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Coeur d'Alene Basin Environmental Monitoring Program, Surface Water, Northern Idaho—Annual Data Summary, Water Year 2017

Open-File Report 2018-1113

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

Cover: U.S. Geological Survey hydrologic technicians sample the Coeur d'Alene River near Cataldo, USGS site 12413500, during flooding in March 2017. Photograph by Daniel Hess, U.S. Geological Survey, March 17, 2017.

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U.S. Geological Survey
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Conversion Factors

U.S. customary units to International System of Units

Multiply	By	To obtain
	Length	
foot (ft)	0.3048	meter (m)
	Flow rate	
cubic foot per second (ft^3/s)	0.02832	cubic meter per second (m^3/s)

International System of Units to U.S. customary units

Multiply	By	To obtain
	Volume	
liter (L)	1.057	quart (qt)
liter (L)	0.2642	gallon (gal)
	Mass	
gram (g)	0.03527	ounce, avoirdupois (oz)

Datums

Vertical coordinate information is referenced to the North American Vertical Datum of 1988 (NAVD 88).
Horizontal coordinate information is referenced to the, North American Datum of 1983 (NAD 83).
Altitude, as used in this report, refers to distance above the vertical datum.

Supplemental Information

Concentrations of chemical constituents in water are given in either milligrams per liter (mg/L) or micrograms per liter (µg/L).

Abbreviations

BEMP	Basin Environmental Monitoring Program
EPA	U.S. Environmental Protection Agency
RPD	relative percent difference
USGS	U.S. Geological Survey

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Abstract

Streams within the Coeur d’Alene River drainage basin in northern Idaho have been extensively affected by historical mining activities and are subject to ongoing remedial actions as part of the Bunker Hill Mining & Metallurgical Complex Superfund Site. The U.S. Geological Survey (USGS) operates 12 real-time streamgages and collects surface-water-quality samples two to four times annually at 20 sites in the Spokane River and Coeur d’Alene River drainage basins. These data are used by the U.S. Environmental Protection Agency (USEPA) to monitor cleanup progress and to support decisions related to implementing remedial actions throughout the basin. USGS data collection highlights from water year 2017 include:

- A rain-on-snow event in March 2017 produced high streamflows and flooding in the basin.
- The March event mobilized high concentrations of total metals (cadmium, lead, zinc, and others) in the Coeur d’Alene River near Cataldo, at Rose Lake, and near Harrison; these concentrations were among the highest that have been measured at these sites during flood events sampled by the USGS.
- Total lead and dissolved zinc and cadmium concentrations decreased in Canyon Creek in 2017 when compared with water years 2007–16; in contrast, concentrations of dissolved zinc and cadmium increased in Ninemile Creek when compared with water years 2007–16.

Introduction

Streams within the Coeur d’Alene River drainage basin have been extensively altered and impacted by historical mining practices that spread contaminants—including cadmium, lead, and zinc—through soil, sediment, groundwater, and surface water. The impacted area is designated as the Bunker Hill Mining & Metallurgical Complex Superfund Site and is subject to ongoing remedial actions led by the U.S. Environmental Protection Agency (USEPA).

The Coeur d’Alene River extends across northern Idaho from the Montana border on the east to where it flows into the Spokane River near the Washington border on the west. The Coeur d’Alene River drainage basin is mountainous, with altitudes ranging from 2,000 to 6,850 ft. About 70 percent of the annual precipitation falls as snow during winter (October–April), and streamflows and metal loads normally are highest during spring runoff. However, warm winter Pacific storms can affect the area, bringing heavy rains and warm temperatures that can cause rapid snowmelt and produce high streamflow rain-on-snow events. These events can be associated with high transport of sediment and sediment-bound trace metals. In contrast, streamflows are lowest and dissolved metal concentrations typically are highest during September and October (Clark and Mebane, 2014).

In cooperation with the USEPA, the U.S. Geological Survey (USGS) operates and maintains 12 real-time streamgages and collects surface-water-quality samples two to four times annually at 20 monitoring sites (fig. 1) in the Spokane River and Coeur d’Alene River drainage basins (Clark and Perreault, 2017). This work is part of the Coeur d’Alene Basin Environmental Monitoring Program (BEMP; U.S. Environmental Protection Agency, 2002, 2012), and these data are used to monitor cleanup progress and to inform remedial action implementation decisions. The surface-water BEMP was initiated in 2004; this report highlights data collection results from water year 2017 (October 1, 2016–September 30, 2017).

Methods

The current surface-water BEMP comprises 20 monitoring sites (fig. 1; table 1). Of these, 12 sites have continuous streamflow-gaging; 14 sites are sampled four times annually; and 6 sites are sampled twice annually (table 1). Each of the 20 sites are sampled during peak snowmelt runoff and fall baseflow; 14 of these sites are also sampled during a winter storm event and the peak hydrograph recession. Additionally, three sites (Coeur d’Alene River near Cataldo, at Rose Lake, and near Harrison) were sampled an extra time during water year 2017 to capture high streamflow conditions in March.

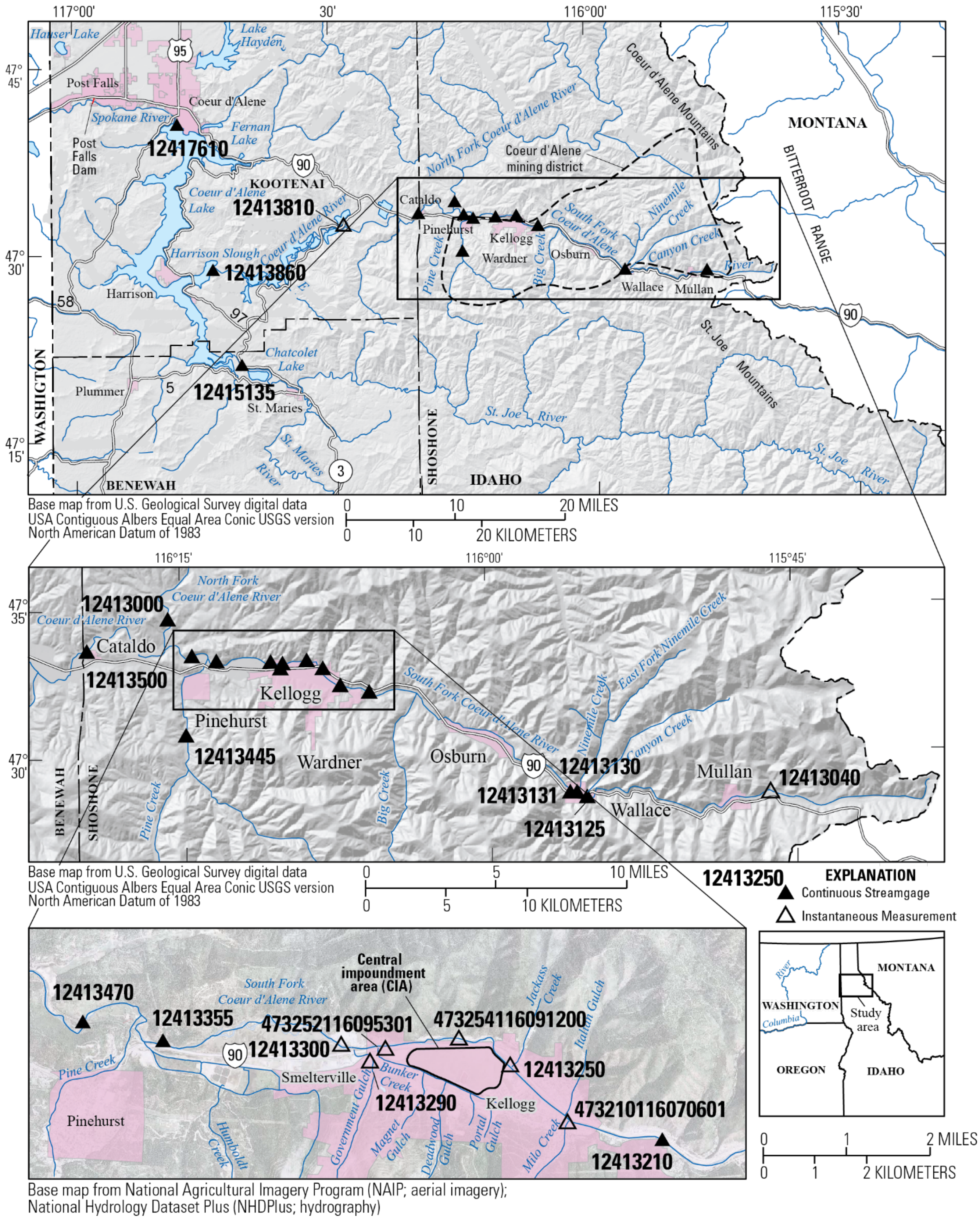

Figure 1. Maps showing location of Basin Environmental Monitoring Program (BEMP) surface-water monitoring sites in the Coeur d'Alene River and Spokane River drainage basins, northern Idaho.

Table 1. Basin Environmental Monitoring Program (BEMP) surface-water monitoring sites in the Coeur d'Alene River and Spokane River drainage basins, northern Idaho.

[Streamflow and water-quality data collected during water year 2017 can be accessed at https://waterdata.usgs.gov/id/nwis/current/?type=BEMP (U.S. Geological Survey, 2018). **Type of streamflow measurement**: Continuous ADVM, continuous streamgage with acoustic Doppler velocity meter; continuous stage, continuous streamgage with pressure transducer; instantaneous, streamflow measured at time of sample collection. USGS, U.S. Geological Survey]

USGS site name	USGS streamgage or site No.	BEMP site No.	Sample schedule (times annually)	Type of streamflow measurement	Period of streamflow record
North Fork Coeur d'Alene River at Enaville	12413000	NF-50	4	Continuous, stage	1911–2017
South Fork Coeur d'Alene River above Deadman Gulch, near Mullan	12413040	SF-208	2	Instantaneous	1998–2017
Canyon Creek above mouth, at Wallace	12413125	CC-288	4	Continuous, stage	1998–2017
Ninemile Creek above mouth, at Wallace	12413130	NM-305	4	Continuous, stage	1998–2017
South Fork Coeur d'Alene River above Placer Creek, at Wallace	12413131	SF-233	4	Continuous, stage	2009–2017
South Fork Coeur d'Alene River at Elizabeth Park, near Kellogg	12413210	SF-268	4	Continuous, stage	1987–2017
South Fork Coeur d'Alene River at Kellogg	12413250	SF-269	4	Instantaneous	1972–2018
Government Gulch Creek near mouth, at Smelterville	12413290	BH-GG-0001	2	Instantaneous	1998–2018
South Fork Coeur d'Alene River at Smelterville	12413300	SF-270	4	Instantaneous	1966–2017
South Fork Coeur d'Alene River above Pine Creek, near Pinehurst	12413355	SF-270A	4	Continuous, stage	2008–2017
Pine Creek below Amy Gulch near Pinehurst[1]	12413445	PC-339	2	Continuous, stage	1999–2018[1]
South Fork Coeur d'Alene River near Pinehurst	12413470	SF-271	4	Continuous, stage	1987–2017
Coeur d'Alene River near Cataldo	12413500	LC-50	4	Continuous, stage	1911–2017
Coeur d'Alene River at Rose Lake	12413810	LC-55	4	Instantaneous	1971–2017
Coeur d'Alene River near Harrison	12413860	LC-60	4	Continuous, ADVM	2004–2018
St. Joe River at Ramsdell Station, near St. Maries	12415135	SJ-65	4	Continuous, ADVM	2009–2018
Spokane River at Lake Outlet, at Coeur d'Alene[2]	12417610	SR-5	4	Continuous, ADVM	2014–2018[2]
Milo Creek Outfall at South Fork Coeur d'Alene River, at Kellogg	473210116070601	BH-MC-0002	2	Instantaneous	2013–2018
Bunker Creek at mouth of culvert, at Kellogg	473252116095301	BH-BC-0006	2	Instantaneous	2013–2018
Seeps north of Deadwood Gulch Tailings at Kellogg	473254116091200	BH-CS-0001	2	Instantaneous	none available

[1]Water-quality samples are collected at site 12413445 on Pine Creek, but continuous streamflow-gaging is upstream on East Fork Pine Creek at site 12413370.

[2]Water-quality samples are collected at site 12417610 on Spokane River, but continuous streamflow-gaging is downstream on Spokane River at site 12417650.

Streamflow

Streamflow at each monitoring site (fig. 1; table 1) was measured using standard USGS procedures as described in Turnipseed and Sauer (2010) and Mueller and others (2013). At nine sites with the real-time streamgages, continuous streamflow records were computed using stage-discharge relationships based on continuous stage measurements that are calibrated to periodic streamflow measurements (Rantz, 1982). At the three sites with streamgages affected by changes in the level of Coeur d'Alene Lake (sites 12413860, 12415125, and 12417610), continuous streamflow records were computed using an index velocity method based on acoustic Doppler velocity meter measurements (Levesque and Oberg, 2012). At the eight sites without continuous streamflow-gaging, streamflow was measured when water-quality samples were collected whenever possible. However, streamflow measurements were occasionally omitted during high streamflow events when maximizing the number of samples collected during short-lived hydrologic conditions was paramount. For these events, streamflow values were calculated using a regression between measured instantaneous streamflow at the site and streamflow measured at a comparable nearby continuous streamgage. As used in this report, daily mean streamflow for water year 2017, and the period of record mean for the daily mean streamflow, were calculated by U.S. Geological Survey (2018).

Water Quality

Water-quality samples were collected according to the procedures described in U.S. Geological Survey (variously dated) and the Quality Assurance Project Plan specific to the BEMP surface-water program (Clark and Perreault, 2017). Samples were collected using width and depth-integrated techniques and composited with a churn. Water samples for "dissolved" constituent analyses were filtered using a capsule filter with 0.45-micrometer pores; these constituents are referred to as "dissolved" herein. Nutrient samples were preserved with sulfuric acid and chilled; metals samples were preserved with nitric acid. All analyses except for sediment were conducted at the USGS National Water Quality Laboratory (Denver, Colorado). Sediment analyses (total suspended sediment and percent sand and fines) were conducted at the USGS Cascades Volcano Observatory Sediment Laboratory (Vancouver, Washington).

Quality control samples were collected in accordance with standard USGS procedures (Mueller and others, 2015) and the Quality Assurance Project Plan specific to the BEMP surface-water program (Clark and Perreault, 2017). Two field blanks were collected during each sampling event. For the field blanks, certified inorganic blank water was processed through cleaned equipment in the field according to the normal sample collection and processing procedures (Mueller and others, 2015) and submitted for analysis. One or two split replicates samples were also collected during each sampling event.

Surface-Water Data, Water Year 2017

Streamflow and water-quality data collected during water year 2017 can be accessed in its entirety online at https://waterdata.usgs.gov/id/nwis/current/?type=BEMP (U.S. Geological Survey, 2018). Selected results are presented here.

Streamflow

Water year 2017 was characterized by several high streamflow events. Heavy rainfall in October 2016 led to high streamflows during the period in which baseflows are normally observed. Figure 2 shows mean daily mean streamflow for the streamflow period of record and water year 2017 daily mean streamflow at sites with continuous streamgages in the drainage basins. Rain-on-snow events in February and March 2017 also caused high streamflows, and streamflow during the March event exceeded flood stage (27,600 cubic feet per second [ft^3/s]), in the Coeur d'Alene River near Cataldo (site 12413500). In water year 2017, the maximum daily streamflow recorded at this site was 31,200 ft^3/s on March 16; the maximum 15-minute streamflow recorded at this site was 33,700 ft^3/s on March 17. Following the March event, spring snowmelt runoff throughout the drainage basins occurred at the same time as mean runoff but was somewhat higher than mean runoff at most sites (fig. 2). The main exception was the Spokane River near the lake outlet (site 12417650), which experienced much higher and later runoff flows than mean runoff; these streamflows were likely affected by downstream dam release operations. Summer baseflows throughout the drainage basins were similar in magnitude and timing to mean baseflows (fig. 2).

Water Quality

The analytical results from water-quality samples collected in the Coeur d'Alene River near Cataldo, at Rose Lake, and near Harrison during the March 2017 flood event, are shown compared to historical data in figures 3–5. Generally, both streamflows and concentrations during the 1996 flooding event (U.S. Geological Survey, 2018) were substantially higher than those measured in March 2017. Moreover, the 1996 samples were not width- or depth-integrated due to hazardous conditions and may underestimate actual concentrations (Beckwith, 1996). Nonetheless, total constituent concentrations (including total lead, total zinc, and total cadmium) from the March 2017 flood event were among the highest measured in the water-quality period of record. Dissolved constituent concentrations (such as dissolved cadmium and zinc), which tend to be highest during baseflow conditions, were unremarkable during the March flood event, indicating that most of the total concentrations were derived from the particulate fraction. Except for some nutrients, constituent concentrations in the Coeur d'Alene River increased from upstream (Cataldo) to downstream (Rose Lake and Harrison), with the largest increases observed between Cataldo and Rose Lake (figs. 3–5).

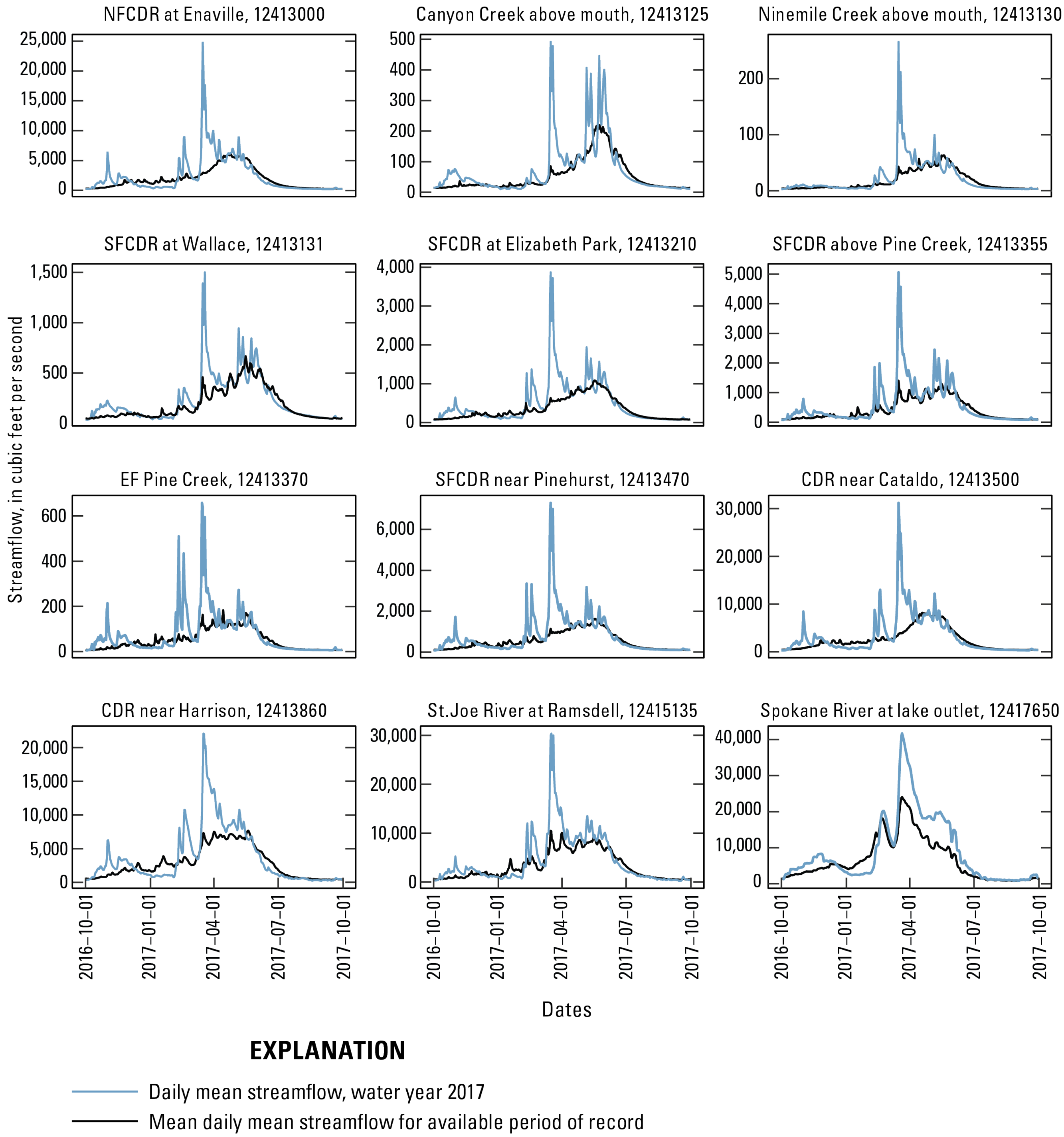

Figure 2. Graphs showing streamflow at Basin Environmental Monitoring Program (BEMP) sites with continuous streamgages in the Coeur d'Alene River and Spokane River drainage basins, northern Idaho, water year 2017. Vertical axis scale varies by site. CDR, Coeur d'Alene River; EF, East Fork; NFCDR, North Fork Coeur d'Alene River; SFCDR, South Fork Coeur d'Alene River.

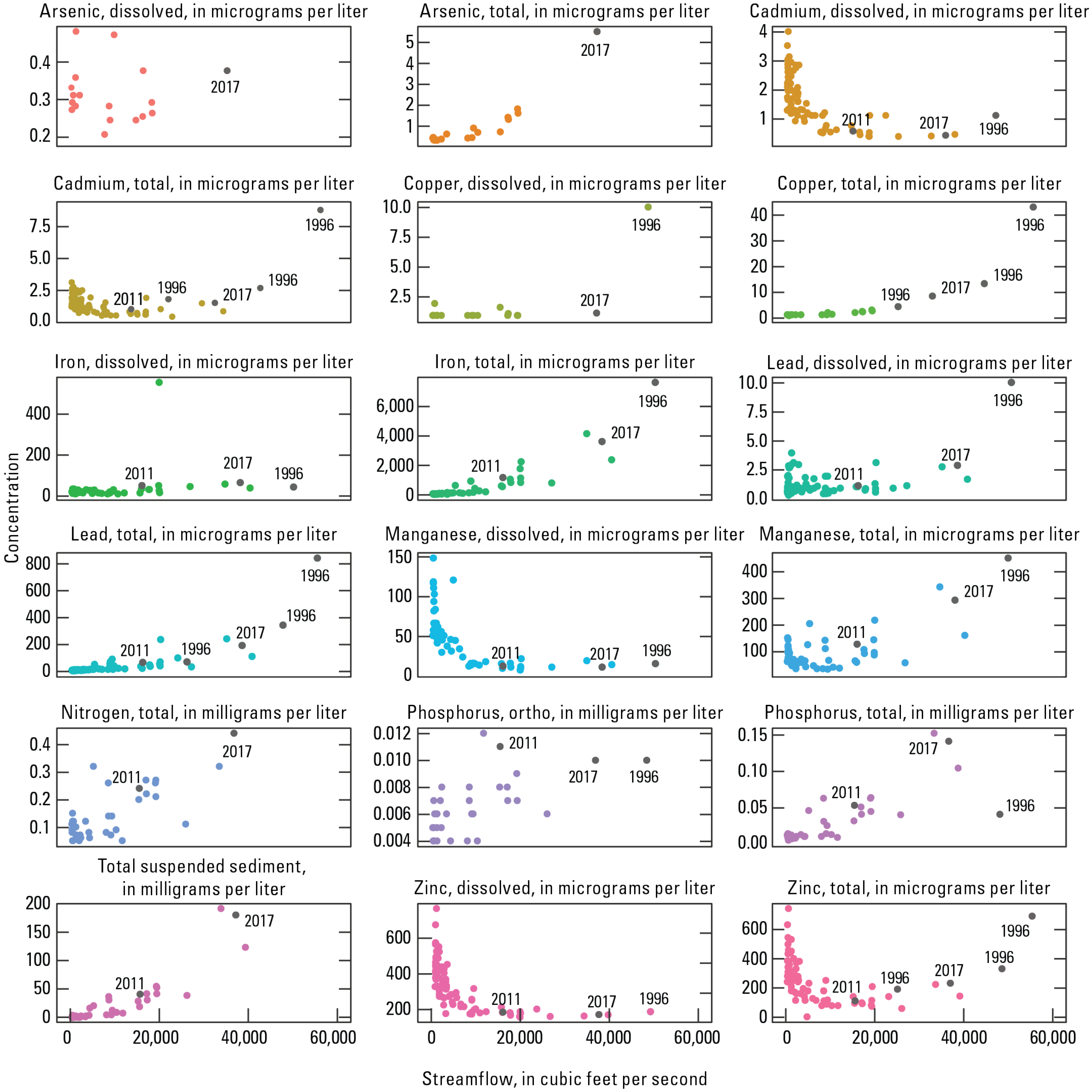

Figure 3. Graphs showing constituent concentration versus streamflow in the Coeur d'Alene River near Cataldo (site 12413500), northern Idaho. Selected high-flow events are labeled by year. Data were not available for every constituent during every event. Vertical axis scale and units vary by constituent.

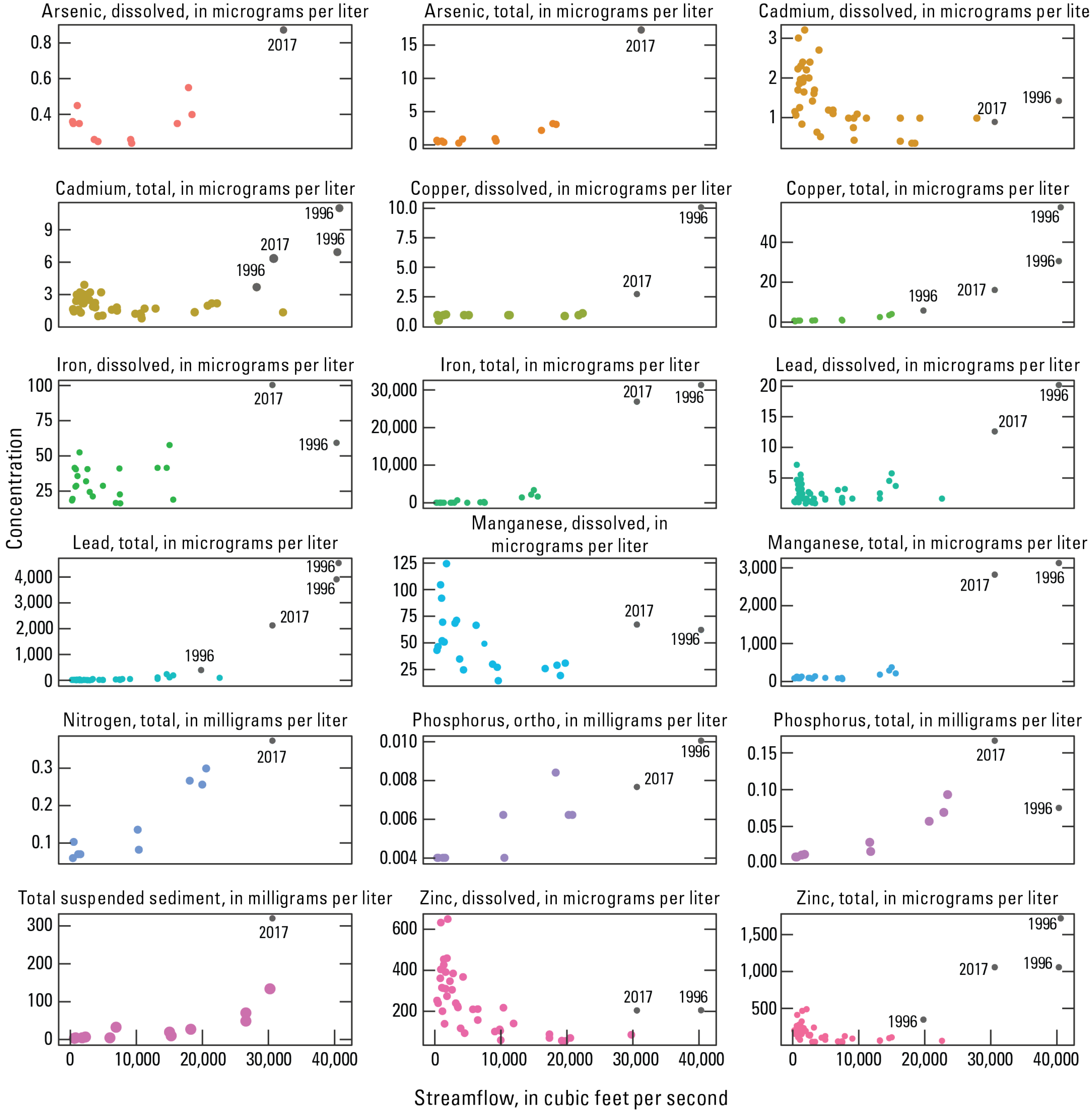

Figure 4. Graphs showing constituent concentration versus streamflow in the Coeur d'Alene River at Rose Lake (site 12413810), northern Idaho. Selected high-flow events are labeled by year. Data were not available for every constituent during every event. Vertical axis scale and units vary by constituent.

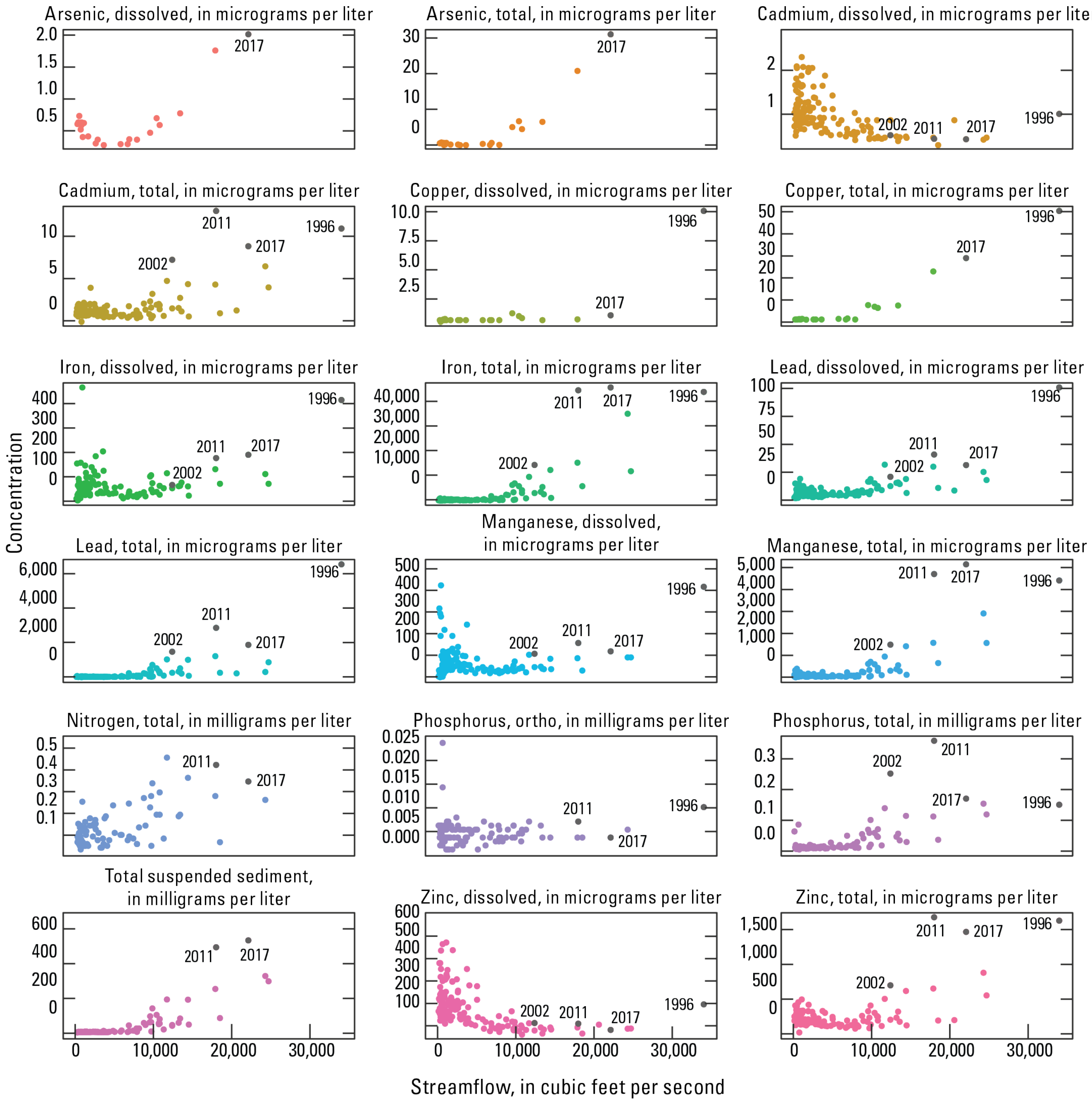

Figure 5. Graphs showing constituent concentration versus streamflow in the Coeur d'Alene River near Harrison (site 12413860), northern Idaho. Selected high-flow events are labeled by year. Data were not available for every constituent during every event. Vertical axis scale and units vary by constituent.

Figures 6 through 8 show selected water year 2017 water-quality results (total lead, dissolved zinc and cadmium) compared to results from the previous 10 years (2007–16). Based on visual comparison, median total lead decreased in water year 2017 in Canyon Creek and in the South Fork Coeur d'Alene River near Mullan and at Wallace (fig. 6). Total lead was higher in Government Gulch and in the seeps north of tailings, and lower in Bunker Creek, but each of these sites had small 2007–16 sample sizes (n = 6) for comparison. Total lead concentrations elsewhere in the basin were similar to past measurements. Based on visual comparison, median dissolved zinc (fig. 7) and cadmium (fig. 8) decreased in Canyon Creek but increased in Ninemile Creek. This result is unexpected considering the extensive and recent remediation activities in Ninemile Creek. Median dissolved zinc and cadmium showed apparent increases in the South Fork Coeur d'Alene River at Kellogg and at Smelterville, and Government Gulch had higher dissolved zinc and cadmium concentrations, but this was likely due to repeated samples taken at these stations during baseflow conditions (when dissolved zinc and cadmium concentrations are highest) during a supplemental study conducted in September 2017. Dissolved zinc and cadmium were lower in water year 2017 in the Coeur d'Alene River near Harrison, in the Spokane River at the lake outlet, and in the seeps north of tailings (figs. 6 and 7). Continued data collection at these stations will help to determine whether these decreases were related to high streamflows in water year 2017 or if they represent a more persistent change.

Quality-Control Samples

Nine replicate samples and ten field blanks were collected in water year 2017. Generally, analytical results were in good agreement (relative percent difference [RPD] less than 20 percent) between parent and replicate samples. However, higher RPDs (up to a maximum of 115 percent) were observed between copper, cadmium, and lead results in several filtered samples that had low concentrations of these constituents. In the blank samples, most constituents were not detected. However, filtered copper and unfiltered and filtered lead were detected in most blank samples, albeit at low concentrations near the reporting limit. Given the occurrence of copper and lead in blanks, and the high RPDs in copper and lead results in replicates, the USGS will carefully evaluate equipment cleaning and sample processing procedures in water year 2018. This evaluation will include collecting sequential equipment blanks (blanks taken after each processing step) to identify problematic equipment and (or) procedures.

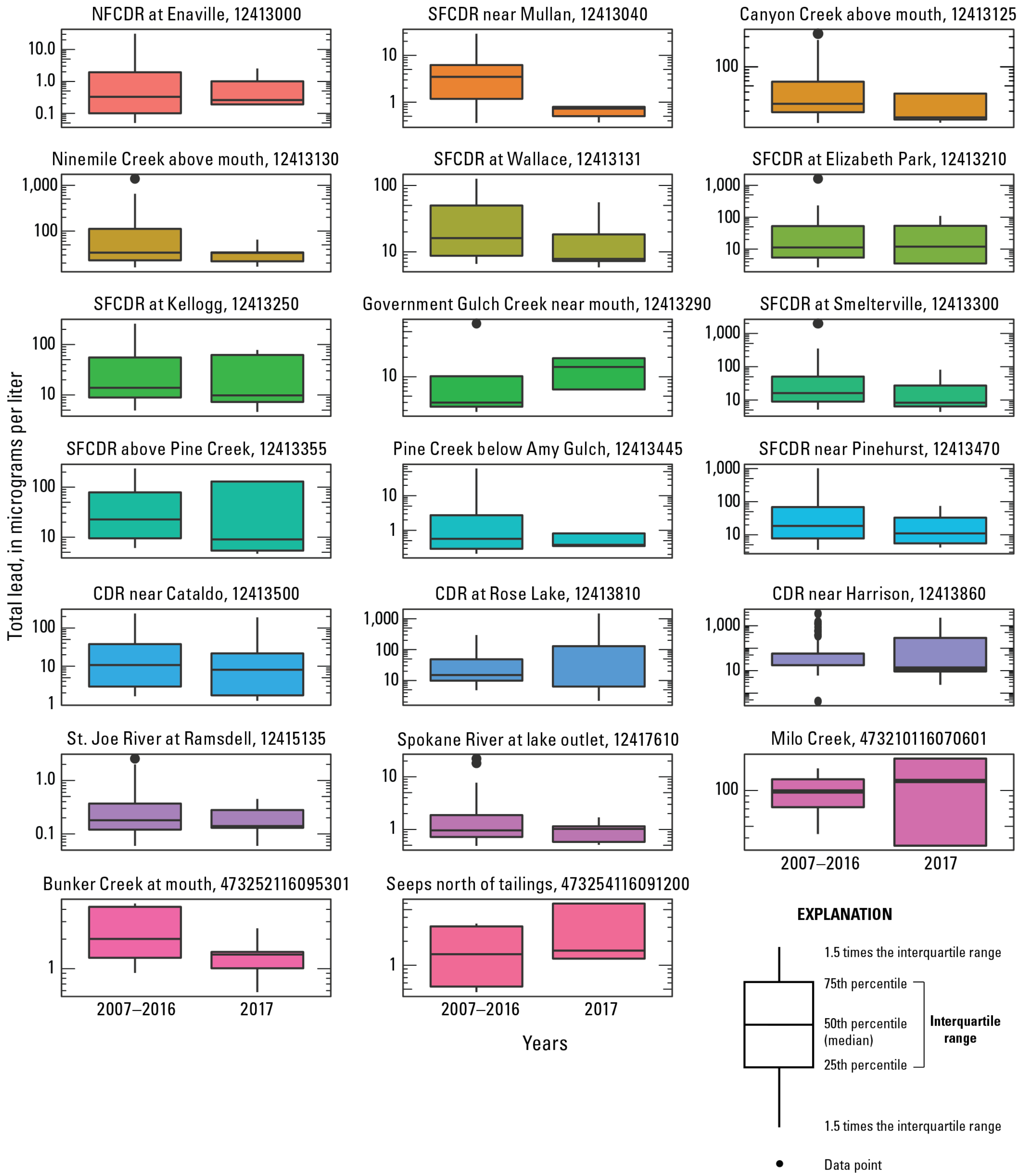

Figure 6. Boxplots showing total lead concentrations at Basin Environmental Monitoring Program (BEMP) sites in water year 2017 versus 2007–16. Vertical axis scale is logarithmic and varies by site. Sample size varies by site: 2007–16, n = 6–62; 2017, n = 3–8.CDR, Coeur d’Alene River; NFCDR, North Fork Coeur d’Alene River; SFCDR, South Fork Coeur d’Alene River.

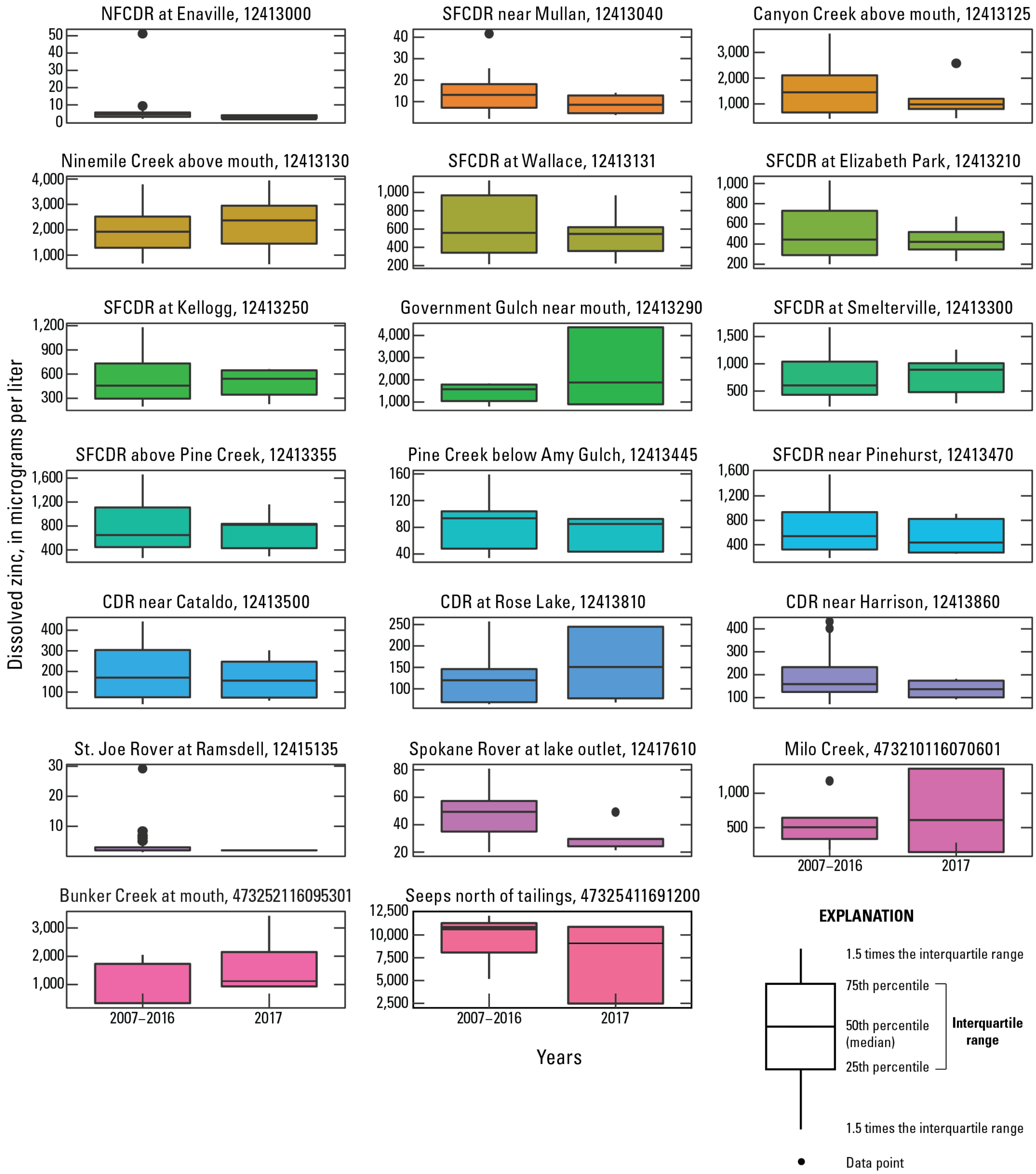

Figure 7. Boxplots showing dissolved zinc concentrations at Basin Environmental Monitoring Program (BEMP) sites in water year 2017 versus 2007–16. Vertical axis scale varies by site. Sample size varies by site: 2007–16, n = 6–62; 2017, n = 3–8. CDR, Coeur d'Alene River; NFCDR, North Fork Coeur d'Alene River; SFCDR, South Fork Coeur d'Alene River.

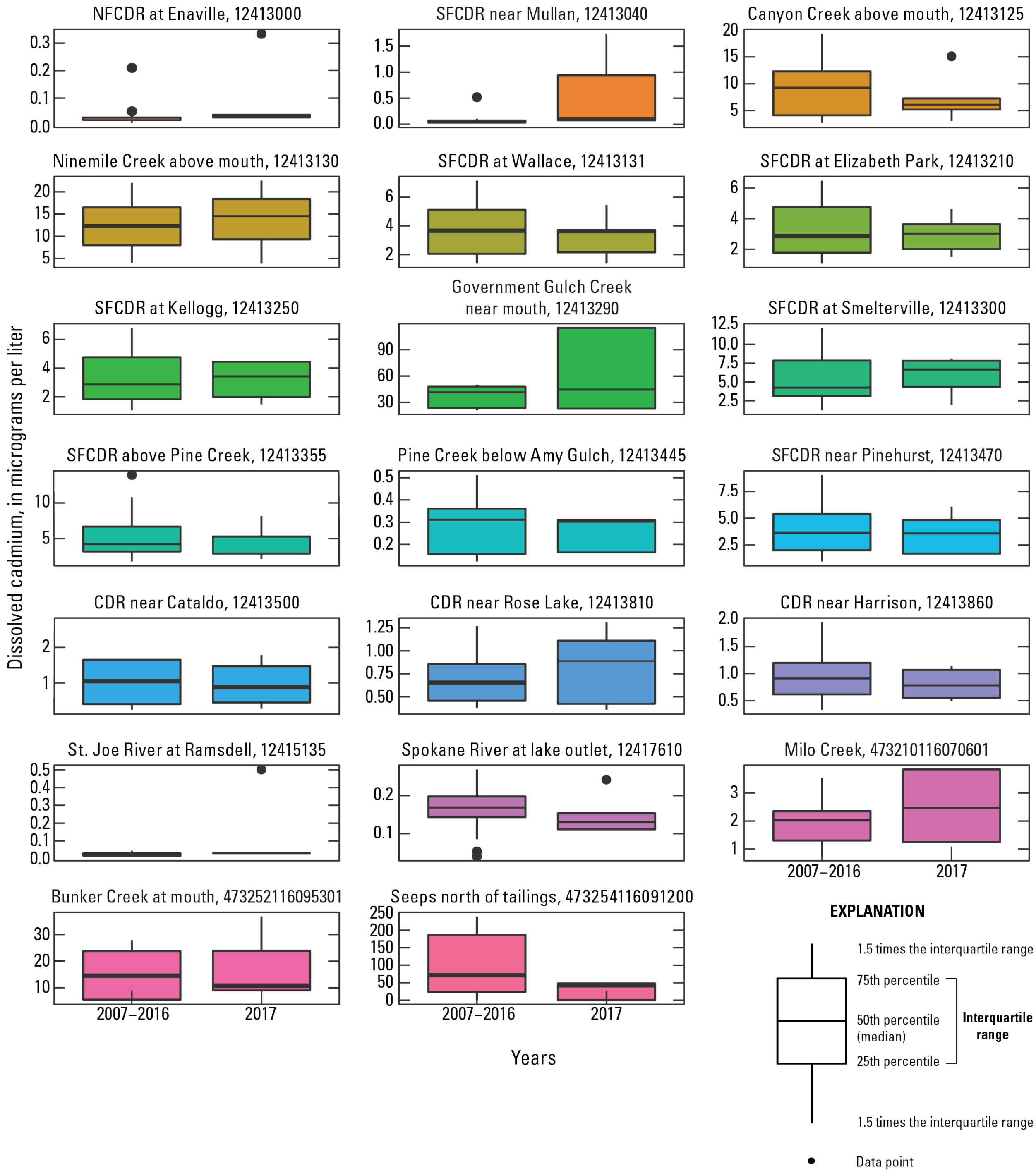

Figure 8. Boxplots showing dissolved cadmium concentrations at Basin Environmental Monitoring Program (BEMP) sites in water year 2017 versus 2007–16. Vertical axis scale varies by site. Sample size varies by site: 2007–16, n = 6–62; 2017, n = 3–8. CDR, Coeur d'Alene River; NFCDR, North Fork Coeur d'Alene River; SFCDR, South Fork Coeur d'Alene River.

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