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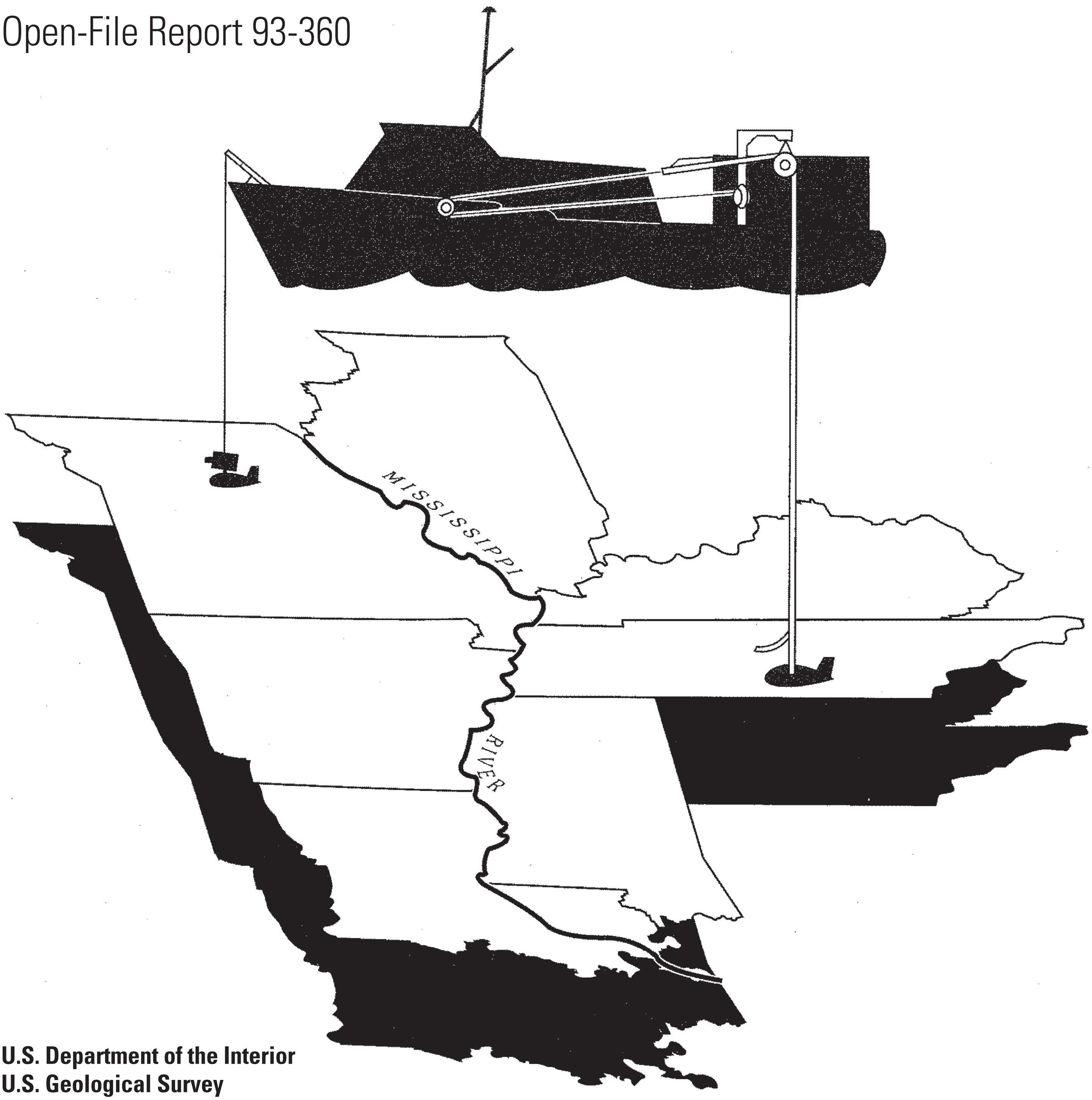
Organic Contaminants Associated with Suspended Sediment Collected During Five Cruises of the Mississippi River and its Principal Tributaries, May 1988 to June 1990

Open-File Report 93-360



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

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By Colleen E. Rostad, LaDonna M. Bishop, Geoffrey S. Ellis, Thomas J. Leiker, Stephanie G. Monsterleet, and Wilfred E. Pereira

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Conversion Factors

Multiply	By	To obtain
	Length	
centimeter (cm)	0.3937	inch (in.)
millimeter (mm)	0.03937	inch (in.)
meter (m)	3.281	foot (ft)
kilometer (km)	0.6214	mile (mi)
kilometer (km)	0.5400	mile, nautical (nmi)
meter (m)	1.094	yard (yd)
	Volume	
liter (L)	0.2642	gallon (gal)
cubic meter (m^3)	264.2	gallon (gal)
cubic meter (m^3)	0.0002642	million gallons (Mgal)
cubic centimeter (cm^3)	0.06102	cubic inch (in^3)
liter (L)	61.02	cubic inch (in^3)
cubic meter (m^3)	35.31	cubic foot (ft^3)
cubic meter (m^3)	1.308	cubic yard (yd^3)
cubic meter (m^3)	0.0008107	acre-foot (acre-ft)
	Flow rate	
cubic meter per second (m^3/s)	70.07	acre-foot per day (acre-ft/d)
meter per second (m/s)	3.281	foot per second (ft/s)
cubic meter per second (m^3/s)	35.31	cubic foot per second (ft^3/s)
cubic meter per day (m^3/d)	35.31	cubic foot per day (ft^3/d)
liter per second (L/s)	15.85	gallon per minute (gal/min)
cubic meter per day (m^3/d)	264.2	gallon per day (gal/d)
cubic meter per second (m^3/s)	22.83	million gallons per day (Mgal/d)
	Mass	
gram (g)	0.03527	ounce, avoirdupois (oz)
kilogram (kg)	2.205	pound, avoirdupois (lb)
megagram (Mg)	1.102	ton, short (2,000 lb)
megagram (Mg)	0.9842	ton, long (2,240 lb)
metric ton per day	1.102	ton per day (ton/d)
megagram per day (Mg/d)	1.102	ton per day (ton/d)
megagram per day per square kilometer [(Mg/d)/km^2]	2.8547	ton per day per square mile [(ton/d)/mi^2]
megagram per year (Mg/yr)	1.102	ton per year (ton/yr)
metric ton per year	1.102	ton per year (ton/yr)
	Hydraulic conductivity	
meter per day (m/d)	3.281	foot per day (ft/d)
	Hydraulic gradient	
meter per kilometer (m/km)	5.27983	foot per mile (ft/mi)

Temperature in degrees Celsius (°C) may be converted to degrees Fahrenheit (°F) as follows:

$$°F=(1.8\times°C)+32$$

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Abstract

Suspended-sediment samples were obtained from sites along the Mississippi River and its principal tributaries to determine the presence of halogenated hydrophobic organic compounds on the suspended sediment smaller than 63 micrometers. Sample collection involved pumping discharge-weighted volumes of river water along a cross section of the river into a continuous-flow centrifuge to isolate the suspended sediment. The suspended sediment was analyzed by gas chromatography/mass spectrometry for pentachlorobenzene, hexachlorobenzene, pentachloroanisole, chlorothalonil, pentachlorophenol, dachthal, chlordane, nonachlor, and penta-, hexa-, hepta-, and octachlorobiphenyls. Samples collected during June 1989 and February-March 1990 also were analyzed for U.S. Environmental Protection Agency priority pollutants, including polycyclic aromatic hydrocarbons, phthalate esters, and triazines. Samples were collected at sites on the Mississippi River from above St. Louis, Missouri to below New Orleans, Louisiana, and on the Illinois, Missouri, Ohio, Wabash, Cumberland, Tennessee, White, Arkansas, and Yazoo Rivers. Masses of selected halogenated hydrophobic organic compounds associated with the suspended sediment at each site are presented in this report in tabular format, along with suspended-sediment concentration, water discharge, and organic-carbon content.

Introduction

The Mississippi River is the major river of North America, draining 2.97 million square kilometers, or 40 percent of the contiguous United States, and parts of two provinces in Canada. It is an important resource for food, transportation, drinking water, recreation, and irrigation. The sediment load of the Mississippi River has decreased substantially over the last 50 years, mostly because of the extensive series of dams built on its tributaries (Meade and Parker, 1985; Keown and others, 1986; Meade and others, 1990).

There have been few studies of the organic compounds associated with suspended sediment. One study on sites in Louisiana reported that almost all compounds were below detection limits of 1 ng/g (Demas and Curwick, 1987; 1988). Suspended-sediment studies on other rivers also reported target compounds to be present below the detection limit of 4 ng/g (Merriman, 1988). Distribution of the organic compounds on the suspended sediment in the entire lower Mississippi River from above St. Louis, Missouri to below New Orleans, Louisiana, however, has not been previously addressed. Consequently, an assessment of the occurrence and distribution of organic contaminants is needed to provide a basis for evaluating contaminant transport associated with the suspended sediment.

Four interactive factors that have substantially affected the suspended-sediment regime over this same period of time include increases in: (1) agriculture; (2) commerce and industry; (3) transportation networks; and (4) population and urbanization (Keown and others, 1981). Industrial discharge and nonpoint-source agricultural runoff have increased the loads of anthropogenic organic compounds in the river. Some of these compounds remain in the aqueous phase and have been investigated throughout the river (Schafer and others, 1969; DeLeon and others, 1986; Pereira and Rostad, 1990). Some of the less-soluble compounds adsorb onto bed sediments and also have been investigated (Barthel and others, 1969; Lytle and Lytle, 1990). Most previous studies have focused only on the transport and deposition of the suspended sediment itself (Everett, 1971; Robbins, 1976; Wells, 1980; Meade and Parker, 1985; Grayman, 1985; Meade and others, 1990).

Suspended-sediment composition is affected by surface-soil runoff and by deposition and resuspension, which are dependent upon the ever-changing flow dynamics of the river. A comprehensive compilation of environmental characteristics and history of suspended sediment in the Mississippi River was provided by Keown and others (1981). Annually, the Ohio River contributes about 50 percent of the water but only about 37 percent of the sediment in the Mississippi River. In contrast, about 15 percent of the water and at least 40 percent of the sediment in the Mississippi River are contributed by the Missouri River (Moody and Meade, 1992). The Missouri River mainly drains agricultural areas; the Ohio River drains more industrial areas. Physical differences in suspended sediment and differences in chemical inputs from these two major tributaries may affect the distribution of organic compounds on the suspended sediment in the Mississippi River.

The Mississippi River Study of the U.S. Geological Survey is a multidisciplinary project to quantify environmental facets of an active river system, such as water and sediment transport, tributary mixing, and water quality. Specific aspects for study included trace metals, nutrients, pesticides, fecal sterols, surfactants, and halogenated organic compounds. The objectives of the portion of the study focusing on halogenated organic compounds included:

1. To procure large enough suspended-sediment sample (smaller than 63 micron) to enable detection of target organic compounds.

2. To extract suspended sediment in order to isolate target organic compounds.

3. To utilize sensitive, specific gas chromatography/negative chemical ionization/mass spectrometry to compensate for complex matrix effects in the analysis for the target organic compounds.

4. To determine the occurrence and distribution of halogenated organic compounds on the suspended sediment in the Mississippi River.

The variety of organic compounds and the trace levels present associated with the suspended sediment necessitate large sample sizes (hundreds of liters) to provide sufficient sample for analysis. Representative suspended sediment in suitable quantities for analysis of trace toxic organic compounds is much more difficult to obtain than the readily available bed sediments. In order to determine transport of organic contaminants on the suspended sediment in the Mississippi River, representative samples at selected sites were combined with information on the water discharge measured at each site.

Purpose and Scope

The purpose of this report is to describe the distribution of halogenated anthropogenic and U.S. Environmental Protection Agency (EPA) priority pollutant (Federal Register, 1980) compounds found on the suspended sediment smaller than 63 micron at selected sites on the Mississippi River for five cruises over a 2-year period, from May 1988 to June 1990.

Suspended sediment was obtained from sites along the Mississippi River and its principal tributaries as part of an ongoing, multidisciplinary study by the U.S. Geological Survey (USGS) (Leenheer and others, 1989; Meade and Stevens, 1990; Pereira and others, 1990; Rees and Ranville, 1990; Taylor and others, 1990). Five sampling cruises during May-June 1988, March-April 1989, June 1989, February-March 1990, and May-June 1990 included a variety of flow conditions. The sampling cruises on the Mississippi River covered over 1,700 km. Sampling locations included sites on the mainstem of the Mississippi River, as well as on the Illinois, Missouri, Ohio, White, Arkansas, and Yazoo Rivers.

The entire Midwest was in a severe drought during the sampling cruise in May-June 1988. For May and June 1988, total flow at the 181 USGS stream index stations in the conterminous United States and southern Canada was the lowest recorded for May and June in the previous 6 years (U.S. Geological Survey, and Canada, Department of the Environment, 1988a and 1988b). The later cruises in 1989 and 1990 were planned to sample the Mississippi River at high water. Detailed hydrologic conditions are given by Moody and Meade (1992 and 1993) for all cruises in this report.

Suspended sediment was collected and analyzed for organic compounds. The analytical protocol was chosen to focus on halogenated hydrophobic anthropogenic organic compounds. By combining large sample sizes with specialized analytical techniques, lower detection limits than those previously mentioned were achieved in this study. The use of highly specific, very sensitive gas chromatography/negative chemical ionization/mass spectrometry enabled a detection limit of 0.05 ng/g for most compounds in spite of the complex sample matrix. The compounds included pentachlorobenzene (present in hexachlorobenzene formulations), hexachlorobenzene (fungicide), pentachloroanisole (transformation product of pentachlorophenol), chlorothalonil (fungicide), pentachlorophenol (wood preservative and general herbicide), dachthal (preemergent herbicide), chlordane (insecticide), nonachlor (present in technical chlordane formulations), and penta-, hexa-, hepta-, and octachlorobiphenyls (PCBs, industrial chemicals).

For each cruise, masses of selected halogenated hydrophobic organic compounds were measured on the suspended sediment analyzed from each site. These data are presented in this report in tabular format, along with water discharge, suspended-sediment concentration, and percent organic carbon on the sediment. In addition, EPA priority pollutants were determined in selected samples from the June 1989 and February-March 1990 sampling cruises.

Acknowledgments

Suspended-sediment sampling of this scale requires the dedicated assistance of many individuals, particularly for the field work. The authors thank the following people for providing data and helping collect and process the samples that we analyzed: T. Brinton, P. Brown, J. Garbarino, J. Leenheer, D. Martin, R. Meade, J. Moody, T. Noyes, D. Peart, T. Rees, J. Ranville, J. Seeley, R. Stallard, H. Stevens, H. Taylor, and T. Willoughby. The authors also thank the crew of Research Vessel *ACADIANA*, owned and operated by Louisiana Universities Marine Consortium: Captains L. Black, C. LeBoeuf, W. Simoneaux, and S. Rabalais, and crewmen W. DeLaune, C. Guidry, D. Lapreyrouse, and R. Cutting.

Methods

Sample collection

Representative, discharge-weighted, suspended-sediment samples were collected during May-June 1988, March-April 1989, June 1989, February-March 1990, and May-June 1990 at various sites along the Mississippi River and its principal tributaries by using techniques described by Moody and Meade (1992 and 1993). The sampling sites for each cruise are shown on figure 1 and listed in table 1.

A Lagrangian sampling scheme (Nordin and others, 1983; Meade and Stevens, 1990) was used that attempted to follow the same parcel of water as it moved down the river channel, as determined by the mean water velocity. The Lagrangian sampling scheme was most successfully attained on the cruises of May-June 1988 and February-March 1990. On the first of these, the Mississippi River velocities were slow enough that tributaries could be sampled without interrupting the Lagrangian continuity; the second cruise was specifically designed to follow the late-winter discharge of the Ohio River from Uniontown, Ky., to Belle Chasse, La., and therefore no tributaries were sampled (Moody, 1993; Moody and Meade, 1993).

Two types of suspended-sediment samples were collected: depth-integrated composite sample (8 to 139 L) and a larger (299 to 916 L) pumped composite sample. Analyses listed in this report are for the pumped composite sample.

The depth-integrated composite samples were collected concurrently with the pumped composite samples, according to procedures described by Meade (1985), Meade and Stevens (1990), and Moody and Meade (1992). The discharge-weighted concentration of suspended sediment finer than 63 micrometers in the river at each site was determined by filtration through paired, preweighed Millipore filters (see Moody and Meade, 1992 and 1993 for details). The concentration of suspended sediment varies with depth. The sample taken for determination of the suspended-sediment concentration, collected concurrently with the pumped samples was discharge-weighted and depth-integrated according to procedures described by Meade (1985), Meade and Stevens (1990), and Moody and Meade (1992 and 1993). As such, this latter sample is more representative of the total suspended-sediment transport in the river than the pumped sample collected for organic analysis and therefore was used to determine the total suspended-sediment concentration. This discharge-weighted concentration of suspended sediment and the discharge as determined by the depth-integration method described by Moody and Troutman (1992) are presented in table 2. Further details of the water-discharge and suspended-sediment measurements are reported by Moody and Meade (1992).

At each sampling cross section, the water discharge was estimated at each of 5-30 equally spaced verticals, using the depth profile of the river and five depth-integrated velocity measurements. A discharge-weighted, pumped sample that was proportional to the estimated fractional discharge at each vertical was collected (Moody, 1993; Moody and Meade, 1993).

The 17-m research vessel from which the samples were collected was positioned in the river at each of as many as 30 verticals in the cross section by using microwave trisponders located on each bank. The discharge-weighted pumped sample was collected at each vertical from one-half the depth or 5 m, whichever was less. The maximum possible sampling depth for the equipment used was 5 m. The water was pumped through FEP Teflon tubing rigidly positioned parallel to the flow by using an air-driven, double-diaphragm Teflon pump, into a 63-micron nickel-mesh sieve. The water then flowed into a large (40 L) glass funnel, which provided constant head pressure into a continuous-flow, high-speed centrifuge (Sharples AS-12). The centrifuge was operated at 16,000 revolutions per minute and is described in detail by Leenheer and others (1989) and Rees and others (1991). To ensure high recovery efficiency of suspended sediment, the 2-L/min flow rate through the centrifuge was one-half that used by Ongley and Blachford (1982), who reported preferential losses of the organic-rich portion over the mineral-rich suspended sediment at 4 L/min. Sediment particles as small as 370 nm were recovered in the centrifuge (Rees and Ranville, 1990).

All exposed centrifuge surfaces were coated with or directly machined from TFA or FEP Teflon to minimize sample contamination. The suspended sediment from a total of 299 to 916 L of water was deposited on the cylindrical wall of the centrifuge bowl, which was lined with a removable sheet of 0.35-mm-thick FEP Teflon. The liner was easily transferred from the bowl, using Teflon tweezers and FEP Teflon gloves, into an FEP Teflon sample bag, where the sediment sample was resuspended by gentle massage of the liner from outside the bag. The suspended sediment from the 299 to 916 L of river water was then contained in 1 to 2 L of water. This solution was transferred to 1-L glass jars, preserved with five drops of chloroform, refrigerated, transported on ice to the laboratory, allowed to settle for at least 1 week, aspirated to remove the supernatant, and air-dried in the original container.

Comparative studies (J.A. Moody and R.H. Meade, U.S. Geological Survey, written commun., 1992) indicated that the size distribution of suspended particles smaller than 63 micrometers in the pumped samples was virtually identical to that in the composite depth-integrated samples; thus, the pumped sample is representative of the fine fraction (smaller than 63 micrometers) of suspended sediment transported by the river.

The organic carbon content in percent (table 2) for the analyzed suspended sediment, was determined by Huffman Laboratories, Golden, Colo. Duplicate samples varied less than 2 percent from the mean. These data enable calculation of loads.

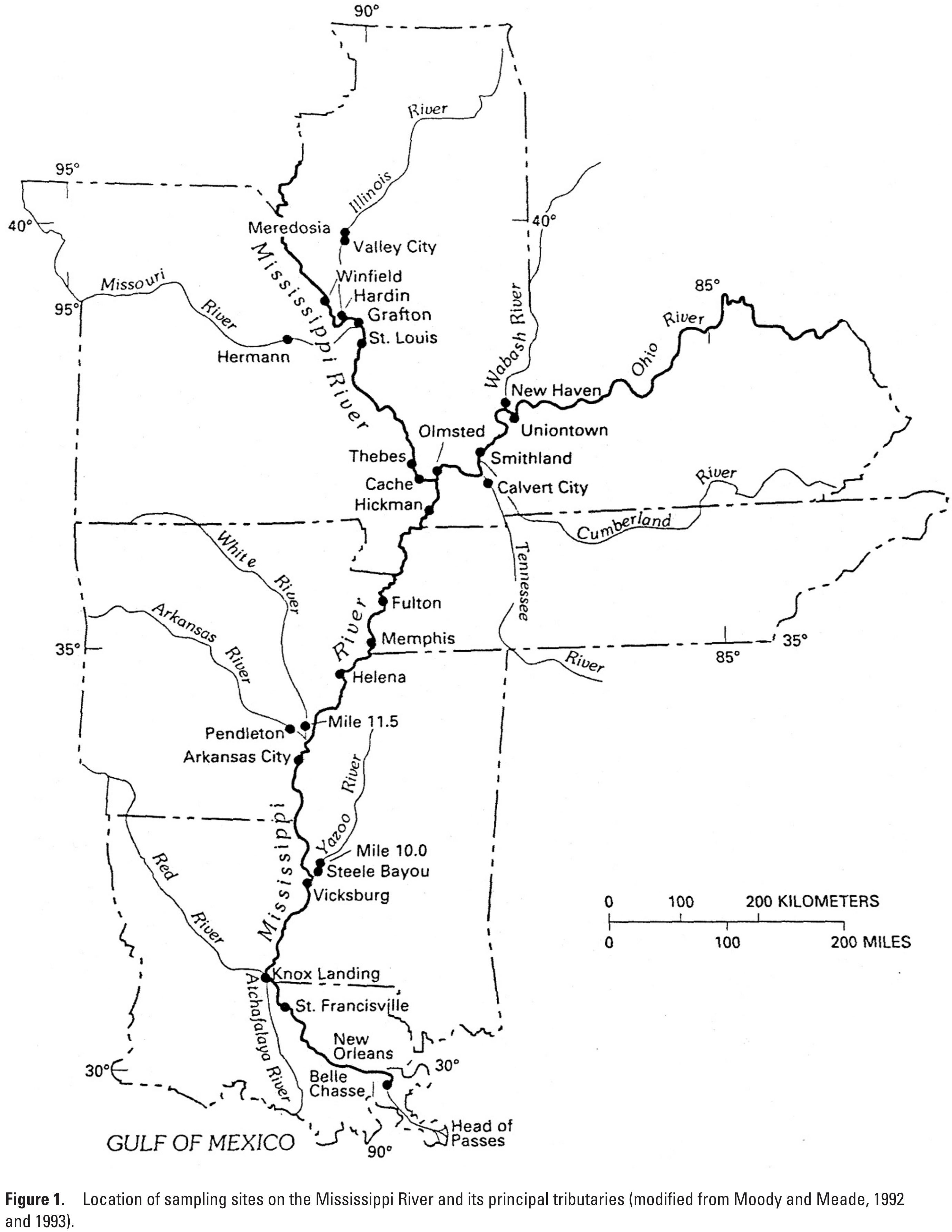

Figure 1. Location of sampling sites on the Mississippi River and its principal tributaries (modified from Moody and Meade, 1992 and 1993).

Table 1. Cross-section sampling sites during cruises of May-June 1988, March-April 1989, June 1989, February-March 1990, and May-June 1990.

[X designates that the cross section was sampled]

Sampling site	River mile[1]	May-June 1988	Mar-April 1989	June 1989	Feb-Mar 1990	May-June 1990
Mississippi River near Winfield, Mo.	UM 239.2	X	X	X		
Illinois River below Meredosia, Ill.	IL 67.2	X				
Illinois River at Valley City, Ill.	IL 61.0					X
Illinois River at Hardin, Ill.	IL 21.8		X	X		
Mississippi River below Grafton, Ill.	UM 214.6					X
Missouri River at Hermann, Mo.	MO 97.9	X	X	X		
Mississippi River at St. Louis, Mo.	UM 179.3	X	X	X		
Mississippi River at Thebes, Ill.	UM 43.9	X	X	X		X
Mississippi River near Cache, Ill.	UM 14.8				X	
Ohio River at Uniontown, Ky.	OH 842.4				X	
Wabash River near New Haven, Ill.	WA 13.8				X	
Cumberland River near Smithland, Ky.	CU 6.8				X	
Tennessee River near Calvert City, Ky.	TE 11.1				X	
Ohio River at Olmsted, Ill.	OH 965.0	X	X	X	X	X
Mississippi River below Hickman, Ky.	LM 916.8	X	X	X	X	
Mississippi River at Fulton, Tenn.	LM 777.3	X		X		
Mississippi River below Fulton, Tenn.	LM 773.5		X		X	
Mississippi River below Memphis, Tenn.	LM 731.2					X
Mississippi River at Helena, Ark.	LM 663.9	X	X	X	X	
White River at Mile 11.5, Ark.	WH 11.5	X	X	X		
Arkansas River at Pendleton, Ark.	AR 22.4		X	X		
Mississippi River above Arkansas City, Ark.	LM 566.0	X	X	X	X	
Mississippi River below Arkansas City, Ark.	LM 551.7					X
Yazoo River at Mile 10.0, Miss.	YZ 10.0	X				
Yazoo River below Steele Bayou, Miss.	YZ 9.0		X	X		X
Mississippi River below Vicksburg, Miss.	LM 433.4	X	X	X	X	X
Old River Outflow Channel near Knox Landing, Ark.	OR 5.5	X	X	X		
Mississippi River near St. Francisville, La.	LM 266.4	X	X	X	X	X
Mississippi River below Belle Chasse, La.	LM 73.1	X	X	X	X	X

[1]UM, Upper Mississippi River miles measured upriver of confluence with Ohio River.

IL, Illinois River miles measured upriver of confluence with Mississippi River (UM 218.0).

MO, Missouri River miles measured upriver of confluence with Mississippi River (UM 195.3).

OH, Ohio River miles measured downriver of Pittsburgh, PA. Ohio-Mississippi River confluence is at Ohio River Mile 981.5 and Lower Mississippi River mile 953.8.

WA, Wabash River miles measured upriver of confluence with Ohio River (OH 848.0).

CU, Cumberland River miles measured upriver of confluence with Ohio River (OH 923.2).

TE, Tennessee River miles measured upriver of confluence with Ohio River (OH 935.5).

LM, Lower Mississippi River miles measured upriver of Head of Passes, La.

WH, White River miles measured upriver of confluence with Mississippi River (LM 598.9).

AR, Arkansas River miles measured upriver of confluence with Mississippi River (LM 581.5).

YZ, Yazoo River miles measured upriver of confluence with Mississippi River (LM 437.2).

OR, Old River Outflow Channel miles measured downriver of the Old River control structure (LM 314.5).

Table 2. Mississippi River suspended-sediment concentration (smaller than 63 micrometer), water discharge, and organic-carbon content.

[mg/L, milligrams per liter; m^3/sec, cubic meters per second; Suspended-sediment and discharge data from Moody and Meade, 1992 and 1993]

Date	River	Sample site	Suspended-sediment concentration (mg/L)	Water discharge (m^3/s)	Organic-carbon content (percent)
		MAY-JUNE 1988			
5-17	Mississippi River	near Winfield, Mo.	34	1,700	6.70
5-16	Illinois River	below Meredosia, Ill.	58	330	4.28
5-19	Missouri River	at Hermann, Mo.	79	1,500	3.38
5-20	Mississippi River	at St. Louis, Mo.	66	3,300	3.61
5-22	Mississippi River	at Thebes, Ill.	74	3,600	3.81
5-23	Ohio River	at Olmsted, Ill.	32	3,200	3.84
5-24	Mississippi River	below Hickman, Ky.	60	6,800	3.47
5-26	Mississippi River	at Fulton, Tenn.	68	7,200	3.47
5-28	Mississippi River	at Helena, Ark.	76	7,100	3.26
5-29	White River	at Mile 11.5, Ark.	96	440	2.02
5-30	Mississippi River	above Arkansas City, Ark.	87	8,200	3.37
6-01	Yazoo River	at Mile 10.0, Miss.	72	70	1.66
6-02	Mississippi River	below Vicksburg, Miss.	80	8,000	3.79
6-04	Old River Outflow Channel	near Knox Landing, La.	74	2,200	3.00
6-05	Mississippi River	near St. Francisville, La.	214	5,700	1.54
6-07	Mississippi River	below Belle Chasse, La.	18	5,600	3.74
		MARCH-APRIL 1989			
3-10	Mississippi River	near Winfield, Mo.	23	850	15.42
3-09	Illinois River	at Hardin, Ill.	99	410	2.78
3-12	Missouri River	at Hermann, Mo.	74	1,480	2.33
3-13	Mississippi River	at St. Louis, Mo.	68	3,940	4.57
3-15	Mississippi River	at Thebes, Ill.	105	4,890	3.69
3-16	Ohio River	at Olmsted, Ill.	152	20,400	2.27
3-17	Mississippi River	below Hickman, Ky.	133	24,700	2.47
3-19	Mississippi River	below Fulton, Tenn.	138	24,800	2.36
3-21	Mississippi River	at Helena, Ark.	133	25,900	2.26
3-22	White River	at Mile 11.5, Ark.	44	1,500	1.95
3-23	Arkansas River	at Pendleton, Ark.	41	1,900	3.08
3-24	Mississippi River	above Arkansas City, Ark.	124	26,800	2.16
3-26	Yazoo River	below Steele Bayou, Miss.	150	1,500	1.42
3-27	Mississippi River	below Vicksburg, Miss.	122	26,600	2.11
3-29	Old River Outflow Channel	near Knox Landing, La.	162	6,160	1.65
3-30	Mississippi River	near St. Francisville, La.	116	23,100	2.06
4-01	Mississippi River	below Belle Chasse, La.	146	22,500	1.71

Table 2. Mississippi River suspended-sediment concentration (smaller than 63 micrometer), water discharge, and organic-carbon content.—Continued

Date	River	Sample site	Suspended-sediment concentration (mg/L)	Water discharge (m³/s)	Organic-carbon content (percent)
		JUNE 1989			
6-05	Mississippi River	near Winfield, Mo.	70	2,320	4.09
6-04	Illinois River	at Hardin, Ill.	708	780	2.20
6-07	Missouri River	at Hermann, Mo.	472	1,760	2.72
6-08	Mississippi River	at St. Louis, Mo.	122	4,760	3.14
6-10	Mississippi River	at Thebes, Ill.	117	5,230	3.19
6-11	Ohio River	at Olmsted, Ill.	115	8,760	2.46
6-12	Mississippi River	below Hickman, Ky.	130	14,100	2.50
6-14	Mississippi River	at Fulton, Tenn.	182	15,300	2.11
6-17	Mississippi River	at Helena, Ark.	216	16,900	2.03
6-18	White River	at Mile 11.5, Ark.	92	770	1.81
6-19	Arkansas River	at Pendleton, Ark.	68	3,600	2.64
6-20	Mississippi River	above Arkansas City, Ark.	170	23,300	2.14
6-22	Yazoo River	below Steele Bayou, Miss.	272	1,070	1.20
6-23	Mississippi River	below Vicksburg, Miss.	153	24,800	1.98
6-25	Old River Outflow Channel	near Knox Landing, La.	160	4,890	2.18
6-26	Mississippi River	near St. Francisville, La.	154	19,000	1.81
6-28	Mississippi River	below Belle Chasse, La.	170	20,100	1.72
		FEBRUARY-MARCH 1990			
2-25	Mississippi River	near Cache, Ill.	108	4,240	2.76
3-01	Ohio River	at Uniontown, Ky.	204	6,620	2.65
2-28	Wabash River	near New Haven, Ill.	148	2,340	2.62
2-23	Cumberland River	near Smithland, Ky.	32	2,170	2.35
2-24	Tennessee River	near Calvert City, Ky.	48	6,570	1.99
3-03	Ohio River	at Olmsted, Ill.	144	16,100	2.41
3-04	Mississippi River	below Hickman, Ky.	158	2,100	2.19
3-05	Mississippi River	below Fulton, Tenn.	141	22,800	2.12
3-07	Mississippi River	at Helena, Ark.	146	23,300	2.43
3-08	Mississippi River	above Arkansas City, Ark.	126	33,200	2.11
3-10	Mississippi River	below Vicksburg, Miss.	126	34,100	1.95
3-12	Mississippi River	near St. Francisville, La.	98	26,300	2.02
3-14	Mississippi River	below Belle Chasse, La.	140	26,700	1.75
		MAY-JUNE 1990			
6-07	Illinois River	at Valley City, Ill.	98	1,230	2.98
6-11	Mississippi River	below Grafton, Ill.	464	5,040	2.24
6-13	Mississippi River	at Thebes, Ill.	1115	12,600	1.83
6-14	Ohio River	at Olmsted, Ill.	177	9,550	1.87

Table 2. Mississippi River suspended-sediment concentration (smaller than 63 micrometer), water discharge, and organic-carbon content.—Continued

Date	River	Sample site	Suspended-sediment concentration (mg/L)	Water discharge (m^3/s)	Organic-carbon content (percent)
MAY-JUNE 1990—Continued					
6-18	Mississippi River	below Memphis, Tenn.	432	20,800	2.06
6-20	Mississippi River	below Arkansas City, Ark.	334	25,500	1.92
6-23	Mississippi River	below Vicksburg, Miss.	273	27,300	2.00
6-25	Mississippi River	near St. Francisville, La.	184	23,200	1.83
6-27	Mississippi River	below Belle Chasse, La.	183	23,300	2.03

Sample preparation

Ultra-high-purity distilled-in-glass (Burdick and Jackson GC[2]) solvents were used. All glassware was baked 8 hours at 340°C prior to use. The suspended sediment (smaller than 63 micrometers) was air-dried at about 23°C, ground in a glass mortar, weighed, and mixed well; a portion was taken for organic-carbon analysis. From the remaining sediment, about 15 g (from the first cruise; larger amounts when possible from later cruises) was weighed into a 150-mL centrifuge bottle and spiked with 10 microliters of 40 ng/microliter 4,4'-dibromooctafluorobiphenyl and 128 ng/microliter of terbuthylazine. The sample was tumbled for 15 minutes to equilibrate the spiked compounds with the sediment. The sample was then extracted twice with 20 mL acetone and once with 5 mL hexane using a sonic probe (Tekmar), pulsed for 3 minutes at 60-percent duty cycle, 40-percent output control, centrifuged at 1,500 revolutions per minute for 10 minutes, and the organic solvent was decanted. The extracts were combined, dried over anhydrous Na_2SO_4, and concentrated to less than 10 mL in a Kuderna-Danish apparatus. Under a gentle stream of dry N2, the sample extract was reduced to about 0.5 mL. The extract was fractionated either on 3 g of neutral alumina (Bio-Rad AG-7) with 10-mL fractions of (a)hexane; (b)benzene; (c)dichloromethane; (d)1:1 dichloromethane:methanol; and (e)methanol, or on 5 g of 2 percent deactivated florisil with 100-mL fractions of (aa)hexane; (bb)1:1 hexane:ethyl ether; (cc)dichloromethane; (dd)ethyl acetate. The (a) and (b) or (aa), (bb), and (cc) fractions were combined and concentrated to less than 0.5 mL as before. The (d), (e), and (dd) fractions were stored for future analysis. All concentrated extracts were stored in a freezer until analyzed.

Sample analysis

The combined fractions were spiked with injection standards, decafluorobiphenyl and d-10 phenanthrene, and analyzed in triplicate by gas chromatography/negative chemical ionization/mass spectrometry (GC/NCI/MS). The extracts were injected at 280°C on a 30-m, 0.25-mm inside-diameter, 0.25-micron Rtx-5 Restec GC column, at 50oC for 1 minute, ramped to 300°C at 10°C/min and held for 12 minutes. Electron-capture negative chemical ionization was achieved with ultra-high-purity methane reagent gas at 0.30 Torr in the ion source at 100°C, with a filament emission current of 0.25 microamperes and electron energy of 100 electron volts. The Finnigan MAT TSQ-46 mass spectrometer scanned the first quadrupole from 50 to 600 daltons in 1 second, with the electron multiplier at 1,000 volts.

The base peak in the negative molecular-ion cluster of each selected compound was used for quantitation, based on the base peak of the surrogate internal standard, 4,4'-dibromooctafluorobiphenyl. A six-point calibration curve was generated for each selected compound. Calibration curves for the reference standard solutions ranging up to four orders of magnitude had correlation coefficients ranging from 0.988 to 0.998, and averaged 0.995 for the selected organic compounds. DDT and its degradation products, DDE and DDD, were not quantitated using this protocol because of their low, nonspecific response to NCI.

With time, the instrument loses sensitivity due to contamination of the ion source. Contamination occurs from the chemical ionization, but also from the complex matrix of the samples. The ion volume in the ion source was replaced often to compensate for this problem. Because the response is dependent upon reagent gas pressure, fluctuations in the reagent gas pressure also can cause variations in the data. Because there could be instrumental reasons for variation of the data, especially nondetected values, samples were analyzed at least twice—more if a substantial loss in sensitivity may have occurred.

The instrumental analytical detection limit for the selected hydrophobic, anthropogenic organic compounds per 1-microliter injection of standard solution are shown in table 3 in nanograms. This value represents approximately 0.05 ng/g for penta- and hexachlorobenzene for a 100-microliter extract of a 20-g sample. Higher detection limits exist, especially for pentachlorophenol and chlorthalonil, due to their polarity. The selected compounds were below detection limits in all blanks analyzed.

Because variation in the extent of halogenation causes variations in the NCI response, the polychlorinated biphenyl quantitation was based on a reference standard compound with the same level of chlorination (Erhardt-Zabik and others, 1990). One isomer each of penta-, hexa-, hepta-, and octachlorobiphenyl was arbitrarily chosen as the quantitation reference standard. As discussed in American Society for Testing and Materials Special Technical Publication 976 (Alford-Stevens and Budde, 1988), the magnitude of the inherent error due to this quantitation approach is unknown. No attempt was made to match the isomer distribution pattern to a single technical Arochlor mixture, new or weathered.

Recovery studies require a similar sample matrix devoid of the compounds of interest. Noncontaminated suspended sediment was not available, so a well-mixed composite of excess sediment from several sites was used for recovery studies. An unspiked composite sample and triplicates spiked with the target compounds at 20 ng/g were carried through the entire extraction and analysis. The background levels from the unspiked composite sample were subtracted to produce the percent recovery for the target compounds shown in table 4, along with the percent relative standard deviation for the triplicate extractions. Chlorothalonil recovery was only 1 percent.

Seventeen June 1989 and eight February-March 1990 extracts were reanalyzed for EPA priority pollutants by GC/MS at the U.S. Geological Survey National Water Quality Laboratory in Denver using standard protocol (Wershaw and others, 1983). The sample extracts also were screened semiquantitatively for some organochlorines, triazines, and carbamates. Some of these semiquantitative compounds, such as atrazine, are water soluble and would not be expected to associate with the suspended sediment. Quantitation was based on the internal injection standard, d-10 phenanthrene.

Organic Contaminant Data

The mass in nanograms of each of the selected hydrophobic halogenated compounds in each sample was determined by duplicate or triplicate analysis of the same extract. In tables 5-9, the original sample weight in grams is shown along with the nanograms of target compound from the reported mass of sample. The data are not corrected for recovery. The detection limit in ng/g is dependent on sample size. By reporting the data in mass, the detection limits are the same for all samples. ND indicates the constituent was not detected. Sample sites are listed in downstream order, with the tributaries included. Not all sites were sampled each cruise, as noted in table 1. Further details on sampling sites may be found in reports by Moody and Meade (1992 and 1993).

Table 3. Instrumental analytical detection limit for 1 microliter of standard solution.

Compound	Detection limit, in nanograms
Pentachlorobenzene	0.01
Hexachlorobenzene	0.01
Pentachloroanisole	0.01
Chlorothalonil	1.00
Pentachlorophenol	10.00
Dachthal	0.01
Chlordane, cis- + trans-	0.10
Nonachlor, trans-	0.10
Pentachlorobiphenyls	0.50
Hexachlorobiphenyls	0.50
Heptachlorobiphenyls	0.05
Octachlorobiphenyls	0.05

Table 4. Percent recovery for triplicate samples spiked at 20 nanograms of target compound per gram suspended sediment.

[RSD = relative standard deviation]

Compound	Percent recovery	Percent RSD
Pentachlorobenzene	159	11
Hexachlorobenzene	136	13
Pentachloroanisole	168	5
Chlorothalonil	1	66
Pentachlorophenol	102	97
Dachthal	122	25
Chlordane, cis- + trans-	147	17
Nonachlor, trans-	107	11
Pentachlorobiphenyls	207	49
Hexachlorobiphenyls	139	93
Heptachlorobiphenyls	115	35
Octachlorobiphenyls	106	38

Table 5. Halogenated organic compounds found in suspended-sediment samples collected during the May-June 1988 cruise.

[ND, not detected; --, no data; masses not corrected for recovery; all masses rounded to two significant figures]

		Mass of compound, in nanograms			
		Replicate samples			
Sampling site and sample weight	Compound	A	B	C	Average
Mississippi River near Winfield, Mo. 12-gram sample	Pentachlorobenzene	3.6	3.7	--	3.6
	Hexachlorobenzene	5.4	5.5	--	5.4
	Pentachloroanisole	35	32	--	34
	Chlorothalonil	4.3	ND	--	4.3
	Pentachlorophenol	ND	ND	--	ND
	Dachthal	21	13	--	17
	Chlordane, cis- + trans-	45	50	--	48
	Nonachlor, trans-	14	21	--	18
	Pentachlorobiphenyls	290	380	--	340
	Hexachlorobiphenyls	850	530	--	690
	Heptachlorobiphenyls	66	77	--	72
	Octachlorobiphenyls	14	11	--	12
Illinois River below Meredosia, Ill., 15-gram sample	Pentachlorobenzene	5.8	3.5	--	4.6
	Hexachlorobenzene	6.5	6.3	--	6.4
	Pentachloroanisole	14	14	--	14
	Chlorothalonil	2.2	ND	--	2.2
	Pentachlorophenol	ND	ND	--	ND
	Dachthal	17	15	--	16
	Chlordane, cis- + trans-	160	180	--	170
	Nonachlor, trans-	40	41	--	40
	Pentachlorobiphenyls	700	600	--	650
	Hexachlorobiphenyls	1200	1200	--	1200
	Heptachlorobiphenyls	270	300	--	280
	Octachlorobiphenyls	72	18	--	45
Missouri River at Hermann, Mo., 15-gram sample	Pentachlorobenzene	6.7	ND	ND	6.7
	Hexachlorobenzene	4.2	2.2	2.7	3
	Pentachloroanisole	9.6	3.6	2.9	5.4
	Chlorothalonil	0.98	0.44	ND	0.71
	Pentachlorophenol	ND	62	ND	62
	Dachthal	1.6	1.5	1.1	1.4
	Chlordane, cis- + trans-	68	62	54	61
	Nonachlor, trans-	28	8	9.6	15
	Pentachlorobiphenyls	ND	ND	260	260
	Hexachlorobiphenyls	360	460	430	420
	Heptachlorobiphenyls	22	34	39	32
	Octachlorobiphenyls	10.3	8.9	5.2	8.1

Table 5. Halogenated organic compounds found in suspended-sediment samples collected during the May-June 1988 cruise.—Continued

Sampling site and sample weight	Compound	Mass of compound, in nanograms			
		Replicate samples			
		A	B	C	Average
Mississippi River at St. Louis, Mo., 15-gram sample	Pentachlorobenzene	5.3	4.7	2.4	4.1
	Hexachlorobenzene	5.1	3.9	3.7	4.2
	Pentachloroanisole	11.1	7	6.2	8.1
	Chlorothalonil	7.28	0.71	ND	4
	Pentachlorophenol	ND	192	ND	190
	Dachthal	28	31	26	28
	Chlordane, cis- + trans-	83	47	51	60
	Nonachlor, trans-	35	23	19	26
	Pentachlorobiphenyls	ND	360	250	300
	Hexachlorobiphenyls	470	470	410	450
	Heptachlorobiphenyls	67	54	51	57
	Octachlorobiphenyls	20	23	7.9	17
Mississippi River at Thebes, Ill., 15-gram sample	Pentachlorobenzene	4	3.9	--	4
	Hexachlorobenzene	4.6	4.8	--	4.7
	Pentachloroanisole	12	12	--	12
	Chlorothalonil	0.44	ND	--	0.44
	Pentachlorophenol	74	ND	--	74
	Dachthal	17	15	--	16
	Chlordane, cis- + trans-	79	74	--	76
	Nonachlor, trans-	23	15	--	19
	Pentachlorobiphenyls	520	500	--	510
	Hexachlorobiphenyls	1,000	810	--	920
	Heptachlorobiphenyls	115	94	--	100
	Octachlorobiphenyls	31	24	--	28
Ohio River at Olmsted, Ill., 8-gram sample	Pentachlorobenzene	ND	ND	11	11
	Hexachlorobenzene	14	28	27	23
	Pentachloroanisole	ND	5.7	5.6	5.6
	Chlorothalonil	ND	0.45	ND	0.45
	Pentachlorophenol	ND	ND	ND	ND
	Dachthal	3.4	5.6	5.2	4.7
	Chlordane, cis- + trans-	17	60	58	45
	Nonachlor, trans-	ND	28	24	26
	Pentachlorobiphenyls	ND	500	400	450
	Hexachlorobiphenyls	410	1,000	910	780
	Heptachlorobiphenyls	50	160	150	120
	Octachlorobiphenyls	17	28	10	18

Table 5. Halogenated organic compounds found in suspended-sediment samples collected during the May-June 1988 cruise.—Continued

Sampling site and sample weight	Compound	Mass of compound, in nanograms			
		Replicate samples			
		A	B	C	Average
Mississippi River below Hickman, Ky., 15-gram sample	Pentachlorobenzene	12	10	--	11
	Hexachlorobenzene	20	19	--	20
	Pentachloroanisole	14	12	--	13
	Chlorothalonil	ND	ND	--	ND
	Pentachlorophenol	ND	ND	--	ND
	Dachthal	10.8	9.6	--	10.2
	Chlordane, cis- + trans-	58	60	--	59
	Nonachlor, trans-	14	18	--	16
	Pentachlorobiphenyls	660	490	--	580
	Hexachlorobiphenyls	1,100	990	--	1,000
	Heptachlorobiphenyls	130	140	--	140
	Octachlorobiphenyls	38	31	--	34
Mississippi River at Fulton, Tenn., 15-gram sample	Pentachlorobenzene	7.3	8.1	6.3	7.2
	Hexachlorobenzene	12	12	12	12
	Pentachloroanisole	ND	7.2	2.4	4.8
	Chlorothalonil	0.77	ND	ND	0.77
	Pentachlorophenol	ND	ND	ND	ND
	Dachthal	3.6	ND	ND	3.6
	Chlordane, cis- + trans-	30	49	37	39
	Nonachlor, trans-	21	14	13	16
	Pentachlorobiphenyls	ND	610	470	540
	Hexachlorobiphenyls	1,200	1,300	1,000	1,200
	Heptachlorobiphenyls	88	150	136	120
	Octachlorobiphenyls	30	25	11	22
Mississippi River at Helena, Ark., 15-gram sample	Pentachlorobenzene	7	6.9	--	7
	Hexachlorobenzene	15	14	--	14
	Pentachloroanisole	6.5	5.8	--	6.2
	Chlorothalonil	2.1	1.6	--	1.8
	Pentachlorophenol	33	ND	--	33
	Dachthal	1.9	0.33	--	1.1
	Chlordane, cis- + trans-	71	64	--	68
	Nonachlor, trans-	24	20	--	22
	Pentachlorobiphenyls	440	430	--	440
	Hexachlorobiphenyls	960	870	--	920
	Heptachlorobiphenyls	170	140	--	160
	Octachlorobiphenyls	48	28	--	38

Table 5. Halogenated organic compounds found in suspended-sediment samples collected during the May-June 1988 cruise.—Continued

Sampling site and sample weight	Compound	Mass of compound, in nanograms			
		Replicate samples			
		A	B	C	Average
White River at Mile 11.5, Ark., 15-gram sample	Pentachlorobenzene	2.3	2.3	1.6	2.1
	Hexachlorobenzene	3.7	3.5	1.5	2.9
	Pentachloroanisole	2.9	2.9	2.1	2.6
	Chlorothalonil	ND	ND	ND	ND
	Pentachlorophenol	ND	ND	ND	ND
	Dachthal	1.8	1.8	1.6	1.7
	Chlordane, cis- + trans-	3.3	ND	5.4	4.4
	Nonachlor, trans-	ND	ND	1.9	1.9
	Pentachlorobiphenyls	142	72	64	93
	Hexachlorobiphenyls	380	ND	430	400
	Heptachlorobiphenyls	9.4	8.3	21.9	13
	Octachlorobiphenyls	2.4	170	4	59
Mississippi River above Arkansas City, Ark., 15-gram sample	Pentachlorobenzene	12.6	9.8	--	11.2
	Hexachlorobenzene	16	16	--	16
	Pentachloroanisole	9	8.5	--	8.8
	Chlorothalonil	1.7	1.6	--	1.6
	Pentachlorophenol	ND	ND	--	ND
	Dachthal	2.9	ND	--	2.9
	Chlordane, cis- + trans-	61	80	--	70
	Nonachlor, trans-	15	16	--	16
	Pentachlorobiphenyls	440	460	--	450
	Hexachlorobiphenyls	1,300	970	--	1,100
	Heptachlorobiphenyls	190	190	--	190
	Octachlorobiphenyls	19	39	--	29
Yazoo River at Mile 10.0, Miss., 15-gram sample	Pentachlorobenzene	6.9	7.5	--	7.2
	Hexachlorobenzene	4.8	17.3	--	11
	Pentachloroanisole	5.8	6.9	--	6.4
	Chlorothalonil	ND	ND	--	ND
	Pentachlorophenol	34	ND	--	34
	Dachthal	2.2	1.2	--	1.7
	Chlordane, cis- + trans-	8.8	13.6	--	11
	Nonachlor, trans-	2.9	5.6	--	4.2
	Pentachlorobiphenyls	86	81	--	84
	Hexachlorobiphenyls	310	310	--	310
	Heptachlorobiphenyls	10	14	--	12
	Octachlorobiphenyls	0.48	0.53	--	0.5

Table 5. Halogenated organic compounds found in suspended-sediment samples collected during the May-June 1988 cruise.—Continued

Sampling site and sample weight	Compound	Mass of compound, in nanograms			
		Replicate samples			
		A	B	C	Average
Mississippi River below Vicksburg, Miss., 15-gram sample	Pentachlorobenzene	11.1	10.9	8.7	10.2
	Hexachlorobenzene	30	32	27	30
	Pentachloroanisole	12.6	8.4	6.5	9.2
	Chlorothalonil	6.1	2.3	1.8	3.4
	Pentachlorophenol	ND	ND	ND	ND
	Dachthal	8.8	6.5	5.4	6.9
	Chlordane, cis- + trans-	84	65	53	67
	Nonachlor, trans-	33.4	19.8	8.8	21
	Pentachlorobiphenyls	ND	470	360	420
	Hexachlorobiphenyls	1,300	1,130	790	1,100
	Heptachlorobiphenyls	180	170	170	170
	Octachlorobiphenyls	50	11	15	25
Old River Outflow Channel near Knox Landing, La., 15-gram sample	Pentachlorobenzene	6.6	12.1	9.6	9.4
	Hexachlorobenzene	12	13	13	13
	Pentachloroanisole	5.6	8.8	9.2	7.9
	Chlorothalonil	1.3	ND	1.4	1.4
	Pentachlorophenol	ND	ND	ND	ND
	Dachthal	8.6	7.5	5.3	7.1
	Chlordane, cis- + trans-	52	55	56	54
	Nonachlor, trans-	13	10	17	13
	Pentachlorobiphenyls	ND	500	440	470
	Hexachlorobiphenyls	1,100	1,100	1,000	1,100
	Heptachlorobiphenyls	110	180	170	150
	Octachlorobiphenyls	27	34	12	24
Mississippi River near St. Francisville, La., 15-gram sample	Pentachlorobenzene	6	5.1	--	5.6
	Hexachlorobenzene	14	13	--	14
	Pentachloroanisole	6.5	5.1	--	5.8
	Chlorothalonil	1.3	0.4	--	0.85
	Pentachlorophenol	250	ND	--	250
	Dachthal	3.5	2.5	--	3
	Chlordane, cis- + trans-	25	23	--	24
	Nonachlor, trans-	5.4	5.2	--	5.3
	Pentachlorobiphenyls	270	260	--	260
	Hexachlorobiphenyls	820	440	--	630
	Heptachlorobiphenyls	86	69	--	78
	Octachlorobiphenyls	10	8.3	--	9.2

Table 5. Halogenated organic compounds found in suspended-sediment samples collected during the May-June 1988 cruise.—Continued

Sampling site and sample weight	Compound	Mass of compound, in nanograms			
		Replicate samples			Average
		A	B	C	
Mississippi River below Belle Chasse, La., 9-gram sample	Pentachlorobenzene	8.2	7.4	--	7.8
	Hexachlorobenzene	39	36	--	38
	Pentachloroanisole	7	6.5	--	6.8
	Chlorothalonil	0.2	ND	--	0.2
	Pentachlorophenol	ND	ND	--	ND
	Dachthal	0.47	ND	--	0.47
	Chlordane, cis- + trans-	66	44	--	55
	Nonachlor, trans-	21.9	8.4	--	15
	Pentachlorobiphenyls	290	290	--	290
	Hexachlorobiphenyls	860	790	--	820
	Heptachlorobiphenyls	120	95.4	--	110
	Octachlorobiphenyls	42.7	1.3	--	22

Table 6. Halogenated organic compounds found in suspended-sediment samples collected during the March-April 1989 cruise.

[ND, not detected; --, no data; masses not corrected for recovery; all masses rounded to two significant figures]

Sampling site and sample weight	Compound	Mass of compound, in nanograms: Replicate samples A	B	C	Average
Mississippi River near Winfield, Mo., 7.2-gram sample	Pentachlorobenzene	ND	6.6	7.6	7.1
	Hexachlorobenzene	7	11	8.5	8.8
	Pentachloroanisole	66	48	46	53
	Chlorothalonil	6.7	1.5	3.1	3.8
	Pentachlorophenol	600	1,500	670	920
	Dachthal	6.7	10.4	10.1	9.1
	Chlordane, cis- + trans-	ND	49	37	43
	Nonachlor, trans-	ND	79	38	58
	Pentachlorobiphenyls	1,300	1,100	900	1,100
	Hexachlorobiphenyls	1,900	2,200	1,300	1,800
	Heptachlorobiphenyls	24	73	36	44
	Octachlorobiphenyls	ND	20.4	1.6	11
Illinois River at Hardin, Ill., 39.96-gram sample	Pentachlorobenzene	15	9.4	--	12
	Hexachlorobenzene	14	9.1	--	12
	Pentachloroanisole	50	32	--	41
	Chlorothalonil	2.7	1.8	--	2.2
	Pentachlorophenol	890	ND	--	890
	Dachthal	17.2	8.4	--	13
	Chlordane, cis- + trans-	135	99	--	120
	Nonachlor, trans-	110	ND	--	110
	Pentachlorobiphenyls	1,600	770	--	1,200
	Hexachlorobiphenyls	4,200	2,800	--	3,500
	Heptachlorobiphenyls	340	120	--	230
	Octachlorobiphenyls	68	37	--	52
Missouri River at Hermann, Mo., 21.15-gram sample	Pentachlorobenzene	5	5.8	--	5.4
	Hexachlorobenzene	5.3	4.6	--	5
	Pentachloroanisole	13	20	--	16
	Chlorothalonil	1.7	2.6	--	2.2
	Pentachlorophenol	750	950	--	850
	Dachthal	5.8	3.2	--	4.5
	Chlordane, cis- + trans-	30	18	--	24
	Nonachlor, trans-	57	ND	--	57
	Pentachlorobiphenyls	94	ND	--	94
	Hexachlorobiphenyls	270	620	--	440
	Heptachlorobiphenyls	20	20	--	20
	Octachlorobiphenyls	ND	ND	--	ND

Table 6. Halogenated organic compounds found in suspended-sediment samples collected during the March-April 1989 cruise.—Continued

Sampling site and sample weight	Compound	Mass of compound, in nanograms			
		Replicate samples			
		A	B	C	Average
Mississippi River at St. Louis, Mo., 20.80-gram sample	Pentachlorobenzene	4.6	5.1	--	4.8
	Hexachlorobenzene	8.1	4.5	--	6.3
	Pentachloroanisole	22	27	--	24
	Chlorothalonil	0.99	0.6	--	0.8
	Pentachlorophenol	ND	1,400	--	1,400
	Dachthal	10.8	5.2	--	8
	Chlordane, cis- + trans-	53	51	--	52
	Nonachlor, trans-	32	108	--	70
	Pentachlorobiphenyls	520	220	--	370
	Hexachlorobiphenyls	1,700	1,100	--	1,400
	Heptachlorobiphenyls	51	30	--	40
	Octachlorobiphenyls	9.8	9	--	9.4
Mississippi River at Thebes, Ill., 24.81-gram sample	Pentachlorobenzene	12.3	3.5	--	7.9
	Hexachlorobenzene	8.2	6.4	--	7.3
	Pentachloroanisole	21	47	--	34
	Chlorothalonil	7	3.3	--	5.2
	Pentachlorophenol	ND	540	--	540
	Dachthal	9.9	4.1	--	7
	Chlordane, cis- + trans-	99	76	--	88
	Nonachlor, trans-	110	130	--	120
	Pentachlorobiphenyls	2,000	340	--	1,200
	Hexachlorobiphenyls	1,200	1,200	--	1,200
	Heptachlorobiphenyls	85	56	--	70
	Octachlorobiphenyls	9	17	--	13
Ohio River at Olmsted, Ill., 39.97-gram sample	Pentachlorobenzene	35	26	--	30
	Hexachlorobenzene	73	70	--	72
	Pentachloroanisole	109	98	--	104
	Chlorothalonil	ND	2.7	--	2.7
	Pentachlorophenol	760	ND	--	760
	Dachthal	9.7	7	--	800
	Chlordane, cis- + trans-	108	98	--	100
	Nonachlor, trans-	150	260	--	200
	Pentachlorobiphenyls	580	860	--	720
	Hexachlorobiphenyls	4,400	4,800	--	4,600
	Heptachlorobiphenyls	200	230	--	220
	Octachlorobiphenyls	44	80	--	62

Table 6. Halogenated organic compounds found in suspended-sediment samples collected during the March-April 1989 cruise.—Continued

Sampling site and sample weight	Compound	Mass of compound, in nanograms			
		Replicate samples			
		A	B	C	Average
Mississippi River below Hickman, Ky., 21.51-gram sample	Pentachlorobenzene	11	21	--	16
	Hexachlorobenzene	21	26	--	24
	Pentachloroanisole	36	39	--	38
	Chlorothalonil	ND	ND	--	ND
	Pentachlorophenol	ND	ND	--	ND
	Dachthal	2.5	5	--	3.8
	Chlordane, cis- + trans-	34	67	--	50
	Nonachlor, trans-	80	101	--	90
	Pentachlorobiphenyls	570	670	--	620
	Hexachlorobiphenyls	1,600	2,400	--	2,000
	Heptachlorobiphenyls	71	170	--	120
	Octachlorobiphenyls	19	30.2	--	25
Mississippi River below Fulton, Tenn., 39.87-gram sample	Pentachlorobenzene	38	16	--	27
	Hexachlorobenzene	52	31	--	42
	Pentachloroanisole	91	70	--	80
	Chlorothalonil	6.8	ND	--	6.8
	Pentachlorophenol	ND	ND	--	ND
	Dachthal	9.3	4.6	--	7
	Chlordane, cis- + trans-	87	57	--	72
	Nonachlor, trans-	220	120	--	170
	Pentachlorobiphenyls	1,400	550	--	980
	Hexachlorobiphenyls	4,900	1,800	--	3,400
	Heptachlorobiphenyls	320	124	--	220
	Octachlorobiphenyls	80	37	--	58
Mississippi River at Helena, Ark., 39.96-gram sample	Pentachlorobenzene	19	34	--	26
	Hexachlorobenzene	32	47	--	40
	Pentachloroanisole	57	62	--	60
	Chlorothalonil	ND	ND	--	ND
	Pentachlorophenol	ND	ND	--	ND
	Dachthal	5.1	5.7	--	5.4
	Chlordane, cis- + trans-	66	96	--	81
	Nonachlor, trans-	110	120	--	120
	Pentachlorobiphenyls	450	900	--	680
	Hexachlorobiphenyls	2,400	4,000	--	3,200
	Heptachlorobiphenyls	130	230	--	180
	Octachlorobiphenyls	24	45	--	34

Table 6. Halogenated organic compounds found in suspended-sediment samples collected during the March-April 1989 cruise.—Continued

Sampling site and sample weight	Compound	Mass of compound, in nanograms			
		Replicate samples			
		A	B	C	Average
White River at Mile 11.5, Ark., 7.81-gram sample	Pentachlorobenzene	5	5.2	6	5.4
	Hexachlorobenzene	5.8	5.6	6.8	6.1
	Pentachloroanisole	11.9	4.4	10.6	9
	Chlorothalonil	0.5	ND	1.2	0.85
	Pentachlorophenol	450	ND	400	420
	Dachthal	7.8	5.2	7.8	6.9
	Chlordane, cis- + trans-	8.2	4	24	12
	Nonachlor, trans-	13	ND	ND	13
	Pentachlorobiphenyls	75	263	145	160
	Hexachlorobiphenyls	480	240	360	360
	Heptachlorobiphenyls	5.4	4	7.2	5.5
	Octachlorobiphenyls	1.5	ND	ND	1.5
Arkansas River at Pendleton, Ark., 11.86-gram sample	Pentachlorobenzene	ND	6.1	--	6.1
	Hexachlorobenzene	2.8	2.4	--	2.6
	Pentachloroanisole	ND	32	--	32
	Chlorothalonil	1.6	1.5	--	1.6
	Pentachlorophenol	ND	ND	--	ND
	Dachthal	2.4	2.1	--	2.2
	Chlordane, cis- + trans-	28	35	--	32
	Nonachlor, trans-	81	ND	--	81
	Pentachlorobiphenyls	160	550	--	360
	Hexachlorobiphenyls	520	310	--	420
	Heptachlorobiphenyls	15	14	--	14
	Octachlorobiphenyls	10	11	--	10
Mississippi River above Arkansas City, Ark., 35.06-gram sample	Pentachlorobenzene	17	21	--	19
	Hexachlorobenzene	33	33	--	33
	Pentachloroanisole	57	78	--	68
	Chlorothalonil	ND	ND	--	ND
	Pentachlorophenol	ND	ND	--	ND
	Dachthal	ND	4.2	--	4.2
	Chlordane, cis- + trans-	59	69	--	64
	Nonachlor, trans-	92	115	--	104
	Pentachlorobiphenyls	1,600	930	--	1,300
	Hexachlorobiphenyls	3,400	3,500	--	3,400
	Heptachlorobiphenyls	150	180	--	160
	Octachlorobiphenyls	42	53	--	48

Table 6. Halogenated organic compounds found in suspended-sediment samples collected during the March-April 1989 cruise.—Continued

Sampling site and sample weight	Compound	Mass of compound, in nanograms			
		Replicate samples			Average
		A	B	C	
Yazoo River below Steele Bayou, Miss., 37.31-gram sample	Pentachlorobenzene	10	26	--	18
	Hexachlorobenzene	6.9	10.7	--	8.8
	Pentachloroanisole	30	37	--	34
	Chlorothalonil	ND	ND	--	ND
	Pentachlorophenol	ND	ND	--	ND
	Dachthal	2.9	2.1	--	2.5
	Chlordane, cis- + trans-	32	ND	--	32
	Nonachlor, trans-	ND	ND	--	ND
	Pentachlorobiphenyls	ND	310	--	310
	Hexachlorobiphenyls	210	720	--	460
	Heptachlorobiphenyls	20	31	--	26
	Octachlorobiphenyls	ND	12	--	12
Mississippi River below Vicksburg, Miss., 38.24-gram sample	Pentachlorobenzene	23	17	27	22
	Hexachlorobenzene	44	32	41	39
	Pentachloroanisole	78	53	70	67
	Chlorothalonil	4.1	2.6	3.3	3.3
	Pentachlorophenol	820	ND	ND	820
	Dachthal	10	6.1	8.6	8.2
	Chlordane, cis- + trans-	105	76	89	90
	Nonachlor, trans-	220	96	140	152
	Pentachlorobiphenyls	1,070	1,360	750	1,100
	Hexachlorobiphenyls	2,600	3,100	2,600	2,800
	Heptachlorobiphenyls	220	180	200	200
	Octachlorobiphenyls	42	41	52	45
Old River Outflow Channel near Knox Landing, La., 39.96-gram sample	Pentachlorobenzene	23	23	--	23
	Hexachlorobenzene	30	22	--	26
	Pentachloroanisole	45	41	--	43
	Chlorothalonil	2.4	ND	--	2.4
	Pentachlorophenol	470	1,200	--	840
	Dachthal	7.2	6.4	--	6.8
	Chlordane, cis- + trans-	74	59	--	66
	Nonachlor, trans-	54	116	--	85
	Pentachlorobiphenyls	610	800	--	700
	Hexachlorobiphenyls	1,800	2,700	--	2,200
	Heptachlorobiphenyls	140	130	--	140
	Octachlorobiphenyls	29	40	--	34

Table 6. Halogenated organic compounds found in suspended-sediment samples collected during the March-April 1989 cruise.—Continued

Sampling site and sample weight	Compound	Mass of compound, in nanograms — Replicate samples A	B	C	Average
Mississippi River near St. Francisville, La., 34.36-gram sample	Pentachlorobenzene	16	13	22	17
	Hexachlorobenzene	19	18	23	20
	Pentachloroanisole	68	46	54	56
	Chlorothalonil	1	2	4.3	2.4
	Pentachlorophenol	1,130	290	670	700
	Dachthal	5.7	5.6	8.4	6.6
	Chlordane, cis- + trans-	52	52	66	57
	Nonachlor, trans-	84	50	99	78
	Pentachlorobiphenyls	550	380	460	460
	Hexachlorobiphenyls	1,700	1,600	2,000	1,800
	Heptachlorobiphenyls	99	88	140	110
	Octachlorobiphenyls	24	14	25	21
Mississippi River below Belle Chasse, La., 37.17-gram sample	Pentachlorobenzene	30	34	26	30
	Hexachlorobenzene	86	81	59	75
	Pentachloroanisole	47	46	39	44
	Chlorothalonil	4.8	4.4	ND	1.6
	Pentachlorophenol	ND	950	920	940
	Dachthal	11	11	11	11
	Chlordane, cis- + trans-	66	108	36	70
	Nonachlor, trans-	77	106	105	96
	Pentachlorobiphenyls	1,100	800	880	930
	Hexachlorobiphenyls	3,000	2,500	2,400	2,600
	Heptachlorobiphenyls	120	160	130	140
	Octachlorobiphenyls	36	26	41	34

Table 7. Halogenated organic compounds found in suspended-sediment samples collected during the June 1989 cruise.

[ND, not detected; --, no data; masses not corrected for recovery; all masses rounded to two significant figures]

Sampling site and sample weight	Compound	Mass of compound, in nanograms					
		Replicate samples					
		A	B	C	D	E	Average
Mississippi River near Winfield, Mo., 19.90-gram sample	Pentachlorobenzene	1	ND	--	--	--	1
	Hexachlorobenzene	3	2.1	--	--	--	2.6
	Pentachloroanisole	ND	ND	--	--	--	ND
	Chlorothalonil	ND	ND	--	--	--	ND
	Pentachlorophenol	ND	ND	--	--	--	ND
	Dachthal	7	4	--	--	--	5.5
	Chlordane, cis- + trans-	13	ND	--	--	--	13
	Nonachlor, trans-	ND	ND	--	--	--	ND
	Pentachlorobiphenyls	540	260	--	--	--	400
	Hexachlorobiphenyls	1,400	510	--	--	--	960
	Heptachlorobiphenyls	20.7	6.9	--	--	--	14
	Octachlorobiphenyls	ND	ND	--	--	--	ND
Illinois River at Hardin, Ill., 39.74-gram sample	Pentachlorobenzene	18	27	--	--	--	22
	Hexachlorobenzene	ND	3.3	--	--	--	303
	Pentachloroanisole	ND	ND	--	--	--	ND
	Chlorothalonil	ND	ND	--	--	--	ND
	Pentachlorophenol	ND	ND	--	--	--	ND
	Dachthal	12	22	--	--	--	17
	Chlordane, cis- + trans-	21	129	--	--	--	75
	Nonachlor, trans-	ND	150	--	--	--	150
	Pentachlorobiphenyls	140	1,300	--	--	--	720
	Hexachlorobiphenyls	970	3,400	--	--	--	2,200
	Heptachlorobiphenyls	31	180	--	--	--	110
	Octachlorobiphenyls	ND	30	--	--	--	30
Missouri River at Hermann, Mo., 40.11-gram sample	Pentachlorobenzene	3.6	1.3	--	--	--	2.4
	Hexachlorobenzene	4.9	2.6	--	--	--	3.8
	Pentachloroanisole	4.3	1.8	--	--	--	3
	Chlorothalonil	1.2	ND	--	--	--	1.2
	Pentachlorophenol	130	ND	--	--	--	130
	Dachthal	7.8	4.7	--	--	--	6.2
	Chlordane, cis- + trans-	31	18	--	--	--	24
	Nonachlor, trans-	41	15	--	--	--	28
	Pentachlorobiphenyls	47	ND	--	--	--	47
	Hexachlorobiphenyls	310	150	--	--	--	230
	Heptachlorobiphenyls	15.5	6.4	--	--	--	11
	Octachlorobiphenyls	1.4	ND	--	--	--	1.4

Table 7. Halogenated organic compounds found in suspended-sediment samples collected during the June 1989 cruise.—Continued

Sampling site and sample weight	Compound	Mass of compound, in nanograms					
		Replicate samples					
		A	B	C	D	E	Average
Mississippi River at St. Louis, Mo., 40.17-gram sample	Pentachlorobenzene	7.2	7.9	--	--	--	7.6
	Hexachlorobenzene	7.2	7.5	--	--	--	7.4
	Pentachloroanisole	16	14	--	--	--	15
	Chlorothalonil	ND	ND	--	--	--	ND
	Pentachlorophenol	ND	ND	--	--	--	ND
	Dachthal	15	14	--	--	--	14
	Chlordane, cis- + trans-	54	48	--	--	--	51
	Nonachlor, trans-	60	62	--	--	--	61
	Pentachlorobiphenyls	410	410	--	--	--	410
	Hexachlorobiphenyls	1,400	1,300	--	--	--	1,400
	Heptachlorobiphenyls	60	58	--	--	--	59
	Octachlorobiphenyls	9.9	11	--	--	--	10
Mississippi River at Thebes, Ill., 30.99-gram sample	Pentachlorobenzene	5.4	5.7	--	--	--	5.6
	Hexachlorobenzene	5.1	5.5	--	--	--	5.3
	Pentachloroanisole	11	12	--	--	--	12
	Chlorothalonil	ND	ND	--	--	--	ND
	Pentachlorophenol	ND	ND	--	--	--	ND
	Dachthal	11	11	--	--	--	11
	Chlordane, cis- + trans-	60	55	--	--	--	58
	Nonachlor, trans-	68	68	--	--	--	68
	Pentachlorobiphenyls	500	420	--	--	--	460
	Hexachlorobiphenyls	1,500	1,600	--	--	--	1,600
	Heptachlorobiphenyls	104	96	--	--	--	100
	Octachlorobiphenyls	20	16	--	--	--	18
Ohio River at Olmsted, Ill., 40.21-gram sample	Pentachlorobenzene	26	25	--	--	--	26
	Hexachlorobenzene	92	88	--	--	--	90
	Pentachloroanisole	41	37	--	--	--	39
	Chlorothalonil	ND	ND	--	--	--	ND
	Pentachlorophenol	ND	ND	--	--	--	ND
	Dachthal	22	22	--	--	--	22
	Chlordane, cis- + trans-	67	64	--	--	--	66
	Nonachlor, trans-	140	120	--	--	--	130
	Pentachlorobiphenyls	1,400	1,500	--	--	--	1,400
	Hexachlorobiphenyls	3,000	3,200	--	--	--	3,100
	Heptachlorobiphenyls	170	160	--	--	--	160
	Octachlorobiphenyls	33	26	--	--	--	30

Table 7. Halogenated organic compounds found in suspended-sediment samples collected during the June 1989 cruise.—Continued

Sampling site and sample weight	Compound	Mass of compound, in nanograms					
		Replicate samples					Average
		A	B	C	D	E	
Mississippi River below Hickman, Ky., 37.94-gram sample	Pentachlorobenzene	15	15	--	--	--	15
	Hexachlorobenzene	57	56	--	--	--	56
	Pentachloroanisole	20	24	--	--	--	22
	Chlorothalonil	ND	ND	--	--	--	ND
	Pentachlorophenol	ND	ND	--	--	--	ND
	Dachthal	15	14	--	--	--	14
	Chlordane, cis- + trans-	64	71	--	--	--	68
	Nonachlor, trans-	91	101	--	--	--	96
	Pentachlorobiphenyls	1,300	1,400	--	--	--	1,400
	Hexachlorobiphenyls	2,600	2,700	--	--	--	2,600
	Heptachlorobiphenyls	146	144	--	--	--	140
	Octachlorobiphenyls	23	22	--	--	--	22
Mississippi River at Fulton, Tenn., 37.47-gram sample	Pentachlorobenzene	16	18	--	--	--	17
	Hexachlorobenzene	40	41	--	--	--	40
	Pentachloroanisole	11	21	--	--	--	14
	Chlorothalonil	ND	ND	--	--	--	ND
	Pentachlorophenol	ND	ND	--	--	--	ND
	Dachthal	11	12	--	--	--	12
	Chlordane, cis- + trans-	40	42	--	--	--	41
	Nonachlor, trans-	45	44	--	--	--	44
	Pentachlorobiphenyls	670	820	--	--	--	740
	Hexachlorobiphenyls	2,200	2,100	--	--	--	2,200
	Heptachlorobiphenyls	96	107	--	--	--	100
	Octachlorobiphenyls	16	18	--	--	--	17
Mississippi River at Helena, Ark., 40.10-gram sample	Pentachlorobenzene	15	16	--	--	--	16
	Hexachlorobenzene	34	34	--	--	--	34
	Pentachloroanisole	18	16	--	--	--	17
	Chlorothalonil	ND	ND	--	--	--	ND
	Pentachlorophenol	ND	ND	--	--	--	ND
	Dachthal	10.2	8.6	--	--	--	9.4
	Chlordane, cis- + trans-	34	36	--	--	--	35
	Nonachlor, trans-	41	ND	--	--	--	41
	Pentachlorobiphenyls	750	600	--	--	--	680
	Hexachlorobiphenyls	2,200	2,200	--	--	--	2,200
	Heptachlorobiphenyls	102	96	--	--	--	99
	Octachlorobiphenyls	19	18	--	--	--	18

Table 7. Halogenated organic compounds found in suspended-sediment samples collected during the June 1989 cruise.—Continued

Sampling site and sample weight	Compound	Mass of compound, in nanograms					
		Replicate samples					
		A	B	C	D	E	Average
White River at Mile 11.5, Ark., 28.99-gram sample	Pentachlorobenzene	5.1	4.6	--	--	--	4.8
	Hexachlorobenzene	6.2	5.6	--	--	--	5.9
	Pentachloroanisole	ND	ND	--	--	--	ND
	Chlorothalonil	ND	ND	--	--	--	ND
	Pentachlorophenol	ND	ND	--	--	--	ND
	Dachthal	7.4	7.2	--	--	--	7.3
	Chlordane, cis- + trans-	ND	ND	--	--	--	ND
	Nonachlor, trans-	ND	ND	--	--	--	ND
	Pentachlorobiphenyls	ND	ND	--	--	--	ND
	Hexachlorobiphenyls	ND	ND	--	--	--	ND
	Heptachlorobiphenyls	ND	ND	--	--	--	ND
	Octachlorobiphenyls	ND	ND	--	--	--	ND
Arkansas River at Pendleton, Ark., 15.03-gram sample	Pentachlorobenzene	ND	ND	--	--	--	ND
	Hexachlorobenzene	ND	ND	--	--	--	ND
	Pentachloroanisole	ND	ND	--	--	--	ND
	Chlorothalonil	ND	ND	--	--	--	ND
	Pentachlorophenol	ND	ND	--	--	--	ND
	Dachthal	2.9	2.8	--	--	--	2.8
	Chlordane, cis- + trans-	ND	ND	--	--	--	ND
	Nonachlor, trans-	ND	ND	--	--	--	ND
	Pentachlorobiphenyls	ND	ND	--	--	--	ND
	Hexachlorobiphenyls	44	90	--	--	--	67
	Heptachlorobiphenyls	5.1	4.4	--	--	--	4.8
	Octachlorobiphenyls	ND	ND	--	--	--	ND
Mississippi River above Arkansas City, Ark., 39.44-gram sample	Pentachlorobenzene	11	15	--	--	--	13
	Hexachlorobenzene	38	38	--	--	--	38
	Pentachloroanisole	14	14	--	--	--	14
	Chlorothalonil	ND	ND	--	--	--	ND
	Pentachlorophenol	ND	ND	--	--	--	ND
	Dachthal	8.7	9	--	--	--	8.8
	Chlordane, cis- + trans-	23	21	--	--	--	22
	Nonachlor, trans-	ND	ND	--	--	--	ND
	Pentachlorobiphenyls	610	500	--	--	--	560
	Hexachlorobiphenyls	2,100	1,900	--	--	--	2,000
	Heptachlorobiphenyls	110	84	--	--	--	97
	Octachlorobiphenyls	15	12	--	--	--	14

Table 7. Halogenated organic compounds found in suspended-sediment samples collected during the June 1989 cruise.—Continued

Sampling site and sample weight	Compound	Mass of compound, in nanograms					
		Replicate samples					Average
		A	B	C	D	E	
Yazoo River below Steele Bayou, Miss., 40.22-gram sample	Pentachlorobenzene	16	ND	--	--	--	16.3
	Hexachlorobenzene	3.4	ND	--	--	--	3.41
	Pentachloroanisole	9.6	ND	--	--	--	9.62
	Chlorothalonil	ND	ND	--	--	--	ND
	Pentachlorophenol	ND	ND	--	--	--	ND
	Dachthal	1.8	ND	--	--	--	1.78
	Chlordane, cis- + trans-	ND	ND	--	--	--	ND
	Nonachlor, trans-	ND	ND	--	--	--	ND
	Pentachlorobiphenyls	ND	ND	--	--	--	ND
	Hexachlorobiphenyls	ND	ND	--	--	--	ND
	Heptachlorobiphenyls	ND	ND	--	--	--	ND
	Octachlorobiphenyls	ND	ND	--	--	--	ND
Mississippi River below Vicksburg, Miss., 39.01-gram sample	Pentachlorobenzene	12	21	ND	ND	17	17
	Hexachlorobenzene	39	48	27	32	42	38
	Pentachloroanisole	5.6	24	ND	ND	16	15
	Chlorothalonil	ND	ND	ND	ND	ND	ND
	Pentachlorophenol	ND	ND	ND	ND	ND	ND
	Dachthal	6.4	10.7	ND	5.2	8	7.6
	Chlordane, cis- + trans-	ND	40	ND	ND	21	30
	Nonachlor, trans-	ND	49	ND	ND	16	32
	Pentachlorobiphenyls	270	770	ND	ND	480	510
	Hexachlorobiphenyls	1,400	2,000	450	980	1,900	1,300
	Heptachlorobiphenyls	74	157	28	40	90	78
	Octachlorobiphenyls	13	30	ND	ND	16	20
Old River Outflow Channel near Knox Landing, La., 35.86-gram sample	Pentachlorobenzene	13	16	--	--	--	14
	Hexachlorobenzene	31	29	--	--	--	30
	Pentachloroanisole	18	16	--	--	--	17
	Chlorothalonil	ND	ND	--	--	--	ND
	Pentachlorophenol	ND	ND	--	--	--	ND
	Dachthal	5.9	5.5	--	--	--	5.7
	Chlordane, cis- + trans-	25	27	--	--	--	26
	Nonachlor, trans-	25	30	--	--	--	28
	Pentachlorobiphenyls	420	490	--	--	--	460
	Hexachlorobiphenyls	1,700	1,700	--	--	--	1,700
	Heptachlorobiphenyls	90	92	--	--	--	91
	Octachlorobiphenyls	14	16	--	--	--	15

Table 7. Halogenated organic compounds found in suspended-sediment samples collected during the June 1989 cruise.—Continued

Sampling site and sample weight	Compound	Mass of compound, in nanograms					
		Replicate samples					
		A	B	C	D	E	Average
Mississippi River near St. Francisville, La., 39.79-gram sample	Pentachlorobenzene	17	18	--	--	--	18
	Hexachlorobenzene	39	37	--	--	--	38
	Pentachloroanisole	17	16	--	--	--	16
	Chlorothalonil	ND	ND	--	--	--	ND
	Pentachlorophenol	ND	ND	--	--	--	ND
	Dachthal	7.5	6.8	--	--	--	7.2
	Chlordane, cis- + trans-	36	29	--	--	--	32
	Nonachlor, trans-	31	18	--	--	--	24
	Pentachlorobiphenyls	530	600	--	--	--	560
	Hexachlorobiphenyls	1,800	1,700	--	--	--	1,800
	Heptachlorobiphenyls	98	87	--	--	--	92
	Octachlorobiphenyls	18	15	--	--	--	16
Mississippi River below Belle Chasse, La., 39.78-gram sample	Pentachlorobenzene	12	15	17	5.8	--	12
	Hexachlorobenzene	110	130	130	100	--	120
	Pentachloroanisole	ND	17	20	ND	--	18
	Chlorothalonil	ND	ND	ND	ND	--	ND
	Pentachlorophenol	ND	ND	ND	ND	--	ND
	Dachthal	6.6	7	7.6	5	--	6.6
	Chlordane, cis- + trans-	ND	ND	19	ND	--	19
	Nonachlor, trans-	ND	ND	ND	ND	--	ND
	Pentachlorobiphenyls	220	680	410	100	--	350
	Hexachlorobiphenyls	1,200	2,700	1,600	730	--	1,600
	Heptachlorobiphenyls	54	107	86	41	--	72
	Octachlorobiphenyls	6.6	23	17	ND	--	16

Table 8. Halogenated organic compounds found in suspended-sediment samples collected during the February-March 1990 cruise.

[ND, not detected; --, no data; masses not corrected for recovery; all masses rounded to two significant figures]

Sampling site and sample weight	Compound	Mass of compound, in nanograms: Replicate sample A	Replicate sample B	Replicate sample C	Average
Mississippi River near Cache, Ill., 20.19-gram sample	Pentachlorobenzene	ND	ND	--	ND
	Hexachlorobenzene	1.8	3.5	--	2.6
	Pentachloroanisole	18	46	--	32
	Chlorothalonil	ND	0.78	--	0.78
	Pentachlorophenol	ND	ND	--	ND
	Dachthal	2	3.1	--	2.6
	Chlordane, cis- + trans-	53	ND	--	53
	Nonachlor, trans-	23	ND	--	23
	Pentachlorobiphenyls	460	480	--	470
	Hexachlorobiphenyls	1,700	1,600	--	1,600
	Heptachlorobiphenyls	79	46	--	62
	Octachlorobiphenyls	17	12	--	14
Ohio River at Uniontown, Ky., 20.04-gram sample	Pentachlorobenzene	22	12	--	17
	Hexachlorobenzene	110	80	--	95
	Pentachloroanisole	63	71	--	67
	Chlorothalonil	ND	3.2	--	3.2
	Pentachlorophenol	620	ND	--	620
	Dachthal	3.5	ND	--	3.5
	Chlordane, cis- + trans-	73	ND	--	73
	Nonachlor, trans-	130	ND	--	130
	Pentachlorobiphenyls	1,300	890	--	1,100
	Hexachlorobiphenyls	3,800	3,900	--	3,800
	Heptachlorobiphenyls	290	130	--	210
	Octachlorobiphenyls	60	20	--	40
Wabash River near New Haven, Ill., 21.61-gram sample	Pentachlorobenzene	ND	2.9	--	2.9
	Hexachlorobenzene	2.7	5.8	--	4.2
	Pentachloroanisole	32	49	--	40
	Chlorothalonil	ND	ND	--	ND
	Pentachlorophenol	ND	ND	--	ND
	Dachthal	2.4	2.6	--	2.5
	Chlordane, cis- + trans-	66	ND	--	66
	Nonachlor, trans-	120	ND	--	120
	Pentachlorobiphenyls	260	290	--	280
	Hexachlorobiphenyls	520	500	--	510
	Heptachlorobiphenyls	20	17	--	18
	Octachlorobiphenyls	0.9	3.3	--	2.1

Table 8. Halogenated organic compounds found in suspended-sediment samples collected during the February-March 1990 cruise.—Continued

Sampling site and sample weight	Compound	Mass of compound, in nanograms — Replicate sample A	B	C	Average
Cumberland River near Smithland, Ky., 6.24-gram sample	Pentachlorobenzene	2.2	ND	--	2.2
	Hexachlorobenzene	4.7	ND	--	4.7
	Pentachloroanisole	7.1	11.7	--	9.4
	Chlorothalonil	ND	1.2	--	1.2
	Pentachlorophenol	510	ND	--	510
	Dachthal	1	ND	--	1
	Chlordane, cis- + trans-	13	ND	--	13
	Nonachlor, trans-	ND	ND	--	ND
	Pentachlorobiphenyls	190	ND	--	190
	Hexachlorobiphenyls	420	ND	--	420
	Heptachlorobiphenyls	16	ND	--	16
Tennessee River near Calvert City, Ky., 8.14-gram sample	Pentachlorobenzene	2.8	ND	--	2.8
	Hexachlorobenzene	7.1	7.4	--	7.2
	Pentachloroanisole	6.7	9.3	--	8
	Chlorothalonil	ND	ND	--	ND
	Pentachlorophenol	ND	ND	--	ND
	Dachthal	0.71	ND	--	0.71
	Chlordane, cis- + trans-	6.6	6.7	--	6.65
	Nonachlor, trans-	ND	ND	--	ND
	Pentachlorobiphenyls	140	ND	--	140
	Hexachlorobiphenyls	330	260	--	300
	Heptachlorobiphenyls	21	7.1	--	14
	Octachlorobiphenyls	0.69	0.7	--	0.7
Ohio River at Olmsted, Ill., 21.50-gram sample	Pentachlorobenzene	14	13	--	14
	Hexachlorobenzene	90	73	--	82
	Pentachloroanisole	48	57	--	52
	Chlorothalonil	ND	ND	--	ND
	Pentachlorophenol	ND	ND	--	ND
	Dachthal	ND	ND	--	ND
	Chlordane, cis- + trans-	67	44	--	56
	Nonachlor, trans-	140	130	--	140
	Pentachlorobiphenyls	800	800	--	800
	Hexachlorobiphenyls	3,000	2,400	--	2,700
	Heptachlorobiphenyls	180	93	--	140
	Octachlorobiphenyls	40	24	--	32

Table 8. Halogenated organic compounds found in suspended-sediment samples collected during the February-March 1990 cruise.—Continued

Sampling site and sample weight	Compound	Mass of compound, in nanograms — Replicate sample A	B	C	Average
Mississippi River below Hickman, Ky., 19.04-gram sample	Pentachlorobenzene	13	10	--	12
	Hexachlorobenzene	64	65	--	64
	Pentachloroanisole	39	37	--	38
	Chlorothalonil	ND	ND	--	ND
	Pentachlorophenol	ND	720	--	720
	Dachthal	2.1	1.7	--	1.9
	Chlordane, cis- + trans-	26	40	--	33
	Nonachlor, trans-	110	70	--	90
	Pentachlorobiphenyls	440	340	--	390
	Hexachlorobiphenyls	2,360	1,400	--	1,900
	Heptachlorobiphenyls	108	55	--	82
	Octachlorobiphenyls	25	15	--	20
Mississippi River below Fulton, Tenn., 19.48-gram sample	Pentachlorobenzene	13.4	9.2	--	11
	Hexachlorobenzene	91	86	--	88
	Pentachloroanisole	30	37	--	34
	Chlorothalonil	ND	ND	--	ND
	Pentachlorophenol	ND	ND	--	ND
	Dachthal	0.8	2.4	--	1.6
	Chlordane, cis- + trans-	48	56	--	52
	Nonachlor, trans-	126	36	--	81
	Pentachlorobiphenyls	1000	680	--	840
	Hexachlorobiphenyls	2,300	1,800	--	2,000
	Heptachlorobiphenyls	93	74	--	84
	Octachlorobiphenyls	11	22	--	16
Mississippi River at Helena, Ark., 18.97-gram sample	Pentachlorobenzene	6.1	9.6	--	7.8
	Hexachlorobenzene	24	32	--	28
	Pentachloroanisole	40	41	--	40
	Chlorothalonil	ND	ND	--	ND
	Pentachlorophenol	200	ND	--	200
	Dachthal	1	2.2	--	1.6
	Chlordane, cis- + trans-	35	46	--	40
	Nonachlor, trans-	65	60	--	62
	Pentachlorobiphenyls	240	580	--	410
	Hexachlorobiphenyls	1,500	1,300	--	1,400
	Heptachlorobiphenyls	68	58	--	63
	Octachlorobiphenyls	17	16	--	16

Table 8. Halogenated organic compounds found in suspended-sediment samples collected during the February-March 1990 cruise.—Continued

Sampling site and sample weight	Compound	Mass of compound, in nanograms			
		Replicate sample			
		A	B	C	Average
Mississippi River above Arkansas City, Ark., 17.26-gram sample	Pentachlorobenzene	5.4	6	--	5.7
	Hexachlorobenzene	18	28	--	23
	Pentachloroanisole	25	26	--	25.5
	Chlorothalonil	ND	ND	--	ND
	Pentachlorophenol	ND	770	--	770
	Dachthal	0.76	1.13	--	0.94
	Chlordane, cis- + trans-	22	22	--	22
	Nonachlor, trans-	72	ND	--	72
	Pentachlorobiphenyls	640	760	--	700
	Hexachlorobiphenyls	170	1,000	--	585
	Heptachlorobiphenyls	49	37	--	43
	Octachlorobiphenyls	8.8	11	--	9.9
Mississippi River below Vicksburg, Miss., 20.46-gram sample	Pentachlorobenzene	5.3	4.6	--	5
	Hexachlorobenzene	14	23	--	18
	Pentachloroanisole	33	35	--	34
	Chlorothalonil	ND	1.9	--	1.9
	Pentachlorophenol	ND	ND	--	ND
	Dachthal	ND	1.7	--	1.7
	Chlordane, cis- + trans-	19	26	--	22
	Nonachlor, trans-	ND	49	--	49
	Pentachlorobiphenyls	220	490	--	360
	Hexachlorobiphenyls	860	1,300	--	1,100
	Heptachlorobiphenyls	43	78	--	60
	Octachlorobiphenyls	13	15	--	14
Mississippi River near St. Francisville, La., 15.55-gram sample	Pentachlorobenzene	ND	13	--	13
	Hexachlorobenzene	7.7	9.7	--	8.7
	Pentachloroanisole	13	26	--	20
	Chlorothalonil	ND	1.5	--	1.5
	Pentachlorophenol	ND	ND	--	ND
	Dachthal	ND	ND	--	ND
	Chlordane, cis- + trans-	ND	23	--	23
	Nonachlor, trans-	ND	ND	--	ND
	Pentachlorobiphenyls	480	420	--	450
	Hexachlorobiphenyls	640	1,100	--	870
	Heptachlorobiphenyls	28	42	--	35
	Octachlorobiphenyls	11	8.3	--	10

Table 8. Halogenated organic compounds found in suspended-sediment samples collected during the February-March 1990 cruise.—Continued

Sampling site and sample weight	Compound	Mass of compound, in nanograms: Replicate sample A	B	C	Average
Mississippi River below Belle Chasse, La., 20.12-gram sample	Pentachlorobenzene	5.1	11.4	--	8.2
	Hexachlorobenzene	29	43	--	36
	Pentachloroanisole	20	25	--	22
	Chlorothalonil	0.63	1.21	--	0.92
	Pentachlorophenol	ND	ND	--	ND
	Dachthal	0.52	1.45	--	0.99
	Chlordane, cis- + trans-	18	42	--	30
	Nonachlor, trans-	34	ND	--	34
	Pentachlorobiphenyls	160	350	--	260
	Hexachlorobiphenyls	600	1,100	--	850
	Heptachlorobiphenyls	36	48	--	42
	Octachlorobiphenyls	11	15	--	13

Table 9. Halogenated organic compounds found in suspended-sediment samples collected during the May-June 1990 cruise.

[ND, not detected; --, no data; masses not corrected for recovery; all masses rounded to two significant figures]

Sampling site and sample weight	Compound	Mass of compound, in nanograms			
		Replicate samples			
		A	B	C	Average
Illinois River at Valley City, Ill., 21.735-gram sample	Pentachlorobenzene	2.5	2.5	--	2.5
	Hexachlorobenzene	5.1	4.6	--	4.8
	Pentachloroanisole	12	11	--	12
	Chlorothalonil	3.1	4	--	3.6
	Pentachlorophenol	190	120	--	160
	Dachthal	10.2	9.2	--	9.7
	Chlordane, cis- + trans-	46	44	--	45
	Nonachlor, trans-	36	29	--	32
	Pentachlorobiphenyls	380	340	--	360
	Hexachlorobiphenyls	1,900	1,500	--	1,700
	Heptachlorobiphenyls	66	63	--	64
	Octachlorobiphenyls	18	19	--	18
Mississippi River below Grafton, Ill., 100.034-gram sample	Pentachlorobenzene	5	4.5	--	4.8
	Hexachlorobenzene	15	13	--	14
	Pentachloroanisole	12	10	--	11
	Chlorothalonil	12.1	7.8	--	10
	Pentachlorophenol	220	ND	--	220
	Dachthal	4	2.8	--	3.4
	Chlordane, cis- + trans-	59	ND	--	59
	Nonachlor, trans-	38	ND	--	38
	Pentachlorobiphenyls	540	430	--	480
	Hexachlorobiphenyls	4,000	1,800	--	2,900
	Heptachlorobiphenyls	99	69	--	84
	Octachlorobiphenyls	35	13	--	24
Mississippi River at Thebes, Ill., 69.657-gram sample	Pentachlorobenzene	4.4	4.4	8.6	5.8
	Hexachlorobenzene	9.3	9.6	11.8	10
	Pentachloroanisole	24	20	22	22
	Chlorothalonil	ND	1.9	ND	1.9
	Pentachlorophenol	860	830	1,679	1,100
	Dachthal	4.8	5.4	7	5.7
	Chlordane, cis- + trans-	60	24	37	40
	Nonachlor, trans-	38	17	26	27
	Pentachlorobiphenyls	210	460	190	290
	Hexachlorobiphenyls	570	1,500	940	1,000
	Heptachlorobiphenyls	17	44	33	31
	Octachlorobiphenyls	2.8	9.9	6.8	6.5

Table 9. Halogenated organic compounds found in suspended-sediment samples collected during the May-June 1990 cruise.—Continued

Sampling site and sample weight	Compound	Mass of compound, in nanograms — Replicate samples A	B	C	Average
Ohio River at Olmsted, Ill., 38.585-gram sample	Pentachlorobenzene	19	16	17	17
	Hexachlorobenzene	170	160	150	160
	Pentachloroanisole	65	58	56	60
	Chlorothalonil	3.5	4.5	3.2	3.7
	Pentachlorophenol	510	310	370	400
	Dachthal	6.1	6.6	6.5	6.4
	Chlordane, cis- + trans-	32	39	67	46
	Nonachlor, trans-	34	34	66	45
	Pentachlorobiphenyls	520	650	450	540
	Hexachlorobiphenyls	1,900	2,700	1,800	2,100
	Heptachlorobiphenyls	94	149	70	100
	Octachlorobiphenyls	20	40	17	26
Mississippi River below Memphis, Tenn., 50.890-gram sample	Pentachlorobenzene	7.5	6.8	7.9	7.4
	Hexachlorobenzene	49	52	42	48
	Pentachloroanisole	44	44	40	43
	Chlorothalonil	1	33	2	12
	Pentachlorophenol	390	320	440	380
	Dachthal	4.1	4.4	4.1	4.2
	Chlordane, cis- + trans-	14	57	30	34
	Nonachlor, trans-	9.8	54	31	32
	Pentachlorobiphenyls	570	520	350	480
	Hexachlorobiphenyls	2,100	1,700	1,800	1,900
	Heptachlorobiphenyls	110	73	67	83
	Octachlorobiphenyls	31	20	22	24
Mississippi River below Memphis, Tenn., 73.072-gram sample	Pentachlorobenzene	13	12	40	22
	Hexachlorobenzene	88	79	76	81
	Pentachloroanisole	18	24	35	26
	Chlorothalonil	11.3	3.1	ND	7.2
	Pentachlorophenol	390	170	380	310
	Dachthal	4	4.5	17.8	8.8
	Chlordane, cis- + trans-	62	64	73	66
	Nonachlor, trans-	73	56	84	71
	Pentachlorobiphenyls	780	430	600	600
	Hexachlorobiphenyls	3,000	2,300	3,800	3,000
	Heptachlorobiphenyls	120	120	190	140
	Octachlorobiphenyls	69	62	64	65

Table 9. Halogenated organic compounds found in suspended-sediment samples collected during the May-June 1990 cruise.—Continued

Sampling site and sample weight	Compound	Mass of compound, in nanograms			
		Replicate samples			
		A	B	C	Average
Mississippi River below Arkansas City, Ark., 53.084-gram sample	Pentachlorobenzene	10.5	10.4	9.2	10
	Hexachlorobenzene	22	22	18	21
	Pentachloroanisole	41	36	35	37
	Chlorothalonil	2.4	4.4	3.5	3.4
	Pentachlorophenol	360	240	250	280
	Dachthal	7.1	7.7	6.4	7
	Chlordane, cis- + trans-	42	21	20	28
	Nonachlor, trans-	32	18	16	22
	Pentachlorobiphenyls	260	300	360	310
	Hexachlorobiphenyls	1,700	2,100	1,700	1,800
	Heptachlorobiphenyls	74	116	78	89
	Octachlorobiphenyls	16	37	25	26
Mississippi River below Vicksburg, Miss., 49.499-gram sample	Pentachlorobenzene	8.5	10.6	--	9.6
	Hexachlorobenzene	20	18	--	19
	Pentachloroanisole	29	23	--	26
	Chlorothalonil	ND	ND	--	ND
	Pentachlorophenol	ND	ND	--	ND
	Dachthal	4.6	4.1	--	4.4
	Chlordane, cis- + trans-	ND	ND	--	ND
	Nonachlor, trans-	ND	ND	--	ND
	Pentachlorobiphenyls	550	160	--	360
	Hexachlorobiphenyls	4,100	3,500	--	3,800
	Heptachlorobiphenyls	140	110	--	120
	Octachlorobiphenyls	23	19	--	21
Mississippi River below Vicksburg, Miss., 31.603-gram sample	Pentachlorobenzene	4	4.9	--	4.4
	Hexachlorobenzene	26	41	--	34
	Pentachloroanisole	19.2	5.4	--	12
	Chlorothalonil	15	27	--	21
	Pentachlorophenol	160	310	--	240
	Dachthal	1.1	1.3	--	1.2
	Chlordane, cis- + trans-	17	22	--	20
	Nonachlor, trans-	ND	14	--	14
	Pentachlorobiphenyls	170	140	--	160
	Hexachlorobiphenyls	1,700	1,900	--	1,800
	Heptachlorobiphenyls	47	46	--	46
	Octachlorobiphenyls	69	25	--	47

Table 9. Halogenated organic compounds found in suspended-sediment samples collected during the May-June 1990 cruise.—Continued

Sampling site and sample weight	Compound	Mass of compound, in nanograms			
		Replicate samples			
		A	B	C	Average
Mississippi River near St. Francisville, La., 56.237-gram sample	Pentachlorobenzene	15	15	--	15
	Hexachlorobenzene	31	29	--	30
	Pentachloroanisole	48	43	--	46
	Chlorothalonil	3.2	7.6	--	5.4
	Pentachlorophenol	230	260	--	240
	Dachthal	7.3	7	--	7.2
	Chlordane, cis- + trans-	18	32	--	25
	Nonachlor, trans-	19	27	--	23
	Pentachlorobiphenyls	370	320	--	340
	Hexachlorobiphenyls	2,000	2,000	--	2,000
	Heptachlorobiphenyls	103	74	--	88
	Octachlorobiphenyls	28	29	--	28
Mississippi River below Belle Chasse, La., 54.391-gram sample	Pentachlorobenzene	17	15	--	16
	Hexachlorobenzene	73	67	--	70
	Pentachloroanisole	40	35	--	38
	Chlorothalonil	1.1	1.2	--	1.2
	Pentachlorophenol	180	220	--	200
	Dachthal	5.6	5.4	--	5.5
	Chlordane, cis- + trans-	19	14	--	16
	Nonachlor, trans-	12	390	--	200
	Pentachlorobiphenyls	420	270	--	340
	Hexachlorobiphenyls	2,400	2,000	--	2,200
	Heptachlorobiphenyls	130	110	--	120
	Octachlorobiphenyls	39	27	--	33

The data were not censored below the detection limit to avoid statistical distortions of the data that can occur (Helsel and Cohn, 1988). When no response occurred for a compound, a “not detected” (ND) designation is used. According to Helsel (1990), “deletion of censored data or fabrication of values for less-thans leads to undesirable and unnecessary errors.”

Halogenated organic compounds found associated with suspended sediment in samples collected during the May-June 1988 cruise are shown in table 5. Sixteen sites were sampled during this cruise. The usual sample size was 15 g although less suspended sediment was available from some sites, such as the Ohio River at Olmsted.

Halogenated organic compounds found associated with suspended sediment in samples from 17 sites from the March-April 1989 cruise are shown in table 6. Spring runoff conditions on the Ohio River resulted in higher suspended-sediment concentrations, as seen in table 2, than in May-June 1988. Larger sample sizes of nearly 40 g were extracted when available.

Suspended-sediment data from samples collected at 17 sites from the June 1989 cruise are shown in table 7. Spring runoff conditions on the Missouri River again produced high suspended-sediment concentrations on the Mississippi River, enabling larger sample sizes to be collected and extracted.

During the February-March 1990 cruise, samples were collected at only 13 sites, many of them different from previous trips, as shown in table 8. Sample sizes averaged about 18 g.

The organic compound data for samples collected during the May-June 1990 cruise are shown in table 9. The extracted sample sizes varied widely. A new, higher capacity balance allowed sample weights to be measured to thousandths of a gram.

The relative standard deviation (RSD) was determined for the replicate analyses of each compound for each sample, data permitting. For each cruise, the average RSD was determined for each compound and is shown in table 10, along with an average for all cruises.

Table 10. Average relative standard deviation, in percent, for replicate analyses.

[--, insufficient data for calculation]

	Cruise					
Compound	May-June 1988	March-April 1989	June 1989	February-March 1990	May-June 1990	Average
Pentachlorobenzene	15	29	17	24	17	20
Hexachlorobenzene	16	19	9	22	10	15
Pentachloroanisole	20	20	20	20	18	19
Chlorothalonil	50	38	--	44	48	45
Pentachlorophenol	--	34	--	--	27	30
Dachthal	25	29	13	39	17	25
Chlordane, cis- + trans-	18	26	20	21	31	23
Nonachlor, trans-	29	34	23	31	48	33
Pentachlorobiphenyls	13	42	28	24	27	27
Hexachlorobiphenyls	15	29	25	26	20	23
Heptachlorobiphenyls	19	29	27	33	23	26
Octachlorobiphenyls	52	35	17	30	32	34

At the Missouri River site on June 7, 1989, there was sufficient material from the depth-integrated composite sample to compare it with the pumped composite sample. Both suspended-sediment samples were discharge-weighted water samples taken at each vertical; however, the pumped sample was not depth integrated. Different sample sizes were extracted. Table 11 includes compound mass and sample weight of the suspended sediment from the discharge-weighted samples collected by pumping and by depth integration.

The suspended-sediment extracts from 17 samples collected during the June 1989 cruise and 8 samples collected during the February-March 1990 cruise were reanalyzed for EPA priority pollutants. The concentration, in microgram/kg of dry suspended sediment (rather than mass as in previous tables), of each of the selected priority pollutants in selected samples is presented in table 12 for the June 1989 cruise and table 13 for the February-March 1990 cruise. The compounds of primary interest were the polycyclic aromatic hydrocarbons.

Table 11. Halogenated organic compounds in suspended-sediment depth-integrated and pumped samples collected June 7, 1989 from the Missouri River at Hermann, Missouri.

[ND, not detected]

		Mass in nanograms		
		Replicates		
Sample type and weight	Compound	A	B	Average
Pumped, 40.11-gram sample	Pentachlorobenzene	3.66	1.3	2.5
	Hexachlorobenzene	4.9	2.6	3.8
	Pentachloroanisole	4.3	1.8	3
	Chlorothalonil	1.2	ND	1.2
	Pentachlorophenol	130	ND	130
	Dachthal	7.8	4.7	6.2
	Chlordane, cis- + trans-	31	18	24
	Nonachlor, trans-	41	15	28
	Pentachlorobiphenyls	47	ND	47
	Hexachlorobiphenyls	310	150	231
	Heptachlorobiphenyls	15.5	6.4	11
	Octachlorobiphenyls	1.4	ND	1.4
Depth integrated, 21.16-gram sample	Pentachlorobenzene	4.4	5.1	4.8
	Hexachlorobenzene	5.1	5.2	5.2
	Pentachloroanisole	3.9	2.4	3.2
	Chlorothalonil	ND	ND	ND
	Pentachlorophenol	ND	ND	ND
	Dachthal	8.2	8.4	8.3
	Chlordane, cis- + trans-	7.5	5.8	6.6
	Nonachlor, trans-	ND	6.8	6.8
	Pentachlorobiphenyls	34	15	24.5
	Hexachlorobiphenyls	76	73	74.6
	Heptachlorobiphenyls	3.4	3.8	3.6
	Octachlorobiphenyls	ND	ND	ND

Table 12. Hydrophobic U.S. Environmental Protection Agency priority pollutants detected in suspended-sediment samples collected during the June 1989 cruise.

[All concentrations in micrograms per kilogram dry sediment; ND, not detected]

Compound	Sampling site		
	Mississippi River near Winfield, Mo.	Illinois River at Hardin, Ill.	Missouri River at Hermann, Mo.
phenol	18	ND	33
benzene, 1,3-dichloro-	ND	ND	1.8
benzene, 1,4-dichloro-	ND	ND	0.32
benzene, 1,2-dichloro-	ND	ND	0.25
nitrobenzene	ND	ND	ND
benzene, 1,2,4-trichloro-	ND	ND	ND
naphthalene	7.2	2.3	2.8
acenaphthylene	7.6	20	0.31
dimethylphthalate	40	16	10
acenaphthene	2.8	2.4	0.88
toluene, 2,4-dinitro-	ND	ND	ND
fluorene	9.9	4.7	1.2
diethylphthalate	200	80	60
hexachlorobenzene	ND	ND	ND
phenanthrene	58	29	12
anthracene	7.6	6	0.67
di-n-butylphthalate	760	630	290
fluoranthene	43	66	11
pyrene	36	78	8.3
butylbenzylphthalate	510	260	53
benz(a)anthracene	10	28	3.8
chrysene	21	44	7.5
bis(2-ethylhexyl)phthalate	1,500	660	1,100
di-n-octylphthalate	ND	ND	4.2
benzo(b)fluoranthene	23	65	6
benzo(k)fluoranthene	14	39	5
benzo(a)pyrene	20	25	39
indeno(1,2,3-cd)pyrene	28	60	11
dibenz(a,h)anthracene	ND	14	ND
benzo(g,h,i)perylene	25	56	ND

Table 12. Hydrophobic U.S. Environmental Protection Agency priority pollutants detected in suspended-sediment samples collected during the June 1989 cruise.—Continued

Compound	Sampling site		
	Mississippi River at St. Louis, Mo.	Mississippi River at Thebes, Ill.	Ohio River at Olmsted, Ill.
phenol	38	33	39
benzene, 1,3-dichloro-	2.6	4	3.6
benzene, 1,4-dichloro-	0.51	0.74	1.1
benzene, 1,2-dichloro-	0.44	0.62	0.93
nitrobenzene	0.43	0.96	ND
benzene, 1,2,4-trichloro-	ND	ND	4
naphthalene	8.4	6.2	33
acenaphthylene	5.2	6.7	13
dimethylphthalate	28	17	29
acenaphthene	2.5	3	6.2
toluene, 2,4-dinitro-	ND	ND	ND
fluorene	5.4	6.3	13
diethylphthalate	160	96	120
hexachlorobenzene	ND	ND	2
phenanthrene	53	41	124
anthracene	6.8	6	120
di-n-butylphthalate	370	320	400
fluoranthene	46	62	97
pyrene	42	60	76
butylbenzylphthalate	170	110	390
benz(a)anthracene	22	37	46
chrysene	40	51	89
bis(2-ethylhexyl)phthalate	2,000	770	1,400
di-n-octylphthalate	34	ND	ND
benzo(b)fluoranthene	63	85	190
benzo(k)fluoranthene	40	36	97
benzo(a)pyrene	19	27	22
indeno(1,2,3-cd)pyrene	45	45	170
dibenz(a,h)anthracene	8.4	8.9	50
benzo(g,h,i)perylene	44	41	180

Table 12. Hydrophobic U.S. Environmental Protection Agency priority pollutants detected in suspended-sediment samples collected during the June 1989 cruise.—Continued

Compound	Sampling site		
	Mississippi River below Hickman, Ky.	Mississippi River at Fulton, Tenn.	Mississippi River at Helena, Ark.
phenol	18	45	0.95
benzene, 1,3-dichloro-	2.5	3.2	3.7
benzene, 1,4-dichloro-	0.47	0.76	1
benzene, 1,2-dichloro-	0.43	0.62	0.94
nitrobenzene	ND	ND	ND
benzene, 1,2,4-trichloro-	0.94	1.8	1.8
naphthalene	8.7	16	20
acenaphthylene	13	7.3	3.9
dimethylphthalate	38	38	27
acenaphthene	5.5	2.1	ND
toluene, 2,4-dinitro-	ND	ND	ND
fluorene	11	5.6	6.1
diethylphthalate	200	190	140
hexachlorobenzene	ND	0.78	0.69
phenanthrene	98	59	48
anthracene	16	8.2	4.4
di-n-butylphthalate	220	200	130
fluoranthene	98	67	50
pyrene	97	58	40
butylbenzylphthalate	210	180	95
benz(a)anthracene	50	29	26
chrysene	69	50	46
bis(2-ethylhexyl)phthalate	410	810	570
di-n-octylphthalate	ND	ND	12
benzo(b)fluoranthene	120	88	200
benzo(k)fluoranthene	38	53	8.7
benzo(a)pyrene	48	14	13
indeno(1,2,3-cd)pyrene	64	63	86
dibenz(a,h)anthracene	12	10	17
benzo(g,h,i)perylene	59	59	79

Table 12. Hydrophobic U.S. Environmental Protection Agency priority pollutants detected in suspended-sediment samples collected during the June 1989 cruise.—Continued

Compound	Sampling site: White River at Mile 11.5, Ark.	Sampling site: Arkansas River at Pendleton, Ark.	Sampling site: Mississippi River above Arkansas City, Ark.
phenol	34	39	120
benzene, 1,3-dichloro-	2	4.9	0.99
benzene, 1,4-dichloro-	0.28	0.75	0.85
benzene, 1,2-dichloro-	0.3	0.79	1.3
nitrobenzene	ND	ND	ND
benzene, 1,2,4-trichloro-	ND	ND	2.4
naphthalene	4	7.4	25
acenaphthylene	0.19	0.97	9.4
dimethylphthalate	61	42	23
acenaphthene	ND	ND	4.1
toluene, 2,4-dinitro-	ND	ND	ND
fluorene	2.2	5	8.6
diethylphthalate	34	220	120
hexachlorobenzene	ND	ND	0.87
phenanthrene	23	31	61
anthracene	0.28	1.9	11
di-n-butylphthalate	290	220	110
fluoranthene	6.6	19	60
pyrene	3.4	16	53
butylbenzylphthalate	180	130	200
benz(a)anthracene	1.5	11	32
chrysene	3.6	22	56
bis(2-ethylhexyl)phthalate	1,200	5,800	5,400
di-n-octylphthalate	42	ND	ND
benzo(b)fluoranthene	1.9	19	80
benzo(k)fluoranthene	1.7	11	57
benzo(a)pyrene	ND	6.6	29
indeno(1,2,3-cd)pyrene	ND	8.7	90
dibenz(a,h)anthracene	ND	ND	15
benzo(g,h,i)perylene	ND	14	88

Table 12. Hydrophobic U.S. Environmental Protection Agency priority pollutants detected in suspended-sediment samples collected during the June 1989 cruise.—Continued

Compound	Sampling site: Yazoo River below Steele Bayou, Miss.	Sampling site: Mississippi River below Vicksburg, Miss.	Sampling site: OutflowChannel near Knox Landing, La.
phenol	56	15	150
benzene, 1,3-dichloro-	0.93	1.2	1.6
benzene, 1,4-dichloro-	0.93	0.16	1.1
benzene, 1,2-dichloro-	0.74	0.21	1.3
nitrobenzene	ND	ND	ND
benzene, 1,2,4-trichloro-	ND	0.7	2.1
naphthalene	3.4	6.7	22
acenaphthylene	0.22	2.1	10
dimethylphthalate	17	8.6	13
acenaphthene	ND	0.72	3.5
toluene, 2,4-dinitro-	ND	ND	ND
fluorene	0.8	2.4	3.5
diethylphthalate	91	44	29
hexachlorobenzene	ND	0.34	ND
phenanthrene	7	25	55
anthracene	0.35	3	7
di-n-butylphthalate	120	48	85
fluoranthene	5	30	45
pyrene	3.2	27	40
butylbenzylphthalate	72	41	110
benz(a)anthracene	0.72	14	22
chrysene	2.7	19	46
bis(2-ethylhexyl)phthalate	150	1,800	650
di-n-octylphthalate	3	ND	11
benzo(b)fluoranthene	4.4	11	120
benzo(k)fluoranthene	1.7	15	69
benzo(a)pyrene	5.8	4.3	14
indeno(1,2,3-cd)pyrene	ND	14	110
dibenz(a,h)anthracene	ND	ND	24
benzo(g,h,i)perylene	ND	12	120

Table 12. Hydrophobic U.S. Environmental Protection Agency priority pollutants detected in suspended-sediment samples collected during the June 1989 cruise.—Continued

Compound	Sampling site: Mississippi River near St. Francisville, La.	Sampling site: Mississippi River belowBelle Chasse, La.	Procedure blank	Procedure blank
phenol	44	33	5.3	10
benzene, 1,3-dichloro-	2.3	2.4	0.82	0.77
benzene, 1,4-dichloro-	1.4	0.4	0.14	0.12
benzene, 1,2-dichloro-	1.1	0.4	0.15	0.15
nitrobenzene	ND	ND	ND	ND
benzene, 1,2,4-trichloro-	2	1.1	ND	ND
naphthalene	17	8.5	0.55	0.5
acenaphthylene	3.4	6.9	ND	ND
dimethylphthalate	27	33	1.5	1.6
acenaphthene	3	3.3	ND	ND
toluene, 2,4-dinitro-	1.3	ND	ND	ND
fluorene	5	5.6	ND	ND
diethylphthalate	ND	190	4.1	3.8
hexachlorobenzene	0.76	2.7	ND	ND
phenanthrene	50	57	0.38	0.35
anthracene	4.1	8.4	ND	ND
di-n-butylphthalate	120	210	23	25
fluoranthene	48	59	0.29	0.2
pyrene	40	51	ND	ND
butylbenzylphthalate	110	220	0.98	ND
benz(a)anthracene	21	29	ND	ND
chrysene	33	47	ND	ND
bis(2-ethylhexyl)phthalate	320	2,300	11,200	15,000
di-n-octylphthalate	ND	ND	570	290
benzo(b)fluoranthene	110	80	ND	ND
benzo(k)fluoranthene	59	32	ND	ND
benzo(a)pyrene	19	21	ND	ND
indeno(1,2,3-cd)pyrene	70	49	ND	ND
dibenz(a,h)anthracene	17	12	ND	ND
benzo(g,h,i)perylene	72	51	ND	ND

Table 13. Hydrophobic U.S. Environmental Protection Agency priority pollutants detected in suspended-sediment samples collected during the February-March 1990 cruise.

[All concentrations in micrograms per kilogram dry sediment; ND, not detected]

Compound	Sampling site		
	Ohio River at Olmsted, Ill.	Mississippi River below Hickman, Ky.	Mississippi River below Fulton, Tenn.
phenol	53	44	44
benzene, 1,3-dichloro-	0.5	0.5	ND
benzene, 1,4-dichloro-	5.3	3.3	2
benzene, 1,2-dichloro-	2.5	1.1	0.54
nitrobenzene	ND	ND	ND
benzene, 1,2,4-trichloro-	17	9.7	4.4
naphthalene	47	29	23
acenaphthylene	7.8	29	18
dimethylphthalate	7	8	6.4
acenaphthene	13	9.3	6.9
toluene, 2,4-dinitro-	ND	ND	ND
fluorene	19	16	12
diethylphthalate	5.9	6.9	6.8
hexachlorobenzene	3.6	2.6	2.8
phenanthrene	160	120	92
anthracene	27	38	26
di-n-butylphthalate	31	23	88
fluoranthene	200	200	150
pyrene	180	180	140
butylbenzylphthalate	41	70	45
benz(a)anthracene	130	98	72
chrysene	180	140	100
bis(2-ethylhexyl)phthalate	730	1,000	670
di-n-octylphthalate	ND	ND	ND
benzo(b)fluoranthene	210	160	130
benzo(k)fluoranthene	100	100	75
benzo(a)pyrene	100	89	65
indeno(1,2,3-cd)pyrene	130	130	100
dibenz(a,h)anthracene	34	22	16
benzo(g,h,i)perylene	110	120	90

Table 13. Hydrophobic U.S. Environmental Protection Agency priority pollutants detected in suspended-sediment samples collected during the February-March 1990 cruise.—Continued

Compound	Sampling site		
	Mississippi River at Helena, Ark.	Mississippi River above Arkansas City, Ark.	Mississippi River below Vicksburg, Miss.
phenol	62	15	15
benzene, 1,3-dichloro-	0.71	0.23	0.26
benzene, 1,4-dichloro-	2.9	1.3	1.7
benzene, 1,2-dichloro-	2	0.42	0.62
nitrobenzene	ND	ND	ND
benzene, 1,2,4-trichloro-	7.5	3.9	4.1
naphthalene	20	16	15
acenaphthylene	20	14	13
dimethylphthalate	8.6	6.6	7.5
acenaphthene	6.4	4.2	5.4
toluene, 2,4-dinitro-	ND	ND	ND
fluorene	11	9.6	9.2
diethylphthalate	8.7	5.4	7.4
hexachlorobenzene	0.88	1.3	ND
phenanthrene	89	72	63
anthracene	26	17	16
di-n-butylphthalate	33	18	21
fluoranthene	110	100	100
pyrene	96	87	96
butylbenzylphthalate	220	59	47
benz(a)anthracene	73	66	48
chrysene	110	87	70
bis(2-ethylhexyl)phthalate	11,200	820	560
di-n-octylphthalate	270	ND	ND
benzo(b)fluoranthene	110	90	110
benzo(k)fluoranthene	53	74	65
benzo(a)pyrene	57	42	44
indeno(1,2,3-cd)pyrene	110	76	65
dibenz(a,h)anthracene	21	13	ND
benzo(g,h,i)perylene	110	72	61

Table 13. Hydrophobic U.S. Environmental Protection Agency priority pollutants detected in suspended-sediment samples collected during the February-March 1990 cruise.—Continued

Compound	Sampling site	
	Mississippi River near St. Francisville, La.	Mississippi River below Belle Chasse, La.
phenol	ND	11
benzene, 1,3-dichloro-	0.28	0.3
benzene, 1,4-dichloro-	2.1	0.5
benzene, 1,2-dichloro-	0.67	0.38
nitrobenzene	ND	ND
benzene, 1,2,4-trichloro-	3.8	2.6
naphthalene	18	11
acenaphthylene	14	8.3
dimethylphthalate	17	13
acenaphthene	4	ND
toluene, 2,4-dinitro-	ND	ND
fluorene	7.3	7
diethylphthalate	14	14
hexachlorobenzene	ND	1.6
phenanthrene	51	48
anthracene	14	14
di-n-butylphthalate	26	30
fluoranthene	89	61
pyrene	84	54
butylbenzylphthalate	74	70
benz(a)anthracene	39	38
chrysene	58	53
bis(2-ethylhexyl)phthalate	780	520
di-n-octylphthalate	ND	ND
benzo(b)fluoranthene	70	50
benzo(k)fluoranthene	48	37
benzo(a)pyrene	23	49
indeno(1,2,3-cd)pyrene	83	47
dibenz(a,h)anthracene	22	8.7
benzo(g,h,i)perylene	79	47

Hexachlorobenzene was targeted by both the halogenated organic compound analysis (by GC/NCI/MS) and the priority pollutant analysis (by GC/EI/MS). The detection limit for the priority pollutant technique was higher than the halogenated technique, and varied with sample size. For samples with data by both techniques, the values in microgram/kg were compared. The GC/NCI/MS values were consistently slightly higher, but the variation of the values from the two techniques averaged about 15 percent of their mean.

The semiquantitative data for organochlorine compounds and herbicides are presented in table 14 for June 1989 and table 15 for February-March 1990. Recoveries of these polar compounds, using the extraction and fractionation technique that targeted isolation of hydrophobic organic compounds, are unknown.

Table 14. Semiquantitative screening for organochlorine compounds and herbicides found in suspended-sediment samples collected during the June 1989 cruise.

[All concentrations in micrograms per kilogram dry sediment; ND, not detected]

Compound	Sampling site		
	Mississippi River near Winfield, Mo.	**Illinois River at Hardin, Ill.**	**Missouri River at Hermann, Mo.**
Organochlorine compounds			
Pentachloronitrobenzene	ND	ND	ND
DDE	12	8.7	0.98
DDD	7.3	4.3	2.5
DDT	13	22	1.1
Herbicides			
Trifluralin	0.34	0.81	0.39
Atrazine	ND	1.6	0.6
Alachlor	10	9.5	3.2
Metolachlor	2.3	0.22	2.9
Carbamate			
Eptan (EPTC)	ND	ND	2.7
	Mississippi River at St. Louis, Mo.	**Mississippi River at Thebes, Ill.**	**Ohio River at Olmsted, Ill.**
Pentachloronitrobenzene	ND	ND	ND
DDE	ND	2.2	5
DDD	ND	3.4	10
DDT	ND	1	40
Herbicides			
Trifluralin	0.17	ND	7
Atrazine	0.88	ND	1.4
Alachlor	4.8	2.8	420
Metolachlor	1	0.74	34
Carbamate			
Eptan (EPTC)	ND	ND	ND

Table 14. Semiquantitative screening for organochlorine compounds and herbicides found in suspended-sediment samples collected during the June 1989 cruise.—Continued

Compound	Sampling site		
	Mississippi River below Hickman, Ky.	**Mississippi River at Fulton, Tenn.**	**Mississippi River at Helena, Ark.**
Pentachloronitrobenzene	ND	ND	ND
DDE	ND	2.4	6.2
DDD	ND	5.9	17
DDT	ND	1.4	46
Herbicides			
Trifluralin	ND	0.94	0.73
Atrazine	6	ND	ND
Alachlor	30	12	13
Metolachlor	3.1	1.5	3.7
Carbamate			
Eptan (EPTC)	ND	ND	ND
	White River at Mile 11.5, Ark.	**Arkansas River at Pendleton, Ark.**	**Mississippi River above Arkansas City, Ark.**
Organochlorine compounds			
Pentachloronitrobenzene	ND	ND	ND
DDE	7.9	4	2.2
DDD	9.1	2.8	16
DDT	6.3	0.98	17
Herbicides			
Trifluralin	0.14	ND	0.79
Atrazine	ND	ND	ND
Alachlor	ND	ND	10
Metolachlor	ND	ND	3.4
Carbamate			
Eptan (EPTC)	ND	ND	ND
	Yazoo River below Steele Bayou, Miss.	**Mississippi River below Vicksburg, Miss.**	**OutflowChannel near Knox Landing, La.**
Organochlorine compounds			
Pentachloronitrobenzene	0.97	ND	ND
DDE	18	1.8	16
DDD	55	5.1	79
DDT	100	0.38	23
Herbicides			
Trifluralin	0.39	0.11	1.2
Atrazine	1.1	ND	ND
Alachlor	ND	1.5	18
Metolachlor	0.94	0.36	3.7

Table 14. Semiquantitative screening for organochlorine compounds and herbicides found in suspended-sediment samples collected during the June 1989 cruise.—Continued

Compound	Sampling site: Yazoo River below Steele Bayou, Miss.	Mississippi River below Vicksburg, Miss.	OutflowChannel near Knox Landing, La.
Carbamate			
Eptan (EPTC)	ND	ND	ND

	Mississippi River near St. Francisville, La.	Mississippi River below Belle Chasse, La.	Procedure blank	Procedure blank
Organochlorine compounds				
Pentachloronitrobenzene	ND	ND	ND	ND
DDE	16	4.6	ND	ND
DDD	34	13	ND	ND
DDT	16	9.9	ND	ND
Herbicides				
Trifluralin	0.84	0.22	ND	ND
Atrazine	0.31	ND	ND	ND
Alachlor	9	2.7	ND	ND
Metolachlor	2	0.89	ND	ND
Carbamate				
Eptan (EPTC)	ND	ND	ND	ND

Table 15. Semiquantitative screening for organochlorine compounds and herbicides found in suspended-sediment samples collected during the February-March 1990 cruise.

[All concentrations in micrograms per kilogram dry sediment; ND, not detected]

Compound	Sampling site		
	Ohio River at Olmsted, Ill.	Mississippi River below Hickman, Ky.	Mississippi River below Fulton, Tenn.
Organochlorine compounds			
Pentachloronitrobenzene	ND	ND	ND
DDE	ND	11	ND
DDD	ND	7.8	ND
DDT	16	40	ND
Herbicides			
Trifluralin	1.9	0.96	1.1
Atrazine	3.1	ND	2.7
Alachlor	ND	4.3	5.2
Metolachlor	ND	1.5	ND
Carbamate			
Eptan (EPTC)	ND	ND	ND
	Mississippi River at Helena, Ark.	Mississippi River above Arkansas City, Ark.	Mississippi River below Vicksburg, Miss.
Organochlorine compounds			
Pentachloronitrobenzene	ND	ND	ND
DDE	ND	3.4	18
DDD	ND	5.7	41
DDT	ND	18	13
Herbicides			
Trifluralin	0.89	0.91	0.85
Atrazine	ND	1.2	ND
Alachlor	2.8	2.9	2.6
Metolachlor	ND	1.2	ND
Carbamate			
Eptan (EPTC)	ND	ND	ND

Table 15. Semiquantitative screening for organochlorine compounds and herbicides found in suspended-sediment samples collected during the February-March 1990 cruise.—Continued

Compound	Sampling site: Mississippi River near St. Francisville, La.	Sampling site: Mississippi River below Belle Chasse, La.
Organochlorine compounds		
Pentachloronitrobenzene	ND	ND
DDE	24	14
DDD	57	44
DDT	21	9.3
Herbicides		
Trifluralin	0.69	0.55
Atrazine	ND	1.6
Alachlor	2.5	2
Metolachlor	ND	0.72
Carbamate		
Eptan (EPTC)	ND	ND

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