

Fish-tissue sampling was done during low-flow conditions to reduce hazards from maneuvering the boat or raft in high water velocities. Fish were captured by electrofishing; additional information on electrofishing sampling safety, sampling permit requirements, and justification for sampling outside the summer season is given in the Hg monitoring plan (Mebane and MacCoy, 2013).

Procedures for collecting and processing fish for analysis of Hg are similar to those outlined in Scudder and others (2008). Sampling procedures specific to this project are given here. Boat and raft electrofishing were used to collect targeted fish species at a site. Fish of edible size (greater than 25 cm in length, or for smallmouth bass, greater than 30 cm in length) were placed in a live well. When at least 10 individuals of the same species were collected, the fish were weighed, measured, euthanized, and placed in separate clean, clear, zip-seal bags on wet ice. Fish were transported to the sample preparation area at the USGS Idaho Water Science Center in Boise and processed within 24 hours to minimize possible loss of sample integrity. Two skinless fillets were obtained from each fish, one for the primary sample and the second retained frozen as a backup sample for Hg analysis. Approximately 5 g of tissue from each of the 10 fish collected from a site was composited for Se analysis. The backup samples were retained until data were received from the laboratory and reviewed. Fish-tissue samples for Hg analysis were shipped on dry ice to the USGS Mercury Research Laboratory (USGS MRL) in Middleton, Wisconsin. Fish-tissue samples for Se analysis were shipped on dry ice to the USGS National Water Quality Laboratory (NWQL) in Denver, Colorado.

Laboratory Methods

Mercury in Water

Unfiltered water samples were analyzed for Hg using laboratory methods consistent with EPA Method 1631 E (U.S. Environmental Protection Agency, Office of Water, 2002) by the Boise City Public Works Water Quality Laboratory. This method provided a minimum detection level of 0.2 ng/L.

Mercury in Fish Tissue

The USGS MRL provided analysis of Hg in fish tissue consistent with EPA Method 7473 (U.S. Environmental Protection Agency, 2007). This method provides a minimum detection limit of 0.005 mg/kg dry weight, based on a 20–50 mg sample size. The detection limit is sufficiently low to quantify Hg concentrations in fish tissue at less than 0.30 mg/kg wet weight. Additional USGS MRL quality-assurance procedures can be found on their website (U.S. Geological Survey, 2013).

Selenium in Fish Tissue

A sample size of less than 20 g is needed for Se analysis. The composite of a portion of tissue from each of 10 fish from a site resulted in a sufficient sample size. NWQL analysis of Se in tissue used methods by Garbarino and others (2006). This method provided a minimum level of detection of 0.1 mg/kg dry weight. The Hg monitoring plan (Mebane and MacCoy, 2013) specified a composite of at least three fish per site. The composite of 10 fish provided a more than adequate sample for general Se screening.

Results

Data-Quality Objectives

All data-quality objectives were met for this study and provide reliable Hg concentrations in water and in fish-tissue data collected from the Snake and Boise Rivers and Brownlee Reservoir. The data-quality objectives of this monitoring study are listed here:

1. The fish collected represent the species and size ranges likely to be caught and consumed by recreational or subsistence anglers in the vicinity of the sampling sites.
2. Sample processing, handling, storing, and shipping to the laboratory used sufficient quality-assurance measures to avoid introducing sample contamination or bias to the data.
3. Laboratory analytical techniques had sufficiently low detection limits to quantify Hg concentrations in fish tissue at less than 0.24 mg/kg wet weight (Idaho RPTE threshold).
4. Quality-control samples were analyzed to provide accuracy and precision information for the fish-tissue samples collected (table 3). The accuracy of the data was within 20 percent of the most probable value for certified reference tissues for Hg, and the precision (repeatability) of the data was within 20 percent relative standard deviation in laboratory replicate analyses.
5. Following review, fish-tissue data were made available to the public and environmental management agencies through the online USGS National Water Information System (NWIS) and in this report.
6. Mercury concentrations in water quality-control samples are presented with the water sample results (table 4) and include field blanks for each site and laboratory matrix spikes. Hg concentrations in all but one field blank were less than or equal to the laboratory detection limit (0.2 ng/L). Matrix spike recovery of Hg in water samples ranged from 96.5 to 100.5 percent, well within the required recovery of 71–125 percent of the theoretical value. The relative percent difference of matrix spike duplicates required by EPA is less than 24 percent (U.S. Environmental Protection Agency, Office of Water, 2002). The observed relative percent difference of the matrix spike recovery was zero at two significant figures.

Mercury in Water

Hg in water was collected at all six sampling sites on the Boise and Snake Rivers and Brownlee Reservoir. Hg concentrations, field blank concentrations, and laboratory matrix spike recovery data are shown in table 4. Concentrations of Hg in water were between 0.73 and 8.78 ng/L with the highest concentration from Brownlee Reservoir. All samples were less than the EPA aquatic life criteria (12 ng/L, Idaho Department of Water Quality, 2014). All field blanks were near or less than the detection level except for the sample taken at the Boise mouth site (detection of 0.70 ng/L Hg). The blank values, as well as the laboratory spike recovery, were within data-quality objectives.

Fish Species, Size, and Tissue Mercury Concentrations

The concentration of Hg in fish tissue, as well as the length and weight of the fish collected from the Boise and Snake Rivers and Brownlee Reservoir in October 2013, are shown in table 5. A graphical summary of Hg concentrations in all fish from all sites is shown in figure 3 and summaries of individual fish length and Hg concentrations are shown in figure 4. All fish-tissue data presented in this report can be accessed on the USGS NWIS website (U.S. Geological Survey, 2014). Although this study was not designed to compare fish size to Hg concentration, graphical summaries of fish size and Hg concentration are presented, as they may be useful for fish advisory development.

Mountain whitefish were collected at the upstream site (Eckert) and at the downstream site (Middleton) of the City of Boise wastewater facilities on the Boise River (fig. 1). Total fish lengths were between 260 and 450 mm with the larger fish sampled from Eckert (fig. 4A). Median Hg concentrations in mountain whitefish were 0.18 and 0.17 mg/kg at Eckert and Middleton, respectively. Concentrations did not exceed the Idaho water-quality criterion, RPTE threshold level, or the IFCAP action level (table 5, fig. 3).

Smallmouth bass were collected from Murphy, the site upstream of the mouth of the Boise River and Brownlee. Total lengths were between 305 and 452 mm with the largest fish sampled from Brownlee (fig. 4B). Median Hg concentrations in smallmouth bass were 0.17 mg/kg from Murphy and 0.32 mg/kg from Brownlee (fig. 3). Brownlee smallmouth bass exceeded the Idaho water-quality criterion, RPTE threshold level, and the IFCAP action level (table 5, fig. 3).

Channel catfish were collected from the Boise mouth, Murphy, and Nyssa sites. Individual fish lengths were between 510 and 708 mm with the largest individual fish sampled from Murphy. There was no discernible relation between fish length and Hg concentrations in channel catfish (fig. 4C). Median Hg concentrations in channel catfish tissue were 0.28 mg/kg from Boise mouth, 0.18 mg/kg from Murphy, and 0.14 mg/kg from Nyssa (table 5, fig. 3). Boise mouth channel catfish exceeded the Idaho water-quality criterion, RPTE threshold level, and the IFCAP action level (table 5, fig. 3). Median Hg concentrations were similar between the channel catfish (0.18 mg/kg) and smallmouth bass from Murphy (0.17 mg/kg).

Selenium in Fish Tissue

The concentration of Se in composite fish-tissue samples from the Boise and Snake Rivers and Brownlee Reservoir collected in October 2013 are given in table 6. Percent water, percent solids, and wet weight concentrations are given to better compare the results to Hg wet-weight concentrations. Concentrations of Se ranged from 0.07 to 0.49 mg/kg wet weight; concentrations were lowest for mountain whitefish and highest for smallmouth bass.

Summary

Water samples and sport fish of edible size were collected for mercury (Hg) analysis from six sites in the Boise and Snake Rivers and Brownlee Reservoir to meet a portion of the City of Boise's National Pollution Discharge and Elimination System Hg monitoring requirements. One water sample was collected from each of the six sites. Ten mountain whitefish were collected from each of the Boise River sites at Eckert and Middleton. Ten smallmouth bass were collected from Murphy and Brownlee. Ten channel catfish were collected from Boise mouth, and from Murphy and Nyssa, upstream and downstream of the confluence of the Boise and Snake Rivers. Two different species, smallmouth bass and channel catfish, were collected from Murphy to compare Hg concentrations between species.

Hg concentrations in water ranged from 0.73 to 1.21 ng/L for the five river sites. Hg concentration was highest (8.78 ng/L) in a water sample from the Brownlee Reservoir at Burnt River site (Brownlee). All samples were less than EPA aquatic life criteria (12 ng/L).

Median fish-tissue Hg concentrations ranged between 0.17 mg/kg in mountain whitefish from Boise River near Middleton, Idaho site and 0.32 mg/kg in smallmouth bass from Brownlee. Hg concentrations in channel catfish from the Boise River at mouth near Parma, Idaho and smallmouth bass from Brownlee exceeded the Idaho water-quality criterion (0.30 mg/kg), reasonable potential to exceed threshold level (>0.24 mg/kg), and the Idaho Fish Consumption Advisory Program action level (0.22 mg/kg).

Concentrations of Se in fish tissue collected from the Boise and Snake Rivers and Brownlee Reservoir were between 0.07 and 0.49 mg/kg wet weight. Se concentrations were lowest in mountain whitefish and highest in smallmouth bass. Se composite samples collected in this study may provide information for comparing Se concentrations between species and for future use in fish consumption advisories.

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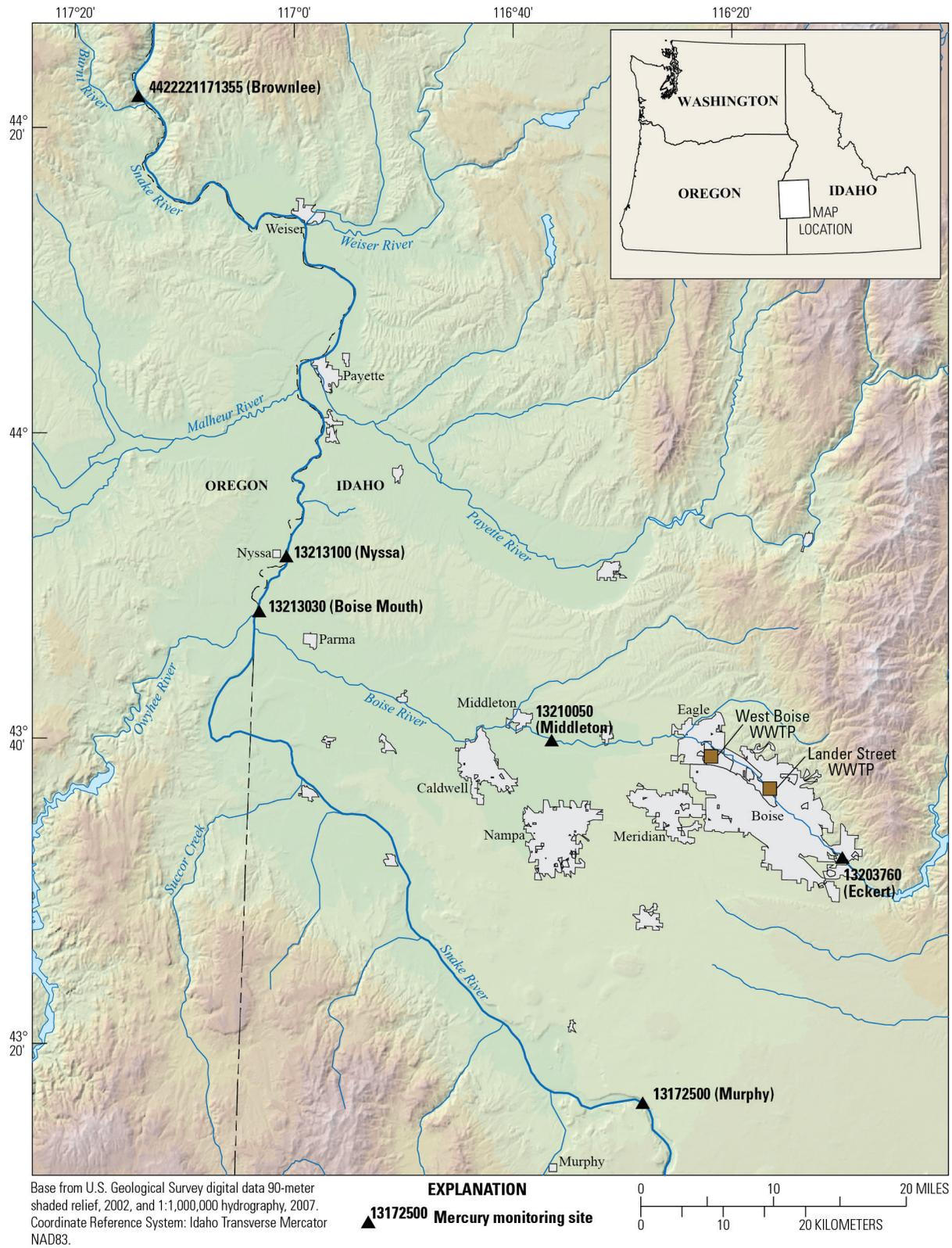


Figure 1. Map showing location of sites where water and fish tissue samples were collected for analysis of total mercury and selenium, Idaho and Oregon, October 2013.



Figure 2. Photographs of channel catfish (A) and smallmouth bass (B) at the Snake River near Murphy sampling site, October 2013. (Photographs taken by Dorene MacCoy)

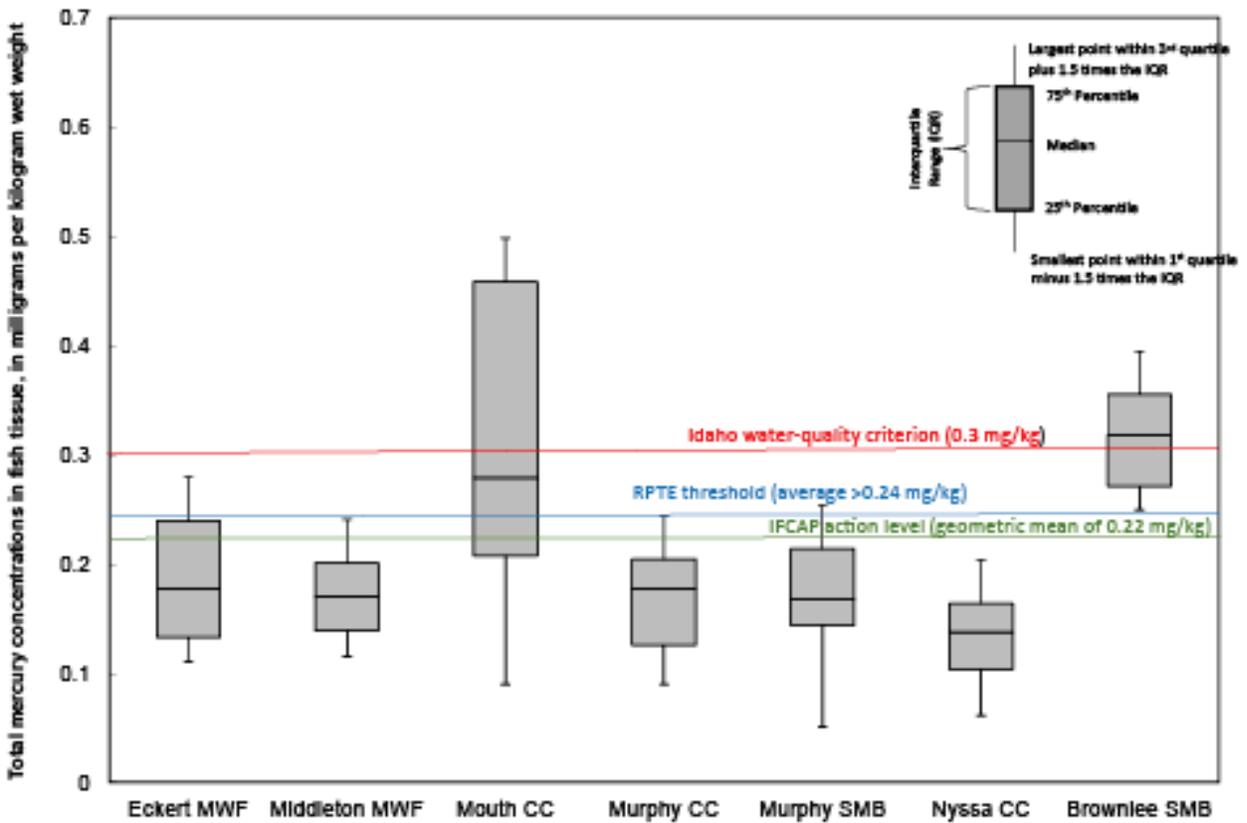
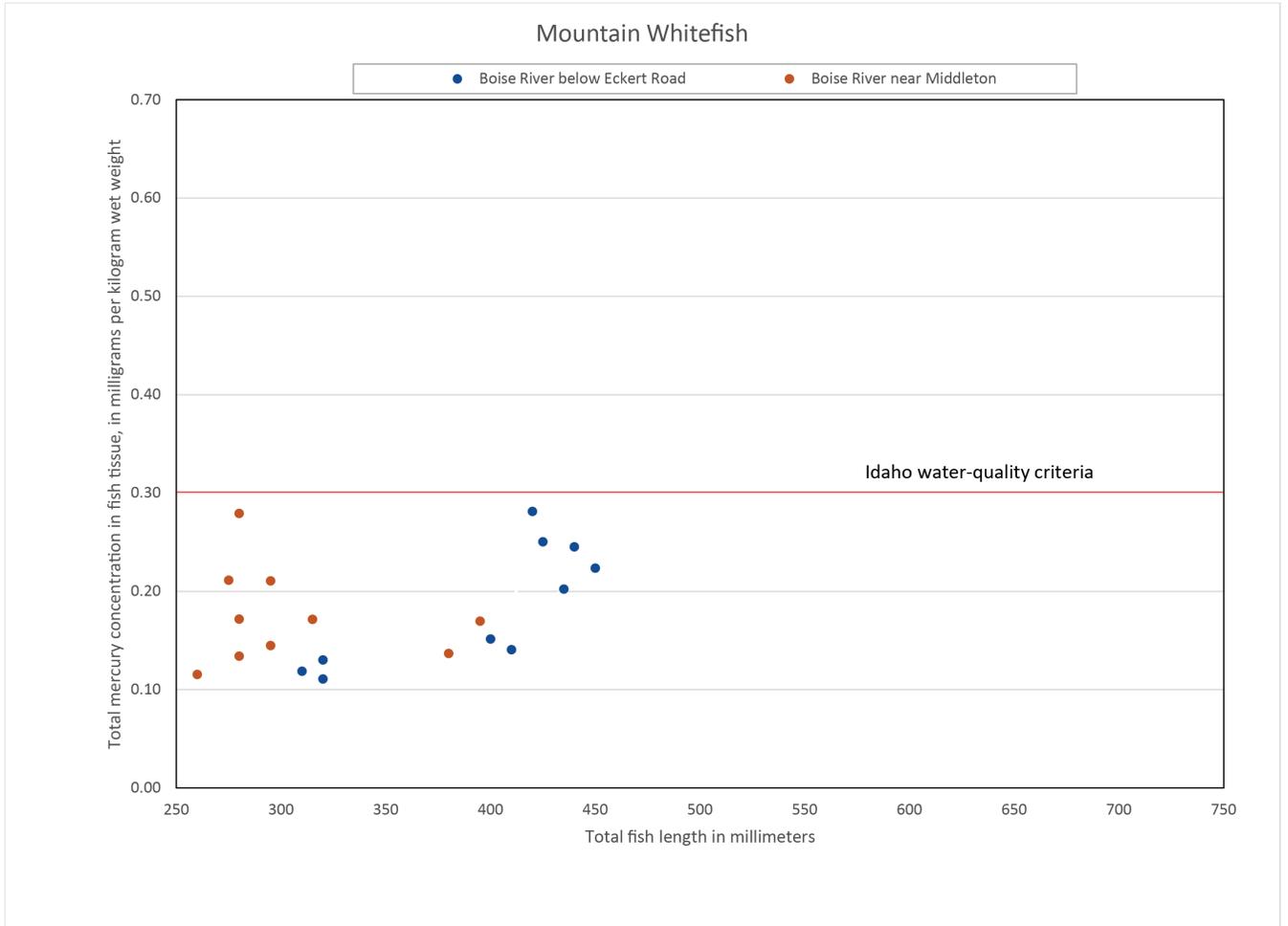
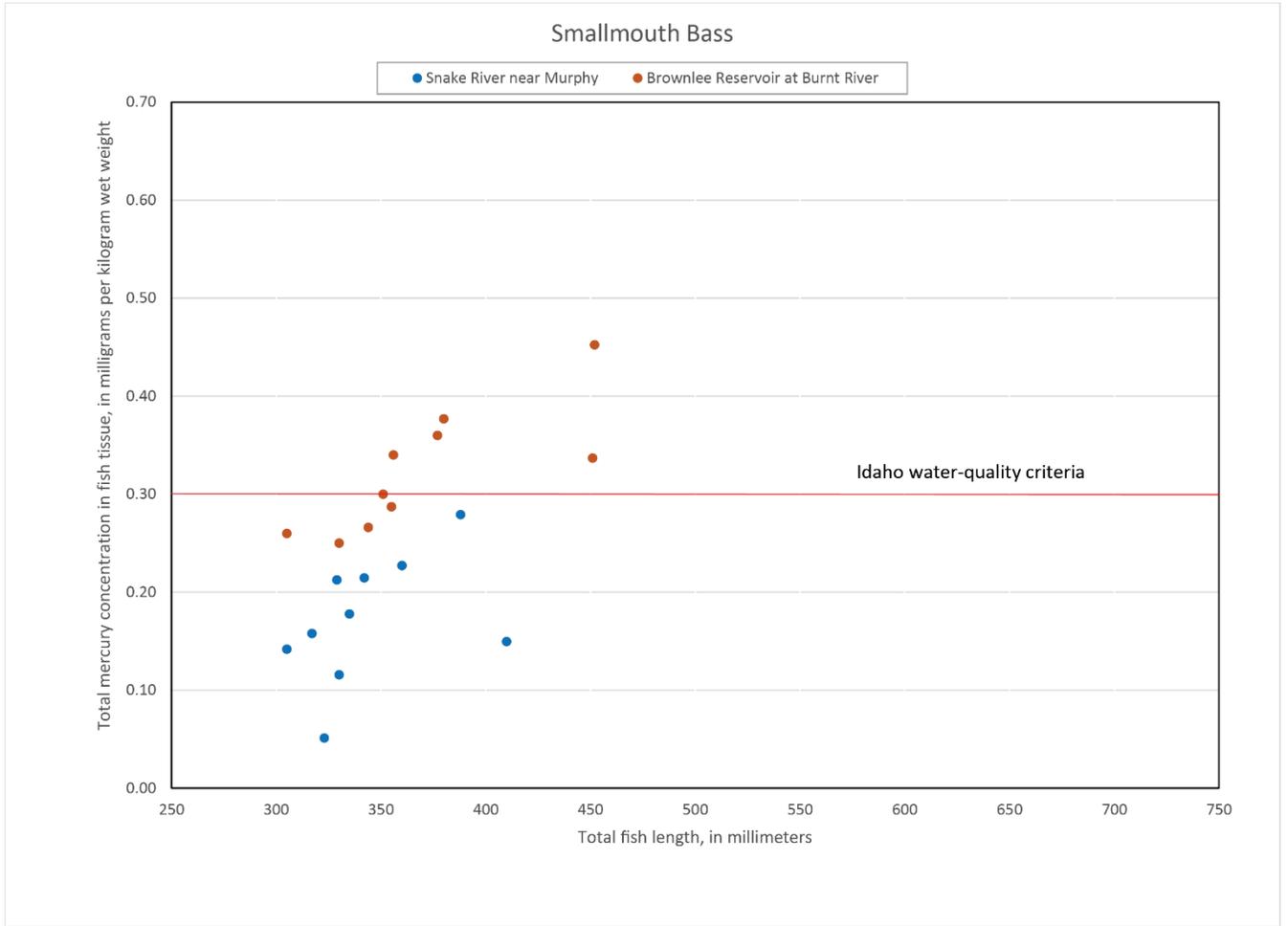


Figure 3. Boxplot showing total mercury concentrations in fish tissue collected from sites in the Boise and Snake Rivers and Brownlee Reservoir, October 2013, Idaho and Oregon. (CC, channel catfish; SMB, smallmouth bass; MWF, mountain whitefish; RPTe threshold, reasonable potential to exceed 80 percent of the Idaho mercury water-quality criterion of 0.30 milligrams per kilogram (mg/kg) wet weight mercury or greater than 0.24 mg/kg in an average of 10 fish; IFCAP action level, Idaho Fish Consumption Advisory Project recommends consideration of issuing a fish advisory when the geometric mean of mercury in 10 fish exceeds 0.22 mg/kg wet weight). Site names are shown in table 1.



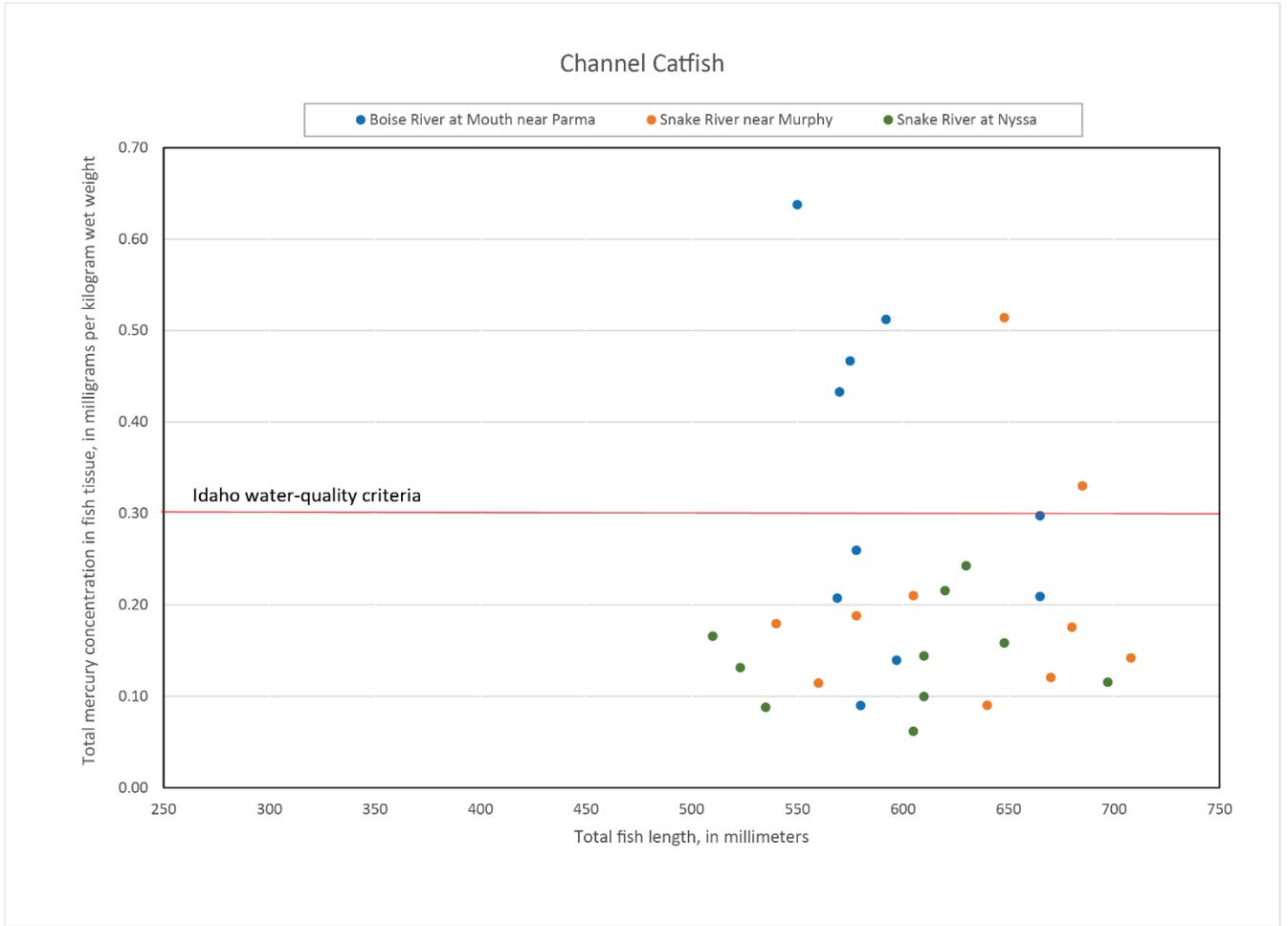
A.

Figure 4. Graphs showing total mercury tissue concentrations and total length of mountain whitefish (A), smallmouth bass (B) and channel catfish (C) in samples from the Boise and Snake Rivers and Brownlee Reservoir, Idaho and Oregon, October 2013.



B.

Figure 4. —Continued.



C.

Figure 4. —Continued.

Table 1. Sites in the Boise and Snake Rivers and Brownlee Reservoir where water and fish samples were collected for mercury analysis, Idaho and Oregon, 2013.

[Site locations are shown in figure 1. NAD83, North American Datum of 1983]

USGS site identification	Site name	Site short name	Decimal latitude (NAD83)	Decimal longitude (NAD83)
13203760	Boise River at Eckert Road, near Boise, Idaho	Eckert	43.56572	-116.13205
13210050	Boise River near Middleton, Idaho	Middleton	43.68488	-116.57374
13213030	Boise River at mouth, near Parma, Idaho	Boise Mouth	43.81516	-117.02043
13172500	Snake River near Murphy, Idaho	Murphy	43.29183	-116.42094
13213100	Snake River at Nyssa, Oregon	Nyssa	43.87611	-116.9825
4422221171355	Brownlee Reservoir at Burnt River, Oregon	Brownlee	44.37266	-117.23295

Table 2. Targeted fish species in the Boise and Snake Rivers and Brownlee Reservoir, Idaho and Oregon.

[Site locations are shown in figure 1. Species in **bold** were collected in October 2013 for tissue analysis]

USGS site identification	Site name	Expected species
13203760	Boise River at Eckert Road, near Boise, Idaho	Mountain whitefish (<i>Prosopium williamsoni</i>) , brown trout (<i>Salmo trutta</i>), rainbow trout (<i>Oncorhynchus mykiss</i>)
13210050	Boise River near Middleton, Idaho	Mountain whitefish , brown trout, largemouth bass (<i>Micropterus salmoides</i>), smallmouth bass (<i>Micropterus dolomieu</i>)
13213030	Boise River at mouth, near Parma, Idaho	Mountain whitefish, largemouth bass, smallmouth bass, channel catfish (<i>Ictalurus punctatus</i>)
13172500	Snake River near Murphy, Idaho	Smallmouth bass , largemouth bass, channel catfish
13213100	Snake River at Nyssa, Oregon	Smallmouth bass, mountain whitefish, largemouth bass, channel catfish
4422221171355	Brownlee Reservoir at Burnt River, Oregon	Smallmouth bass , crappie spp. (<i>Pomoxis</i> sp.), largemouth bass, channel catfish

Table 3. Quality-control sample results for analysis of total mercury in fish from the Boise and Snake Rivers and Brownlee Reservoir, Idaho and Oregon, October 2013.

[Certified reference material from the International Atomic Energy Agency, laboratory identification number beginning with IAEA (2003); a description of IAEA-407 is available at <http://www.iaea.org/nael/refmaterial/iaea407.pdf>. Triplicate samples from a single fish at a sampling site (laboratory identification samples beginning with MSC) were analyzed separate from the original sample for laboratory method repeatability (precision) and reported as relative standard deviation (RSD), RSD = Standard deviation of the three replicate concentrations divided by the average of those replicates. ng/g, nanograms per gram]

Certified				
Laboratory identification	Date of analysis	Mercury, ng/g dry weight	Laboratory detection limit, ng/g dry weight	Certified reference material percent recovery
IAEA-407	2/18/2014	213	2.99	96.02
IAEA-407	2/18/2014	221	3.4	99.57
IAEA-407	2/18/2014	224	3.56	100.81
IAEA-407	2/18/2014	240	4.22	108.12
IAEA-407	2/18/2014	246	3.48	110.74
IAEA-407	2/18/2014	238	2.46	107.21
IAEA-407	2/19/2014	236	5.31	106.35
IAEA-407	2/19/2014	248	6.1	111.77
IAEA-407	2/19/2014	248	4.63	111.78
IAEA-407	2/19/2014	247	6.02	111.23
IAEA-407	2/19/2014	249	6.45	112.08
IAEA-407	2/19/2014	248	7.3	111.72
IAEA-407	2/19/2014	244	6.57	109.92
IAEA-407	2/19/2014	250	6.39	112.54
IAEA-407	2/19/2014	248	5.95	111.53
IAEA-407	2/20/2014	237	10.53	106.9
IAEA-407	2/20/2014	247	7.72	111.45
IAEA-407	2/20/2014	247	10.48	111.14
IAEA-407	2/20/2014	254	7.02	114.26
IAEA-407	2/20/2014	255	11.29	114.86
IAEA-407	2/21/2014	249	5.68	112.05
IAEA-407	2/21/2014	242	3.91	109.13
IAEA-407	2/21/2014	240	4.51	108.26
IAEA-407	2/21/2014	245	4.29	110.35
IAEA-407	2/24/2014	238	4.73	107.38
IAEA-407	2/24/2014	242	4.59	108.93
IAEA-407	2/24/2014	251	4.99	113.2

Triplicate				
Laboratory identification	Date of analysis	Mercury, ng/g dry weight	Laboratory detection limit, ng/g dry weight	Triplicate relative standard deviation (percent)
MSC568T	2/18/2014	957	4.1	1.1
MSC568T	2/18/2014	975	3.88	
MSC568T	2/18/2014	976	4.1	
MSC718T	2/18/2014	929	4.42	1.43
MSC718T	2/18/2014	956	4.04	
MSC718T	2/18/2014	948	3.83	
MSC299T	2/19/2014	714	10.1	1.2
MSC299T	2/19/2014	697	8.92	
MSC299T	2/19/2014	704	6.69	
MSC565T	2/19/2014	1,215	12.14	0.91
MSC565T	2/19/2014	1,227	12.9	
MSC565T	2/19/2014	1,237	11.38	
MSC887T	2/19/2014	328	8.35	4.39
MSC887T	2/19/2014	351	7.34	
MSC887T	2/19/2014	357	13.38	
MSC891T	2/20/2014	3,035	13.03	3.27
MSC891T	2/20/2014	3,173	15.12	
MSC891T	2/20/2014	3,237	15.57	
MSC726T	2/21/2014	626	5.71	2.4
MSC726T	2/21/2014	656	5.15	
MSC726T	2/21/2014	648	5.78	
MSC730T	2/21/2014	982	7.45	2.08
MSC730T	2/21/2014	1,020	7.73	
MSC730T	2/21/2014	988	6.37	

Table 4. Total mercury concentrations in water from the Boise and Snake Rivers and Brownlee Reservoir, and associated field blanks and laboratory matrix spike recovery for samples collected in October and November 2013.

[Site locations are shown in figure 1. Samples collected by City of Boise personnel and analyzed by Boise City Public Works Water Quality Laboratory, Boise, Idaho. <, less than]

USGS site identification	Site name	Sample date	Sample time	Total mercury concentration (ng/L) ^a	Field blank concentration (ng/L)
13203760	Boise River at Eckert Road, near Boise, Idaho	11/1/2013	0937	0.73	0.22
13210050	Boise River near Middleton, Idaho	11/1/2013	1057	0.89	<0.20
13213030	Boise River at mouth, near Parma, Idaho	11/1/2013	1221	1.21	0.70
13172500	Snake River near Murphy, Idaho	10/28/2013	1515	0.93	<0.20
13213100	Snake River at Nyssa, Oregon	10/28/2013	1323	1.20	<0.20
4422221171355	Brownlee Reservoir at Burnt River, Oregon	10/28/2013	1138	8.78	<0.20

Boise City Public Works Water Quality Laboratory matrix spike recovery

Lab sample identification	Date of analysis	Total mercury spike concentration (µg/L)	Percent recovery
AP07402	11/12/2013	0.19	100.5
AP07406	11/12/2013	0.19	96.5

^a Environmental Protection Agency total mercury chronic aquatic life criteria for Idaho is 12 ng/L (Idaho Department of Environmental Quality, variously dated).

Table 5. Individual sport fish tissue total mercury concentrations, fish size data, and statistical site summaries in samples collected from the Boise and Snake Rivers and Brownlee Reservoir, Idaho and Oregon, October 2013.

[Site locations are shown in figure 1. g, gram; mm, millimeter; mg/kg, milligram per kilogram]

Site name	Sample date	Time	Total length (mm)	Weight (g)	Mercury, dry weight (mg/kg)	Percent water	Percent Solids	Mercury, wet weight (mg/kg)	Mercury, wet weight geometric mean per site (mg/kg)	Mercury, wet weight median per site (mg/kg)	Mercury, wet weight average per site (mg/kg)
Mountain whitefish											
Boise River at Eckert Road, near Boise, Idaho	10/29/2013	1001	440	959	0.975	74.84	25.16	0.25	0.18	0.18	0.19
		1002	420	626	1.19	76.36	23.64	0.28			
		1003	450	850	0.94	76.21	23.79	0.22			
		1004	400	702	0.507	70.11	29.89	0.15			
		1005	425	699	0.851	70.57	29.43	0.25			
		1006	435	866	0.626	67.68	32.32	0.20			
		1007	410	636	0.58	75.74	24.26	0.14			
		1008	320	360	0.436	74.56	25.44	0.11			
		1009	310	330	0.418	71.58	28.42	0.12			
		1010	320	315	0.498	73.84	26.16	0.13			
Boise River near Middleton, Idaho	10/21/2013	1201	380	491	0.527	74.03	25.97	0.14	0.17	0.17	0.17
		1202	280	182	1.08	74.14	25.86	0.28			
		1203	395	506	0.652	73.97	26.03	0.17			
		1204	295	217	0.948	77.78	22.22	0.21			
		1205	315	321	0.708	75.77	24.23	0.17			
		1206	280	207	0.783	78.06	21.94	0.17			
		1207	280	186	0.534	74.88	25.12	0.13			
		1208	295	211	0.625	76.81	23.19	0.14			
		1209	275	190	0.906	76.67	23.33	0.21			
		1210	260	149	0.433	73.32	26.68	0.12			

Site name	Sample date	Time	Total length (mm)	Weight (g)	Mercury, dry weight (mg/kg)	Percent water	Percent Solids	Mercury, wet weight (mg/kg)	Mercury, wet weight geometric mean per site (mg/kg)	Mercury, wet weight median per site (mg/kg)	Mercury, wet weight average per site (mg/kg)
Channel catfish											
Boise River at mouth, near Parma, Idaho	10/30/2013	1501	665	3,485	1.58	81.18	18.82	0.30	0.28	0.28	0.33
		1502	580	2,086	0.35	74.29	25.71	0.09			
		1503	570	1,595	2.23	80.59	19.41	0.43			
		1504	550	1,211	3.17	79.88	20.12	0.64			
		1505	665	3,080	1.08	80.65	19.35	0.21			
		1506	592	2,245	2.33	78.02	21.98	0.51			
		1507	578	2,017	1.25	79.22	20.78	0.26			
		1508	569	2,007	1.02	79.68	20.32	0.21			
		1509	575	1,785	2.29	79.62	20.38	0.47			
		1510	597	2,326	0.644	78.35	21.65	0.14			
Snake River near Murphy, Idaho	10/22/2013	1201	540	1,747	0.889	79.83	20.17	0.18	0.18	0.18	0.21
		1202	578	1,841	0.898	79.06	20.94	0.19			
		1203	670	2,663	0.568	78.79	21.21	0.12			
		1204	648	2,526	2.7	80.96	19.04	0.51			
		1205	708	3,880	0.648	78.09	21.91	0.14			
		1206	560	1,717	0.536	78.64	21.36	0.11			
		1207	685	3,526	1.65	79.83	20.17	0.33			
		1208	640	2,715	0.446	79.02	20.98	0.09			
		1209	605	2,496	0.988	79.13	20.87	0.21			
		1210	680	3,017	0.853	79.42	20.58	0.18			
Smallmouth bass											
Snake River near Murphy, Idaho	10/22/2013	1001	330	557	0.517	77.63	22.37	0.12	0.16	0.17	0.17
		1002	388	906	1.28	78.19	21.81	0.28			
		1003	305	442	0.64	77.86	22.14	0.14			
		1004	410	1,108	0.659	77.3	22.7	0.15			
		1005	342	661	0.918	76.63	23.37	0.21			
		1006	323	441	0.219	76.69	23.31	0.05			
		1007	360	689	1.03	77.94	22.06	0.23			
		1008	329	596	0.953	77.71	22.29	0.21			
		1009	335	535	0.788	77.45	22.55	0.18			
		1010	317	457	0.696	77.34	22.66	0.16			

Site name	Sample date	Time	Total length (mm)	Weight (g)	Mercury, dry weight (mg/kg)	Percent water	Percent Solids	Mercury, wet weight (mg/kg)	Mercury, wet weight geometric mean per site (mg/kg)	Mercury, wet weight median per site (mg/kg)	Mercury, wet weight average per site (mg/kg)
Channel catfish											
Snake River at Nyssa, Oregon	10/22/2013	1331	535	1,409	0.33	73.37	26.63	0.09	0.13	0.14	0.14
		1332	523	1,299	0.528	75.12	24.88	0.13			
		1333	510	1,202	0.704	76.47	23.53	0.17			
		1334	610	2,187	0.822	82.47	17.53	0.14			
		1335	697	2,122	0.524	77.98	22.02	0.12			
		1336	605	2,228	0.247	75.04	24.96	0.06			
		1337	620	2,159	1.27	83.04	16.96	0.22			
		1338	610	2,368	0.368	72.92	27.08	0.10			
		1339	648	2,399	0.821	80.72	19.28	0.16			
		1340	630	2,404	1.23	80.27	19.73	0.24			
Smallmouth bass											
Brownlee Reservoir at Burnt River, Oregon	10/23/2013	1401	452	1,306	2.05	77.93	22.07	0.45	0.32	0.32	0.32
		1402	355	647	1.28	77.57	22.43	0.29			
		1403	451	1,378	1.52	77.85	22.15	0.34			
		1404	344	620	1.17	77.26	22.74	0.27			
		1405	380	880	1.75	78.47	21.53	0.38			
		1406	330	456	1.13	78.18	21.82	0.25			
		1407	305	424	1.18	77.81	22.19	0.26			
		1408	377	789	1.64	78.19	21.81	0.36			
		1409	351	737	1.3	76.85	23.15	0.30			
		1410	356	673	1.52	77.74	22.26	0.34			

Table 6. Selenium concentrations in individual sport fish tissue collected from the Boise and Snake Rivers and Brownlee Reservoir, Idaho and Oregon, October 2013.

[Site locations are shown in figure 1. mg/kg, milligram per kilogram; dry wt, dry weight; wet wt, weight wet]

Site name	USGS site Identification	Sample date	Species	Number in composite	Selenium (mg/kg, dry wt)	Percent water	Percent solids	Selenium (mg/kg, wet wt)
Boise River at Eckert Road, near Boise, Idaho	13203760	10/29/2013	Mountain whitefish	10	0.30	75.43	24.57	0.07
Boise River near Middleton, Idaho	13210050	10/21/2013	Mountain whitefish	10	0.77	78.82	21.18	0.16
Boise River at mouth, near Parma, Idaho	13213030	10/30/2013	Channel catfish	10	0.72	80.57	19.43	0.14
Snake River near Murphy, Idaho	13172500	10/22/2013	Channel catfish	10	0.67	78.36	21.64	0.14
Snake River near Murphy, Idaho	13172500	10/22/2013	Smallmouth bass	10	2.13	77.07	22.93	0.49
Snake River at Nyssa, Oregon	13213100	10/22/2013	Channel catfish	10	0.88	79.79	20.21	0.18
Brownlee Reservoir at Burnt River, Oregon	4422221171355	10/23/2013	Smallmouth bass	10	1.48	78.39	21.61	0.32

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