

Prepared in cooperation with the Bureau of Land Management

Characterization of the Quality of Water, Bed Sediment, and Fish in Mittry Lake, Arizona, 2014–15



Scientific Investigations Report 2017–5008

Cover. Mittry Lake, facing northeast. Photo by Edyth Hermosillo of the U.S. Geological Survey.

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By Edyth Hermosillo and Alissa L. Coes

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U.S. Department of the Interior
U.S. Geological Survey

U.S. Department of the Interior
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U.S. Geological Survey, Reston, Virginia: 2017

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Suggested citation:

Hermosillo, E., and Coes, A.L., 2017, Characterization of the quality of water, bed sediment, and fish in Mittry Lake, Arizona, 2014–15: U.S. Geological Survey Scientific Investigations Report 2017-5008, 13 p., <https://doi.org/10.3133/sir20175008>.

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Conversion Factors

Inch/Pound to International System of Units

Multiply	By	To obtain
Area		
acre	0.00405	square kilometer (km ²)
Flow rate		
cubic foot per second (ft ³ /s)	0.02832	cubic meter per second (m ³ /s)

Temperature in degrees Celsius (°C) may be converted to degrees Fahrenheit (°F) as °F = (1.8 × °C) + 32.

Temperature in degrees Fahrenheit (°F) may be converted to degrees Celsius (°C) as follows °C = (°F – 32) / 1.8.

Abbreviated Water-Quality and Isotopic Units

Chemical concentrations are given in metric units. Chemical concentrations in water are given in milligrams per liter (mg/L) or micrograms per liter (µg/L). Milligram per liter is a unit expressing the solute per unit volume (liter) of water. One thousand micrograms per liter is equivalent to 1 milligram per liter. For concentrations less than 7,000 milligrams per liter, the numerical value is about the same as for concentrations in parts per million. Chemical concentrations in bed sediment and fish are given in milligrams per kilogram (mg/kg) or micrograms per kilogram (µg/kg). Bacteria concentrations are given in colony-forming units per 100 milliliters (cfu/100 mL).

Specific conductance is given in microsiemens per centimeter (µS/cm) at 25 °C. Microsiemens per centimeter at 25 °C is a unit expressing the amount of electrical conductivity of a solution as measured between opposite faces of a centimeter cube of solution at a specified temperature of 25 °C.

Abbreviations

ADEQ	Arizona Department of Environmental Quality
AZGFD	Arizona Game and Fish Department
BLM	Bureau of Land Management
EPA	U.S. Environmental Protection Agency
MLWA	Mittry Lake Wildlife Area
NWQL	National Water Quality Laboratory
PEC	probable effect concentration
RPD	relative percent difference
SMCL	secondary maximum contaminant level
SQG	sediment quality guidance
TEC	threshold effect concentration
USGS	U.S. Geological Survey

Characterization of the Quality of Water, Bed Sediment, and Fish in Mittry Lake, Arizona, 2014–15

By Edyth Hermosillo and Alissa L. Coes

Abstract

Water, bed-sediment, and fish sampling was conducted in Mittry Lake, Arizona, in 2014–15 to establish current water-quality conditions of the lake. The parameters of temperature, dissolved-oxygen concentration, specific conductance, and alkalinity were measured in the field. Water samples were collected and analyzed for dissolved major ions, dissolved trace elements, dissolved nutrients, dissolved organic carbon, dissolved pesticides, bacteria, and suspended-sediment concentrations. Bed-sediment and fish samples were analyzed for trace elements, halogenated compounds, total mercury, and methylmercury.

U.S. Environmental Protection Agency secondary maximum contaminant levels in drinking water were exceeded for sulfate, chloride, and manganese in the water samples. Trace-element concentrations were relatively similar between the inlet, middle, and outlet locations. Concentrations for nutrients in all water samples were below the Arizona Department of Environmental Quality's water-quality standards for aquatic and wildlife uses, and all bacteria levels were below the Arizona Department of Environmental Quality's recommended recreational water-quality criteria. Three out of 81 pesticides were detected in the water samples.

Trace-element concentrations in bed sediment were relatively consistent between the inlet, middle, and outlet locations. Lead, manganese, nickel, and zinc concentrations, however, decreased from the inlet to outlet locations. Concentrations for lead, nickel, and zinc in some bed-sediment samples exceeded consensus-based sediment-quality guidelines probable effect concentrations. Eleven out of 61 halogenated compounds were detected in bed sediment at the inlet location, whereas three were detected at the middle location, and five were detected at the outlet location. No methylmercury was detected in bed sediment. Total mercury was detected in bed sediment at concentrations below the consensus-based sediment-quality guidelines probable effect concentration.

Sixteen trace elements were detected in at least one of the fish-tissue samples, and trace-element concentrations were relatively consistent between the three fish-tissue samples. Seven halogenated compounds were detected in at least one of the whole-body fish samples; four to five compounds were detected in each fish. One fish-tissue sample exceeded the U.S. Environmental Protection Agency human health consumption criteria for methylmercury.

Introduction

Mittry Lake is an oxbow lake of the Colorado River and is located in the Mittry Lake Wildlife Area (MLWA), near Yuma, Arizona (fig. 1). The MLWA was created in 1951 through the Fish and Wildlife Coordination Act. At that time, the Arizona Game and Fish Department (AZGFD) entered into a lease and agreement with the U.S. Department of the Interior to develop and manage the MLWA to improve the fish and wildlife habitat potential and to provide compatible recreational opportunities for present and future generations (Arizona Game and Fish Department, 2012). The area is currently managed cooperatively by the AZGFD, the Bureau of Reclamation, and the Bureau of Land Management (BLM).

The MLWA encompasses approximately 3,575 acres of desert upland, marsh, wetland, and open water (Bureau of Land Management, 2012). About 12 cubic feet per second of water continually flows into Mittry Lake from the Colorado River by way of an inlet channel through Imperial Dam, and water flows out of Mittry Lake back to the Colorado River by way of an outlet weir through Laguna Dam. The area is popular for nature study, birdwatching, small game hunting, and sport fishing. The most common fish species found in Mittry Lake are largemouth bass (*Micropterus salmoides*), flathead (*Pylodictis olivaris*) and channel (*Ictalurus punctatus*) catfish, bluegill (*Lepomis macrochirus*), tilapia (*Tilapia* spp.), crappie (*Pomoxis* spp.), and carp (*Cyprinus* spp.) (Arizona Game and Fish Department, 2012).

In May 2011, hundreds of acres burned in a wildfire along the lower Colorado River, including 75 percent of the MLWA. Because of the wildfire, a Proposed Action was established by the BLM to rehabilitate the burned area within the MLWA. The Proposed Action has led to lake restoration, including marsh dredging, revegetation, and fish habitat improvement (Stewart, 2011). Dredging the marsh, however, has the potential to detrimentally affect the water quality in Mittry Lake because contaminants previously deposited in the lakebed sediment could be reintroduced to the water column. Inorganic and organic contaminants can accumulate in primary producers and invertebrates and bioaccumulate in organisms at higher trophic levels. In addition, the 2011 wildfire may also have affected water quality by increasing sediment and nutrient loads; large loads of sediment and nutrients can distress the available biological habitat (Riggan and others, 1994). The potential for water-quality degradation because of the

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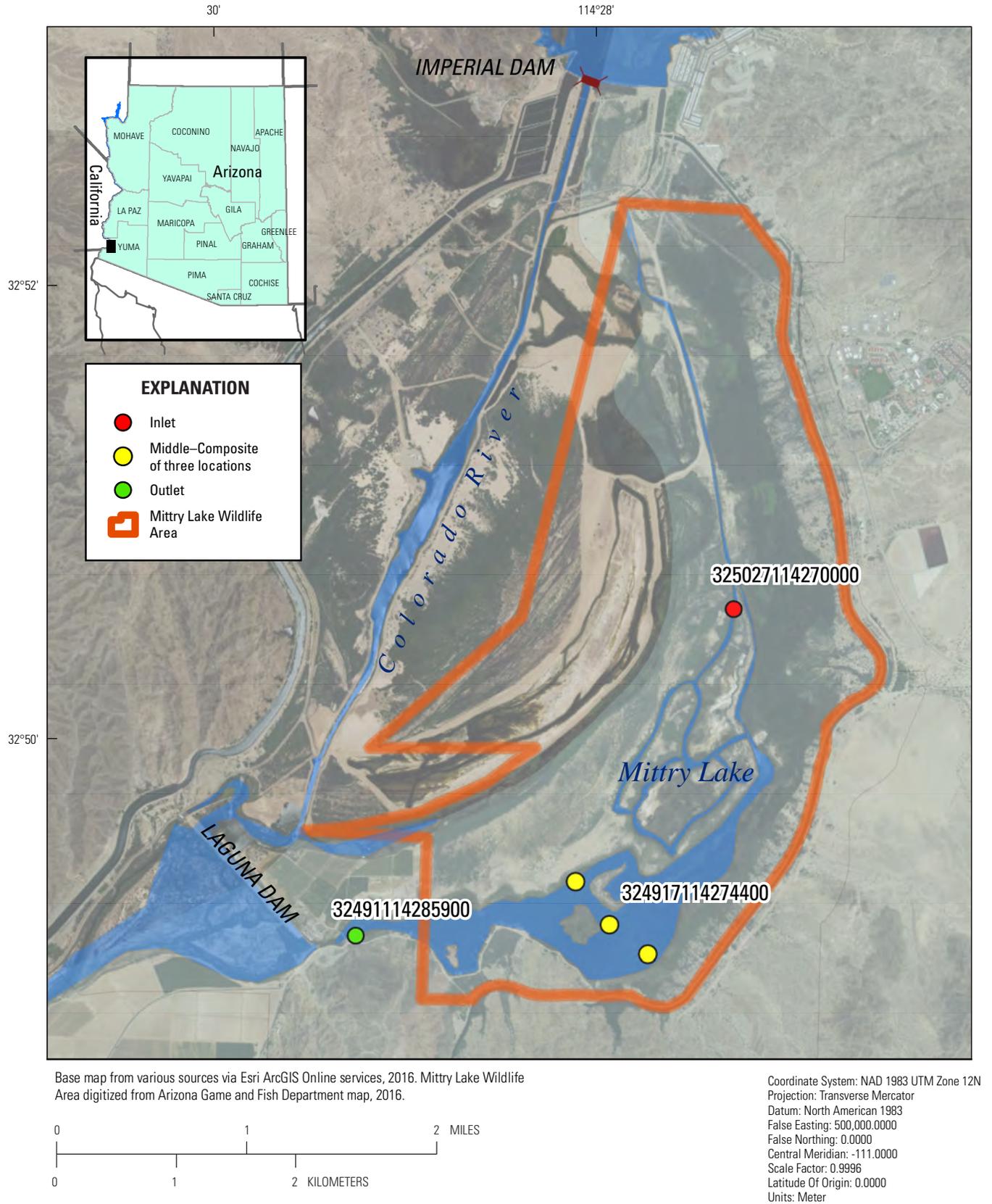


Figure 1. Map showing location of Mittry Lake Wildlife Area and water and bed-sediment sampling locations, Arizona.

Table 1. Geographic location information of surface-water sites selected for water-quality and sediment sampling in the Mittry Lake area, Arizona, 2014–15.

[°, degrees; ', minutes; ", seconds]

Site name	Site number	Latitude	Longitude
Mittry Lake near Inlet, Arizona	325027114270000	32° 50' 27.7"	–114° 27' 02.9"
Mittry Lake at Middle, Arizona	324917114274400	32° 49' 26.8"	–114° 27' 57.3"
		32° 49' 15.6"	–114° 27' 46.2"
		32° 49' 08.2"	–114° 27' 33.9"
Mittry Lake near Outlet, Arizona	324911114285900	32° 49' 11.6"	–114° 29' 01.8"

2011 wildfire and restoration activities led to the BLM and the U.S. Geological Survey (USGS) to enter into an agreement to determine current water-quality conditions in Mittry Lake.

Purpose

The purpose of this report is to present a general assessment of current (2014–15) quality of water, bed sediment, and fish in Mittry Lake to establish a baseline for future studies. Bed-sediment and fish data will provide information for current and future restoration programs.

Methods

Mittry Lake was sampled in 2014 and 2015 at the lake's inlet, middle, and outlet (table 1). The sampling point at the lake's middle consisted of a composite of three sampling points across the middle of the lake. Sites were sampled for water in August and November, 2014, and in February and May, 2015, to represent all four seasons. Sites were sampled for bed sediment and fish in August 2014. Water samples were analyzed for field constituents, dissolved major ions, dissolved trace elements, dissolved nutrients, dissolved organic carbon, dissolved pesticides, bacteria, and suspended sediment concentrations. Bed-sediment and fish samples were analyzed for trace elements, halogenated compounds (including organochlorine pesticides, polychlorinated biphenyls, and brominated flame retardants), and total mercury and methylmercury.

Water Sampling and Analysis

All water samples were collected and processed according to standard USGS protocols outlined in the USGS National Field Manual (U.S. Geological Survey, variously dated). Prior to water sampling, oxygen and temperature profiles were measured using a multiparameter meter at different depths in the lake to check for lake stratification. The dissolved oxygen and temperature profiles indicated that the lake was not stratified, similar to what previous studies have indicated at Mittry Lake

(Schleusner, 1997), and therefore vertical profiles were adequate for the collection of water samples. Water samples were collected using a DH-95 sampler with a 1-liter Teflon bottle from a boat using the dip method by removing the nozzle from the sampler bottle and sampling the entire vertical. Samples for major ions, trace elements, and nutrients were composited in an 8-liter plastic churn to split samples into subsamples. Water samples for pesticides were collected in a 4-liter glass carboy, and water samples for suspended sediment were collected in a 4-liter plastic bottle. Samples for bacteria analysis were collected by hand-dipping a sterile 500-milliliter glass bottle at each sampling site. Pesticide samples were processed first and were filtered with a stainless steel plate-filter assembly through a precombusted 0.7-micrometer-pore-size glass microfiber filter to remove suspended particulate matter and collected in 1-liter baked amber glass bottles. Major ion, trace-element, nutrient, and organic carbon samples were withdrawn from the churn and filtered through a 0.45-micrometer capsule filter. Chemical treatment was used for sample preservation after filtration for subsamples analyzed for organic carbon (sulfuric acid), phosphorus (sulfuric acid), and trace metals (nitric acid and hydrochloric acid). All samples were kept chilled until analysis.

All water samples were analyzed for dissolved major ions, dissolved trace elements, dissolved nutrients, dissolved organic carbon, bacteria, and suspended sediment. Only the August 2014 samples were analyzed for dissolved pesticides. Water samples were sent to the USGS National Water Quality Laboratory (NWQL) for analysis. Major ions, trace elements, and nutrients were analyzed by collision/reaction cell inductively coupled plasma-mass spectrometry (Garbarino and others, 2005). Pesticide samples were analyzed by gas chromatography/mass spectrometry (Zaugg and others, 1995). Mercury was analyzed by cold vapor–atomic fluorescence spectrometry (Fishman and Friedman, 1989). Phosphorus was analyzed by Kjeldahl digestion (Patton and Truitt, 1992).

Bacterial analysis for *Escherichia coli* was processed using the membrane filtration method in which an appropriate sample volume passed through a membrane filter with a pore size of 0.45 micrometer to retain the bacteria present. The filter was placed in a petri dish saturated with a culture medium that was selective for coliform growth. The petri dish containing the filter was incubated, upside down, for 24 hours

at the appropriate temperature. After incubation, the colonies that were present were identified and counted.

Suspended sediment samples were analyzed at the Cascades Volcano Observatory Sediment Laboratory in Washington. Analyses were completed using the filtration method (percent by weight of total sediment in sample). The filtration method is used only on samples with sand concentrations less than 10,000 parts per million and clay concentrations less than 200 parts per million; filters are used to separate water from the sediment. This method is based on “Standard Test Methods for Determining Sediment Concentration in Water Samples” (American Society for Testing Materials, 2002).

Field parameter readings of temperature, specific conductance, pH, and dissolved oxygen were measured at the time of sampling using a multiparameter meter. The meter was calibrated in the field prior to sampling. Alkalinity concentrations were determined using the inflection-point titration method on filtered samples. The inflection-point titration method uses inflection points—determined by constructing a titration curve that plots change in pH divided by change in titrant volume added to the sample—to determine equivalence points.

Bed-Sediment Sampling and Analysis

All bed-sediment samples were collected and processed according to standard USGS protocols outlined in the USGS National Field Manual (U.S. Geological Survey, variously dated). Bed-sediment samples were collected in August 2014 at each sampling site using a BMH-60 sampler. Samples were freeze-dried to a consistent weight and homogenized. Samples for trace elements were analyzed at the USGS Central Region Mineral and Environmental Resources Laboratory by inductively coupled plasma-atomic emission spectrometry and inductively coupled plasma-mass spectrometry (Taggart, 2002). Samples were analyzed by the USGS Mercury Research Laboratory in Wisconsin for total mercury by cold vapor atomic adsorption (U.S. Geological Survey, 2016a) and for methylmercury by cold vapor fluorescence detection (DeWild and others, 2004). Halogenated compounds in bed sediment were analyzed at the NWQL by gas chromatography/mass spectrometry as described by Wagner and others (2014).

Fish Sampling and Analysis

All fish samples were collected and processed following the USGS National Water Quality Assessment Program protocols for studies of contaminants in biological tissue (Crawford and Luoma, 1993). Fish samples were collected in August 2014 by boat electrofishing with the assistance of AZGFD. Fish are well distributed throughout the lake and were captured as they were encountered. USGS site numbers were assigned to each fish sample for database purposes. Only largemouth bass (*Micropterus salmoides*) were collected as they are relatively common in the lake and are the top predator. Skinless dorsal muscle tissue was dissected from three

individual fish for trace elements, total mercury, and methylmercury analysis. Three additional individual fish were analyzed as whole-body samples for halogenated compounds. Samples were frozen immediately after collection until analysis. Trace elements were analyzed at the USGS Central Region Mineral and Environmental Resources Laboratory in Colorado by inductively coupled plasma-atomic emission spectrometry and inductively coupled plasma-mass spectrometry (Taggart, 2002). Samples were analyzed at the USGS Mercury Research Laboratory in Wisconsin for total mercury by cold vapor atomic adsorption (U.S. Geological Survey, 2016b) and for methylmercury by cold vapor atomic fluorescence (U.S. Geological Survey, 2016b). Halogenated compounds in whole fish were analyzed at the USGS NWQL by gas chromatography/mass spectrometry as described by Nilsen and others (2014).

Quality Assurance

Field protocols outlined in the USGS National Field Manual (U.S. Geological Survey, variously dated) were followed to ensure consistent field collection and processing procedures. Quality-control samples were collected and analyzed to investigate possible bias and variability in the environmental samples. One field blank for water and one field replicate for water were collected and analyzed for dissolved major ions, dissolved trace elements, dissolved nutrients, and dissolved organic carbon in water samples. One field matrix spike for bed sediment and one field matrix spike for whole fish were collected and analyzed for halogenated compounds. Two geochemical reference materials, SCo1 (Smith, 1995) and SGR-1b (Wilson, 2001), were analyzed for trace elements by the USGS Central Region Mineral and Environmental Resources Laboratory. The USGS NWQL follows strict internal and external quality-assurance and quality-control procedures (Stevenson, 2012).

Results

All water, bed-sediment, and fish data collected as part of this study are archived in the USGS National Water Information System database (U.S. Geological Survey, 2016c). All data are also available in appendixes 1–7 of this report.

Quality-Control Data

The analytical results for the field blank water sample were less than the NWQL reporting levels for all major ions, trace elements, nutrients, and organic carbon, except for barium (appendix 1). The detected concentration of barium in the blank (0.7 microgram per liter [$\mu\text{g/L}$]), however, was less than 100 times the lowest environmental sample concentration for water; barium contamination is not considered significant. The relative percent differences (RPD) between analytes in

the field replicate water sample and the associated environmental water sample were calculated to understand potential variability (appendix 1). The RPDs of replicate concentrations were less than 10 percent for all major ions, were 0.4 percent for organic carbon, and ranged from 0 to 13.3 percent for all nutrients and from 0 to 17 percent for most trace elements. The RPDs for manganese and nickel were 60 and 61 percent, respectively; variability may have affected the environmental water data for these compounds.

The recoveries for the bed-sediment field matrix spike sample for halogenated compounds ranged from 73 to 212 percent, with 89 percent of the recoveries between 73 and 150 percent (appendix 2). None of the seven compounds with recoveries greater than 150 percent were detected in the environmental bed-sediment samples; high bias most likely did not affect the environmental data for these compounds. The RPDs between the certified values and the laboratory analytical results for the bed-sediment geochemical reference material were less than 20 percent for 28 trace elements (appendix 3). The RPDs were greater than 20 percent for 11 trace elements. Two trace elements, selenium and zinc, had RPDs between the laboratory results and certified values that were greater than 80 percent; laboratory bias may have affected the environmental bed-sediment data for these compounds.

The percent recoveries for the whole fish field matrix spike sample for halogenated compounds ranged from 60 to 244 percent, with 83 percent of the recoveries between 60 and 150 percent (appendix 2). Nine of 10 of the compounds with recoveries greater than 150 percent were not detected in the environmental whole fish samples; high bias most likely did not affect the environmental data for these compounds. One compound, p,p'-dichlorodiphenyldichloroethylene (DDE), had a recovery of 177 percent and was detected in all three environmental fish samples; environmental concentrations of this compound may be biased high.

Water-Chemistry Data

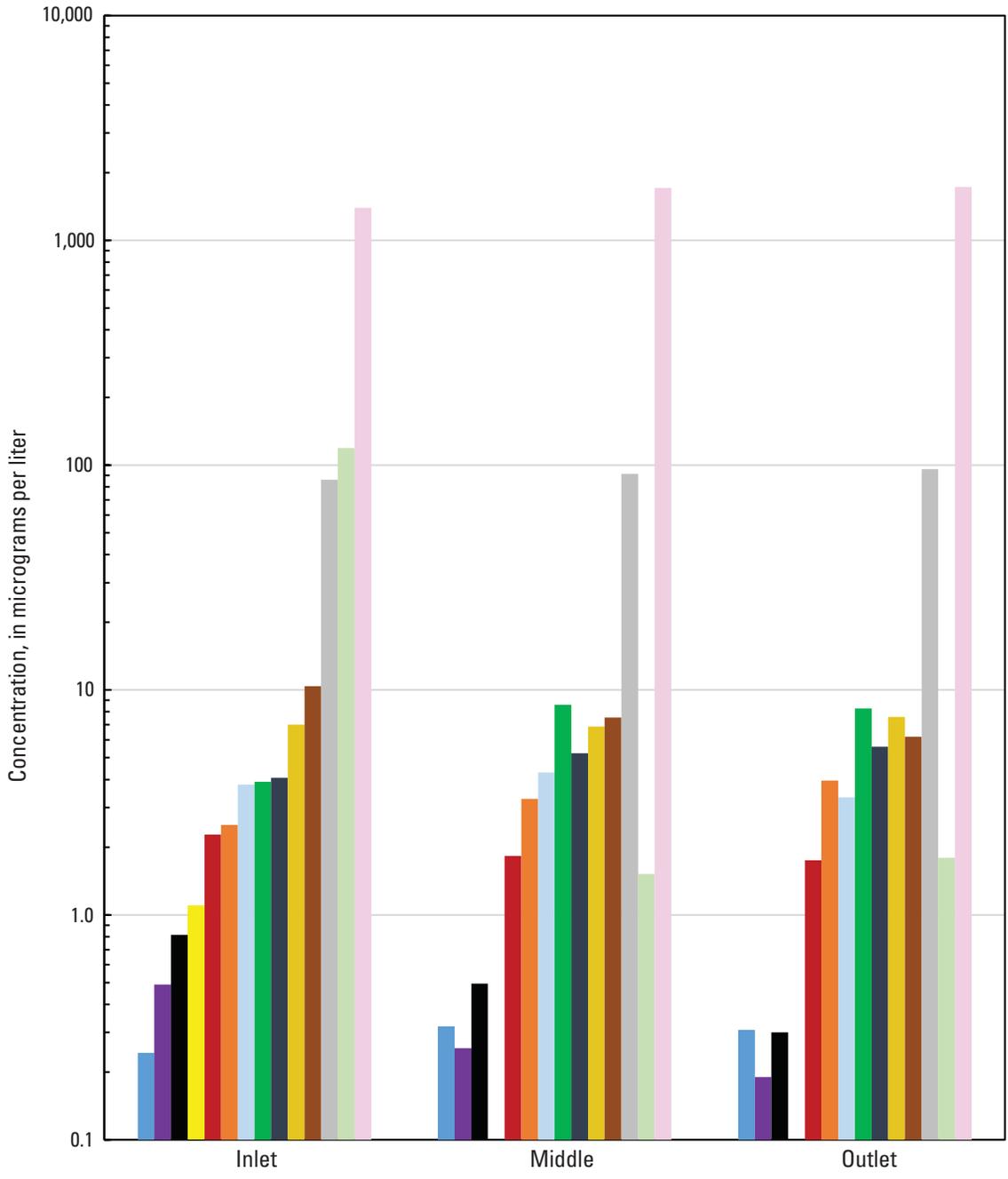
Water temperature, pH, specific conductance, and dissolved oxygen were measured during every water sample collected (appendix 4). The pH was generally neutral; all field measurements were between 7.7 and 8.5. On average, specific conductance was highest near the inlet (1,983 microsiemens per centimeter at 25 degrees Celsius [$\mu\text{S}/\text{cm}$ at 25 °C]) and lowest towards the middle (1,790 $\mu\text{S}/\text{cm}$). Dissolved oxygen (DO) ranged from 6.0 to 10.2 milligrams per liter (mg/L); average DO was highest near the inlet (7.7 mg/L) and lower near the middle and outlet (7.5 and 7.4 mg/L, respectively). The concentrations of sulfate in all water samples exceeded the U.S. Environmental Protection Agency (EPA) secondary maximum contaminant level (SMCL) in drinking water of 250 mg/L (U.S. Environmental Protection Agency, 2016a). Samples collected near the inlet exceeded the SMCL of 250 mg/L for chloride (305 mg/L)

in November 2014 and the SMCL of 50 $\mu\text{g}/\text{L}$ for manganese (384 mg/L) in February 2015 (U.S. Environmental Protection Agency, 2016a). The RPD for the one manganese replicate sample pair was 60 percent (appendix 1); part of the high manganese concentration in November 2014 may be attributed to variability related to manganese sampling and analytical procedures. Overall, average trace-element concentrations in water were relatively consistent between the inlet, middle, and outlet locations (fig. 2). Concentrations for nutrients in all water samples were below the Arizona Department of Environmental Quality (ADEQ) surface water-quality standards for aquatic and wildlife (Arizona Department of Environmental Quality, 2009). *Escherichia coli* levels were under the ADEQ recommended recreational water-quality criteria of 235 cfu/100 mL (colony-forming units per 100 milliliters) for full-body contact (Arizona Department of Environmental Quality, 2009) for all samples. Three out of 81 pesticides were detected during the August 2014 sampling: Dacthal was detected at all three locations, terbuthylazine was detected at the inlet location, and trifluralin was detected at the middle location.

Bed-Sediment Chemistry Data

Overall, trace-element concentrations in bed sediment were relatively consistent between the inlet, middle, and outlet locations (appendix 5; fig. 3). Lead, manganese, nickel, and zinc concentrations, however, decreased from the inlet to outlet locations. Eleven out of 61 halogenated compound concentrations were detected in the bed-sediment samples (fig. 4). Eleven compounds were detected in bed sediment at the inlet location, whereas three were detected at the middle location, and five were detected at the outlet location. Methylmercury concentrations in bed-sediment samples were all less than the minimum reporting level of 0.08 microgram per kilogram ($\mu\text{g}/\text{kg}$).

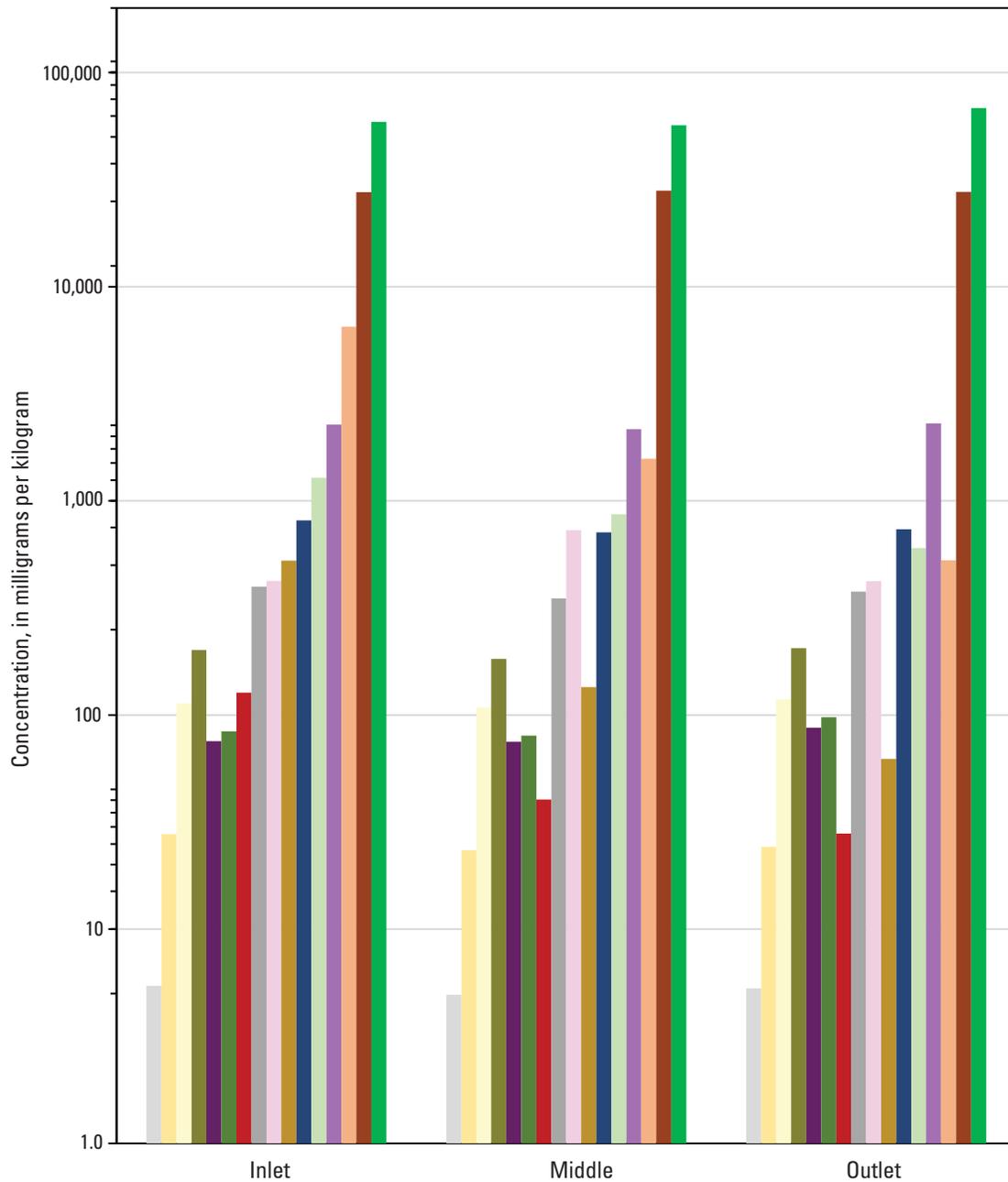
Bed-sediment concentrations of arsenic, cadmium, chromium, copper, lead, nickel, zinc, five halogenated compounds, and total mercury were compared to consensus-based sediment quality guidelines (SQG) described in MacDonald and others (2000; table 2). These SQG are benchmarks established to estimate the potential toxicity of bed sediment to biota. MacDonald and others (2000) classified SQGs into two categories: (1) low level—threshold effect concentration (TEC)—in which adverse effects to sediment-dwelling organisms are not expected and (2) high level—probable effect concentration (PEC)—in which harmful effects on sediment-dwelling organisms are expected to occur. Measured trace-metal concentrations in bed-sediment samples exceeded the PEC of 48.6 milligrams per kilogram (mg/kg) for nickel near the inlet, 128 mg/kg for lead near the inlet and at the middle, and 459 mg/kg for zinc at all sample locations. Zinc concentrations in bed sediment, however, may be associated with high laboratory bias based on the reference material results (appendix 3). None of the detected halogenated compounds



EXPLANATION

- Strontium
- Manganese
- Barium
- Iron
- Molybdenum
- Vanadium
- Aluminum
- Uranium
- Arsenic
- Nickel
- Copper
- Selenium
- Beryllium
- Antimony

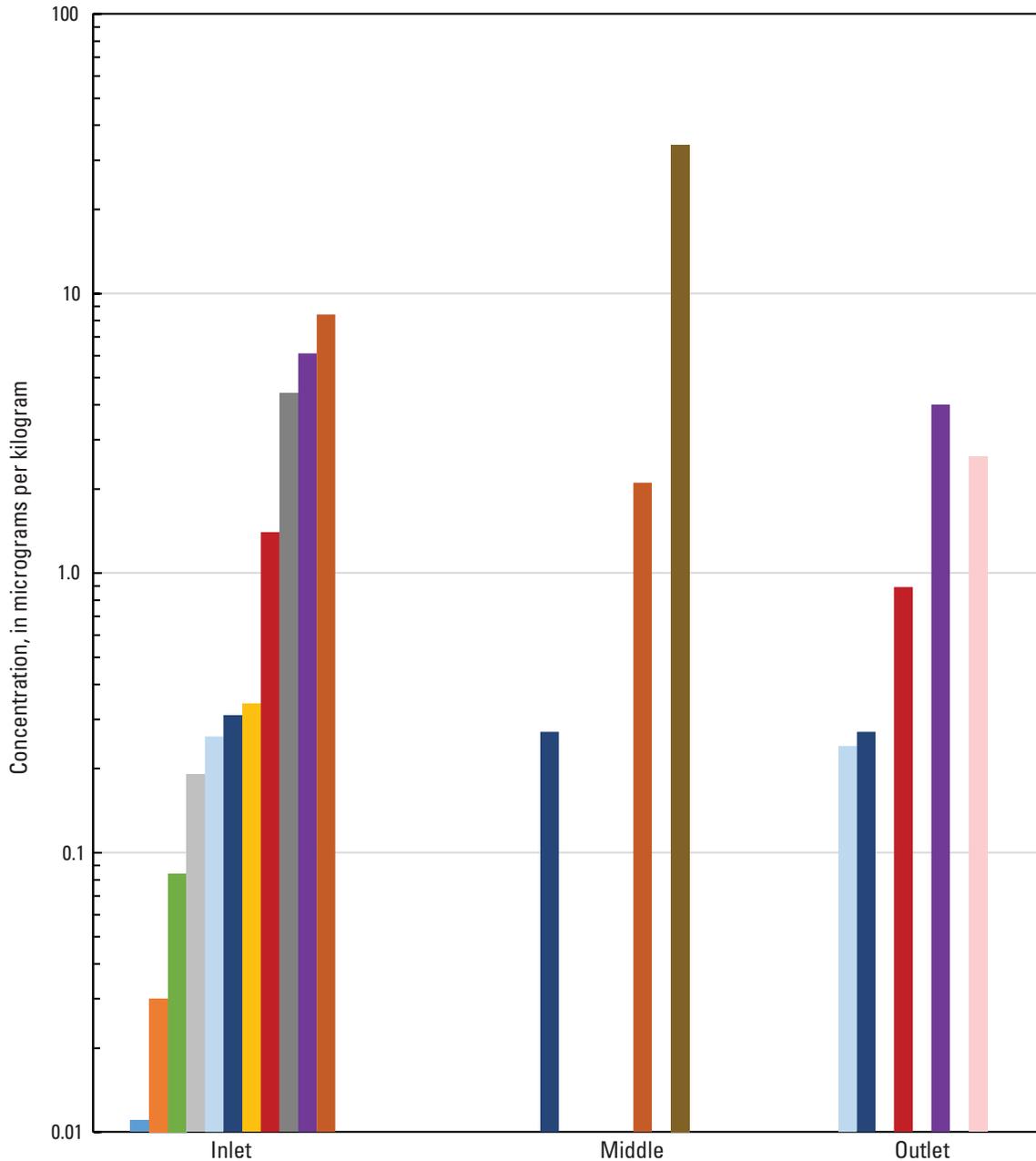
Figure 2. Graph of average trace-element concentrations in water at the inlet, middle, and outlet locations of Mittry Lake, Arizona, 2014–15.



EXPLANATION

- | | | | | |
|------------|-----------|--------------|------------|----------|
| Aluminum | Barium | Cesium | Beryllium | Silver |
| Iron | Nickel | Praseodymium | Antimony | Thulium |
| Zinc | Rubidium | Arsenic | Ytterbium | Bismuth |
| Titanium | Vanadium | Cobalt | Erbium | Tantalum |
| Manganese | Lanthanum | Thorium | Molybdenum | Terbium |
| Phosphorus | Copper | Scandium | Uranium | Thallium |
| Lead | Lithium | Niobium | Dysprosium | Holmium |
| Strontium | Chromium | Gallium | Selenium | Ercopium |
| | Cerium | Yttrium | Gadolinium | Cadmium |
| | | Neodymium | Samarium | |

Figure 3. Graph of trace-element concentrations in bed sediment at the inlet, middle, and outlet locations of Mittry Lake, Arizona, August 20, 2014.



EXPLANATION

- Polychlorinated biphenyl 52
- Hexachlorobenzene
- Polychlorinated biphenyl 138
- p,p'-Dichlorodiphenyldichloroethane
- Polychlorinated biphenyl 110
- Pentachloronitrobenzene
- Dacthal
- Polybrominated diphenyl ether 47
- Polybrominated diphenyl ether 66
- 1,2-Bis(2,4,6-tribromophenoxy)ethane
- Endosulfan I
- Polybrominated diphenyl ether 154
- Polybrominated diphenyl ether 153

Figure 4. Graph of halogenated compound concentrations in bed sediment at the inlet, middle, and outlet locations of Mittry Lake, Arizona, August 20, 2014.

exceeded the PECs. Bed-sediment total mercury concentrations ranged from 31.6 to 45.3 µg/kg (table 2), well below the PEC of 1,060 µg/kg mercury.

Fish Chemistry Data

Sixteen trace elements were detected in at least one of the fish-tissue samples (appendix 6; fig. 5). Overall, trace-element concentrations were relatively consistent between the three fish-tissue samples. Seven out of 58 halogenated compounds were detected in at least one of the whole-body fish samples (appendix 7; fig. 6). Four compounds were detected in fish 1, and five compounds were detected in fish 2 and 3. One of the compounds detected in all three fish, p,p'-dichlorodiphenyl-dichloroethylene (DDE), had a field matrix spike recovery of 177 percent; the environmental concentrations in the three fish may be biased high.

Total mercury dry weight concentrations in fish-tissue ranged from 534 to 1,920 µg/kg, and methylmercury dry weight concentrations ranged from 495 to 1,510 µg/kg (appendix 6). Total mercury and methylmercury dry weight concentrations increased with the weight of the total fish. Total mercury and methylmercury dry weight intake rates reported

by the laboratory were converted to wet weight intake rates (as-consumed or uncooked weight of fish) to compare concentrations to the EPA human health consumption criteria by using this equation:

where

- IR_{dw} = dry weight intake rate
- IR_{ww} = wet weight intake rate
- W = percent moisture

Total mercury wet weight concentrations in fish-tissue ranged from 96.5 to 304 µg/kg, and methylmercury concentrations ranged from 104 to 386 µg/kg (appendix 6). One of the three individual samples of methylmercury concentrations in fish muscle tissue exceeded the human health consumption criterion calculated by the EPA of 300 µg/kg wet weight (U.S. Environmental Protection Agency, 2016b).

Conclusion

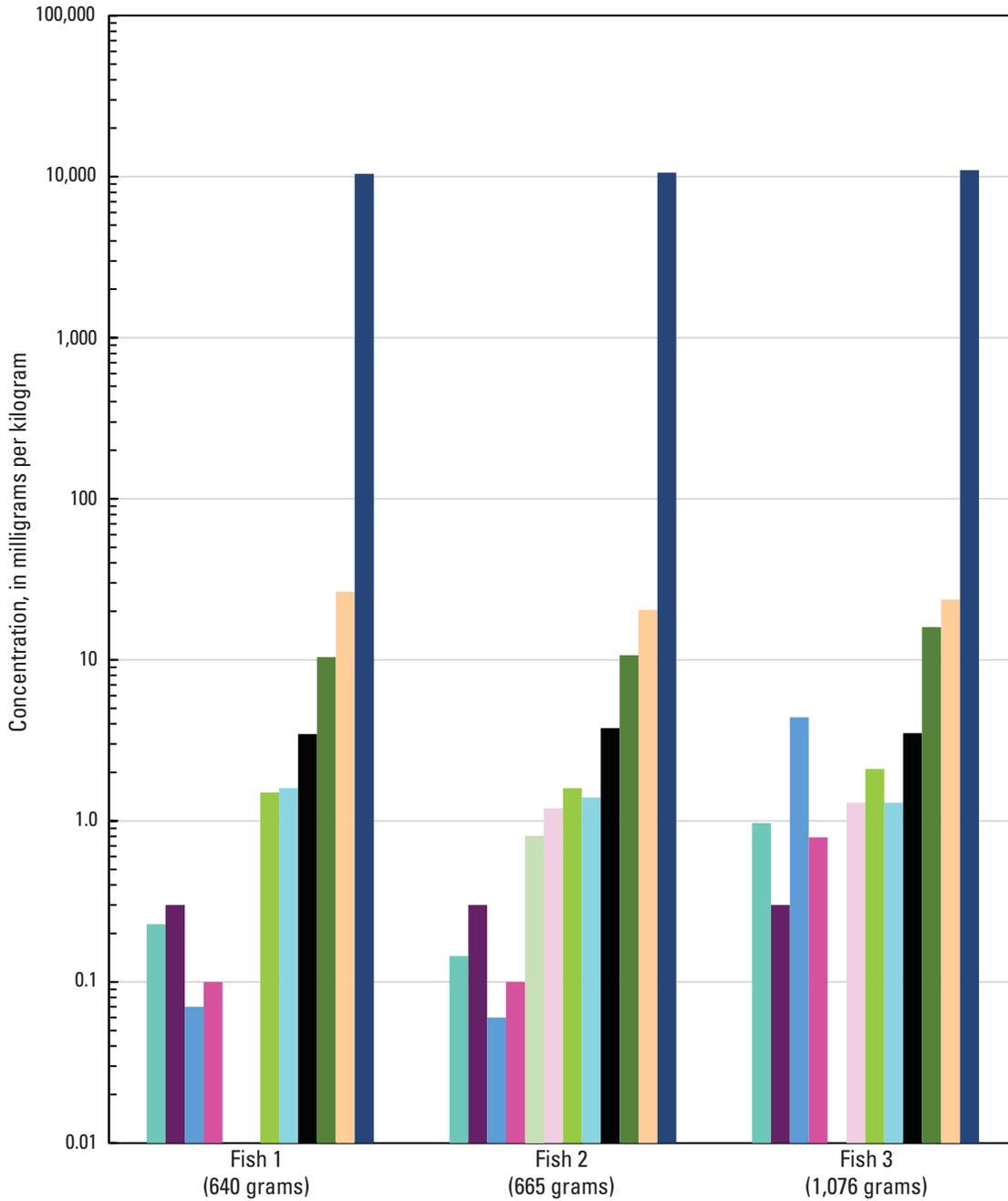
The USGS conducted water, sediment, and biological sampling to assess current (2014–15) water-quality conditions in Mittry Lake, Arizona. The purpose of the project was

Table 2. Concentrations of selected contaminants in three bed-sediment samples collected at Mittry Lake, Arizona, compared to consensus-based sediment quality guidelines and probable effect concentrations.

[Bold values indicate threshold effect concentration (TEC) values were exceeded, and bold italicized values indicate probable effect concentration (PEC) values were exceeded]

Parameter	TEC ¹	PEC ¹	Station number and name		
			325027114270000 Mittry Lake near Inlet	324917114274400 Mittry Lake at Middle	324911114285900 Mittry Lake near Outlet
Trace elements, in milligram per kilogram					
Arsenic	9.79	33	8.2	10	7.6
Cadmium	0.99	4.98	1.3	0.63	0.44
Chromium	43.4	111	49.2	49	56.6
Copper	31.6	149	32.4	24.4	25.2
Lead	35.8	128	525	135	62.2
Nickle	22.7	48.6	127	40.3	27.9
Zinc	121	459	6,510	1,570	527
Halogenated compounds, in microgram per kilogram					
Chlordane	3.24	17.6	<0.2	<0.2	<0.2
Dieldrin	1.9	61.8	<0.1	<0.1	<0.1
p,p'-Dichlorodiphenyldichloroethane	4.88	28	6.1	<2	4
p,p'-Dichlorodiphenyldichloroethylene	3.16	31.3	<1	<1	<1
p,p'-Dichlorodiphenyltrichloroethane	4.16	62.9	<4	<4	<4
Mercury, in microgram per kilogram					
Total mercury	180	1,060	36.5	45.3	31.6

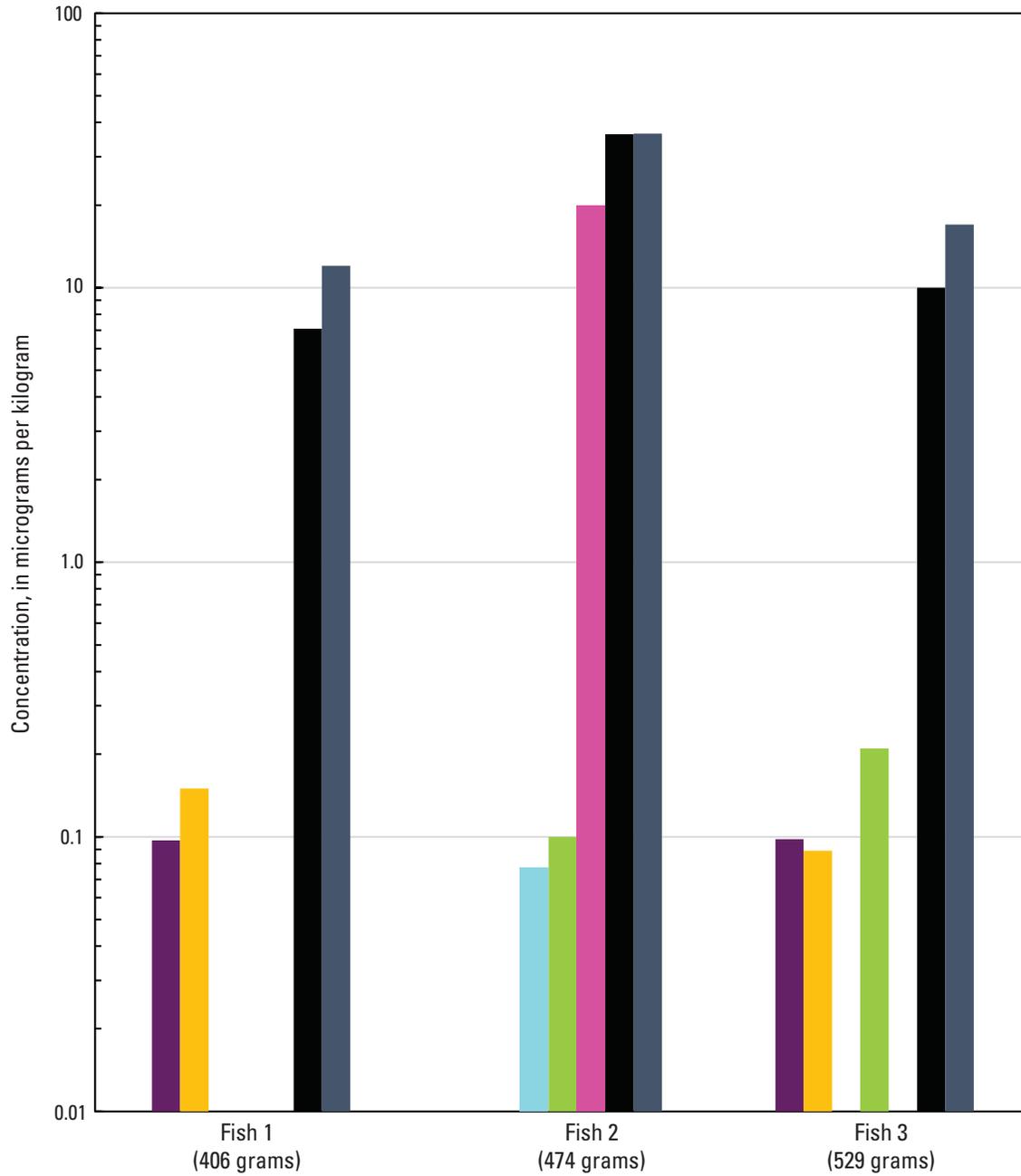
¹MacDonald and others, 2000



EXPLANATION

- Phosphorus
- Zinc
- Rubidium
- Selenium
- Chromium
- Lithium
- Strontium
- Manganese
- Niobium
- Antimony
- Vanadium
- Silver
- Cesium
- Molybdenum
- Bismuth
- Gallium

Figure 5. Graph of trace-element concentrations in tissue of fish collected in Mittry Lake, Arizona, August 19, 2014.



EXPLANATION

- p,p'-Dichlorodiphenyldichloroethylene
- Triclosan
- Dechlorane plus
- Polychlorinated biphenyl 180
- Polychlorinated biphenyl 170
- Dacthal
- Trifluralin

Figure 6. Graph of halogenated compound concentrations in whole fish collected in Mittry Lake, Arizona, August 19, 2014.

to provide a baseline for future studies as well as to provide information for current and future restoration programs.

Measured concentrations of sulfate for all water samples were greater than the U.S. Environmental Protection Agency secondary maximum contaminant levels for drinking water. The secondary maximum contaminant levels for chloride and manganese were exceeded in one sample each. Average trace-element concentrations in water were relatively consistent between the inlet, middle, and outlet locations. Concentrations for nutrients in all water samples were below the Arizona Department of Environmental Quality water-quality standards for aquatic and wildlife, and *Escherichia coli* levels in all samples were under the recommended recreational water-quality criteria. Only 3 out of 81 pesticide compounds were detected in the water samples.

Bed-sediment trace-element concentrations were relatively consistent throughout all sampling locations. Lead, manganese, nickel, and zinc concentrations, however, decreased from the inlet to outlet locations. Lead, nickel, and zinc were detected in concentrations above consensus-based sediment-quality guidelines probable effect concentrations, which are benchmarks above which harmful effects on sediment-dwelling organisms are estimated to occur. Eleven out of 61 halogenated compounds were detected in bed sediment. Eleven halogenated compounds were detected at the inlet site, three were detected at the middle site, and five were detected at the outlet site. Methylmercury was not detected in bed-sediment samples. None of the halogenated compound concentrations or the total mercury concentrations exceeded the probable effect concentrations of the consensus-based sediment quality guidelines.

Sixteen out of 34 trace elements were detected in the fish-tissue samples. Trace-element concentrations were relatively consistent between all three individual fish-tissue samples. Seven out of 58 halogenated compounds were detected in at least one of the whole-body fish samples. Four compounds were detected in fish 1, and five compounds were detected in fish 2 and 3. Only one of the three individual fish-tissue samples analyzed for methylmercury exceeded the EPA human health consumption criteria.

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Menlo Park Publishing Service Center, California
Manuscript approved January 30, 2017
Edited by Jessica Dyke
Design and layout by Vivian Nguyen

