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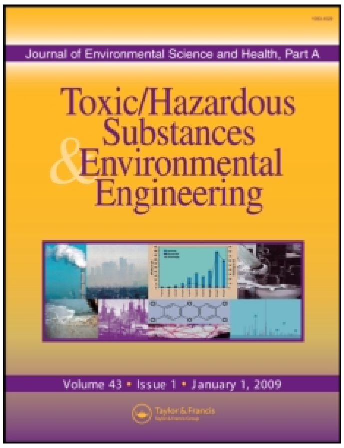

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Total Hg and methyl Hg distribution in sediments of selected Louisiana water bodies

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Total Hg and methyl Hg distribution in sediments of selected Louisiana water bodies

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Sediment samples (543) collected from selected Louisiana streams and lakes were analyzed for total Hg and methyl Hg content. The average total Hg content among 543 samples was 92.3 ± 95.1 μg kg^{-1}. The average methyl Hg content in the samples was 0.68 ± 0.80 μg kg^{-1}. Methyl Hg accounted for an average of 0.73% of the total Hg in sediment. Linear regression analysis of total Hg versus methyl Hg content of the sediment showed methyl Hg content was significantly correlated to total Hg content of sediment ($P > 0.01$, $n = 537$) and sediment organic matter content. ($P > 0.01$, $n = 536$) Methyl Hg was also positively correlated to clay ($P > 0.01$, $n = 537$) and inversely correlated to sand content of sediment ($P > 0.01$, $n = 537$). Total Hg and methyl Hg content in these sediments was within the normal range reported elsewhere indicating no significant industrial or municipal Hg contamination. A comparison of selected water bodies with fishing advisories showed no relationship to total Hg and methyl Hg in sediment.

Keywords: Hg accumulation, sediment Hg, Louisiana, water bodies fish contamination.

Introduction

Hg methylation in sediment has been well documented in numerous studies. Methyl Hg biomagnifies up the food chain more efficiently than inorganic Hg.[1] As a result, methyl Hg accumulates in fish. Methyl Hg is a neutrotoxin that poses a health risk to humans who consume methyl Hg contaminated fish.

Fish in a number of lakes, bayous, and rivers in Louisiana are reported to contain elevated levels of Hg. The Louisiana Department of Environmental Quality (LADEQ) periodically sampled both fish and sediment across the state for total levels with emphasis on Hg in fish tissue since excess Hg in human diets can be deleterious to health.

This statewide Hg monitoring effort has identified problem areas from the perspective of frequent fish consumption. Information on sediment factors affecting the mobility and biological availability of Hg and methyl Hg is needed for predicting Hg concentrations in fish for specific Louisiana water bodies. If these factors are understood, it would be possible at some point in the future to better predict where problem levels of Hg in fish are going to occur, and possibly to apply management practices that would minimize Hg accumulation in the food web and ultimately human consumers.

This study represents an effort in determining total Hg and methyl Hg level in sediment as related to sediment properties of selected Louisiana water bodies that may contribute to excess levels of Hg in fish. In this study, we determined total Hg and methyl Hg in sediment collected from numerous Louisiana water bodies. Characterizing methyl Hg content in surface sediment is an important step in relating causes of elevated Hg levels in fish.

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Materials and methods

Procedures for analyzing sediments

Sediment sampling. Sediment samples were collected from selected sites in streams and water bodies throughout the state of Louisiana by DEQ personnel between 2001 and 2007. Some sites were sampled multiple times. A subsample of the sediment that had not come in contact with the metal of the dredge was placed in jars, sealed and was stored on ice until transported to the laboratory for storage at 2°C until the various analysis were carried out. The jars were

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completely filled to exclude air (oxygen) in order to prevent any oxidation reactions.

Analysis

After transport to Department of Oceanography and Costal Sciences laboratory an aliquot from each jar was removed and used for the determination of total Hg, methyl Hg, organic matter, total metal analysis, grain size, redox potential and pH as described next.

Redox potential and pH

Redox potential was measured using platinum electrodes and a calomel half cell. Four replicate electrodes were inserted in the sediment and allowed to equilibrate for 6 hours before measurement. The pH was measured using a combination glass-reference electrode.

Total metal analysis

Sediments were dried (100°C), ground, and thoroughly mixed prior to analysis. Sediment samples were digested using nitric-perchloric acid digestion procedure.[2] The digested samples were diluted to volume and analyzed using Inductively Couple Argon Plasma (ICAP) emission spectroscopy. Analysis was calibrated against a known standard of each metal. Data were compiled and statistical analyses performed using Microsoft Excel available in Microsoft Professional 2000 on an IBM PC.

Organic matter analysis

Organic matter was measured by loss on ignition following pretreatment with acid to remove carbonate.[3]

Grain size analysis

Sand, silt, and clay distribution of soil particles was measured on 40 g of air dried sediment by the hydrometer method.[4]

Total Hg

Total (organic and inorganic) Hg was measured by cold vapor atomic absorption based on EPA Method # 245.1, 245.5, and 7471A using a Hg Instruments Analytical Technologies LabAnalyzer Model 254.

Hg contained in the prepared sample is reduced to its elemental state by reductant (tin-II- chloride). A stream of air, which is produced by a built-in membrane pump, strips the Hg from the sample and draws it into the optical cell. The concentration of Hg in the cell is determined by measuring light absorption at a wavelength of 253.7 nm. A built-in computer performs the quantitative evaluation of the response. A double beam spectrometer design contributes to a very stable baseline. In addition, the UV-detectors of the LabAnalyzer are thermostatically stabilized. Heating of the optical cell prevents a decrease in sensitivity associated with water vapor. Thus the use of a desiccant, which contributes some adsorption of vapor, is avoided. Using this method, a stable and accurate 5-point linear calibration was obtained ($R = 0.998$).

Methyl Hg

Methyl Hg analyses was performed using a GC-AFS system. An integrated gas chromatograph-Hg atomic fluorescence spectrometer included an Agilent Model HP 6890 Plus Series gas chromatograph coupled to a PSA Merlin Detector via a pyrolysis oven maintained at 810°C.

A fused silica analytical column with dimensions of 15 m × 0.53 mm i.d. (Megabore) coated with a 1.5 μm film thickness of DB-I (J&W Scientific) was used in the analysis. The column oven temperature was maintained at 50°C for 1.0 min, programmed at 30°C/min to 140°C, which was held for 3.0 min, then was programmed at 30°C/min to 250°C, which was held for 3.0 min. A split/splitless injector was used in the splitless mode and maintained at 200°C. The carrier gas flow was 4.0 mL/min of high-purity argon and the make-up gas flow was 120 mL/min of high-purity argon.

The column eluate containing methyl Hg was passed through a pyrolyzer to convert the methyl Hg to Hg^0 (Thermolyne Tube Furnace 21100) via deactivated fused silica tubing into a Merlin Mercury Fluorescence Detector System (AFS) Model 10.023 (P.S. Analytical) which was used for Hg detection. For the PSA Merlin Mercury Fluorescence Detector system, the sheath gas flow was 200 mL/min of argon. A real time chromatograph control and data acquisition system (Hewlett Packard) was interfaced with the GC and AFS detector system for the analysis.[5] Quantitative methyl Hg analysis was obtained using a 5-point (between 0.2 $\mu g\ L^{-1}$ and 10.0 $\mu g\ L^{-1}$) calibration curve forced to zero ($R = 0.999$). Sample preparation was performed based on the method of Alli et al.[6] and Cai et al.[7–9].

Results and discussion

Table 1 shows total Hg and methyl Hg in 543 sediment samples from various water bodies in the state of Louisiana. Table 2 shows the average values of total Hg and methyl Hg and other chemical and physical properties of the sediment. The average total Hg content was 92.3 ± 95.1 $\mu g\ kg^{-1}$. The level of total Hg varied between 0.7 to 899.7 $\mu g\ kg^{-1}$ (Table 1).

The average methyl Hg content in the samples was 0.68 ± 0.80 $\mu g\ kg^{-1}$ with a range of between 0.0 to 8.49 $\mu g\ kg^{-1}$

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Table 1. Total mercury (THg) and methyl mercury (MeHg) concentration in sediment sample collected from various Louisiana water bodies (concentrations are in μg/kg dry sediment) (n = 543).

#	*Sample location and date (mm/yy)*	*MeHg µg/kg*	*THg µg/kg*
1	Bayou Bartholomew @ Hwy 425 (10/01)	0.16	49.02
2	Boeuf River nr Columbia (10/01)	0.09	39.48
3	Bayou Louis @ Hwy 8 (10/01)	0.37	157.04
4	Turkey Creek Lake (10/01)	0.97	224.36
5	Salt Lake (10/01)	0.77	393.86
6	Lake Chicot (10/01)	0.66	265.20
7	Black Lake nr Natchitoches (10/01)	1.43	401.05
8	Toledo Bend nr Hunter (10/01)	0.32	86.59
9	Toledo Bend (San Patrice) (10/01)	0.48	166.74
10	Toledo Bend nr Toro (10/01)	1.62	156.62
11	Nantachie Lake (10/01)	3.33	257.94
12	Black Lake nr Hosston (11/01)	0.43	124.83
13	Ivan Lake (11/01)	1.37	191.51
14	Henderson Lake (11/01)	0.67	180.56
15	Vermilion River @ Lafayette (11/01)	1.31	118.12
16	Bayou Amy (11/01)	0.29	105.69
17	Kepler Lake (12/01) (12/01)	4.36	354.99
18	Cypress Bayou Reservoir (12/01)	1.24	180.74
19	Vermilion River nr Abbeville (12/01)	1.03	108.55
20	Spanish Lake nr New Iberia (01/02)	3.47	257.14
21	Blind River (01/02)	2.19	183.77
22	Lake Fausse Pointe (01/02)	1.46	147.16
23	Lake Dauterive (01/02)	0.93	188.45
24	Grassey Lake (01/02)	2.15	205.38
25	Henderson Lake (01/02)	3.16	290.18
26	Lake Misere (01/02)	1.21	104.85
27	Lake Fields (01/02)	2.22	148.97
28	Bayou Lafourche nr Lockport (01/02)	1.92	170.46
29	Wham Brake (02/02)	1.02	79.27
30	Bayou Macon Cutoff #2 (02/02)	2.02	128.96
31	Bayou Macon Cutoff #3 (02/02)	3.40	165.20
32	Eunice City Park Lake (02/02)	0.21	101.06
33	Vernon Lake (02/02)	3.84	81.25
34	Long Bayou (Concordia Parish) (02/02)	0.47	200.07
35	Big Alabama Bayou (02/02)	0.95	131.07
36	Little Alabama Bayou (02/02)	0.96	87.57
37	Black Bayou Lake nr Lamkin (03/02)	1.43	180.68
38	Lake Lafourche nr Hebert (03/02)	1.14	105.52
39	Buffalo Cove (03/02)	0.94	64.48
40	Bayou Gravenburg (03/02)	1.06	108.87
41	Clear Lake (Lake Edwards) (03/02)	0.54	153.27
42	Caney Lake nr Minden (Upper) (03/02)	0.95	232.53
43	Caney Lake nr Minden (Lower) (03/02)	0.28	78.12
44	Caddo Lake WSW of Oil City (04/02)	1.18	165.80
45	Grand Bayou Reservoir (04/02)	1.59	82.05
46	ICWW nr Bourg (04/02)	0.86	112.72
47	Union Oil Canal System (04/02)	2.13	216.08
48	Petite Lac Des Allemands (04/02)	0.97	194.22
49	West Fork Calcasieu River (04/02)	1.83	173.28
50	Calcasieu River @ Moss Bluff (4/02)	1.67	106.80
51	Toledo Bend nr Hunter (05/02)	0.21	58.91
52	Black Lake nr Natchitoches (05/02)	8.49	152.61
53	Bayou Lacombe N of Lacombe (05/02)	1.06	142.83
54	Bogue Falaya River (05/02)	0.45	25.42
55	Tchefuncte River (05/02)	1.77	98.42
56	Pearl River nr Slidell (05/02)	0.02	10.49
57	English Bayou (05/02)	0.73	153.21
58	Tangipahoa River nr Lees Landing (06/02)	0.09	63.59
59	Lake Concordia (06/02)	0.33	181.98
60	Ouachita River nr Harrisonburg (06/02)	0.04	10.05
61	Henderson Lake (06/02)	2.59	266.67
62	Bayou DeLoutre SW of Sterlington (07/02)	0.57	27.05
63	Hamilton Lake (07/02)	1.57	117.34
64	Big Creek (07/02)	0.67	28.02
65	Bayou Lafourche nr Columbia (07/02)	0.09	4.77
66	Bayou deLoutre nr deLoutre (07/02)	1.40	45.77
67	Black River S of Jonesville Lock (07/02)	0.20	10.57
68	Catahoula Lake (LaSalle Parish) (07/02)	0.87	118.66
69	Bayou Liberty (07/02)	0.19	47.22
70	Bogue Chitto River nr Sun (07/02)	0.05	0.72
71	Pearl River Diversion Canal (07/02)	0.57	81.99
72	Tchefuncte River (07/02)	0.79	81.91
73	Black River (08/02)	0.18	22.76
74	Tensas River nr Jonesville (08/02)	0.49	36.96
75	Murphy Lake (08/02)	0.43	55.44
76	Bayou Sorrel (08/02)	0.06	23.23
77	Bayou Cowan (08/02)	0.46	95.11
78	Boeuf River (08/02)	0.96	87.62
79	Bayou Bartholomew nr Sterlington(08/02)	0.28	36.23
80	Ouachita River nr Sterlington (08/02)	0.41	70.63
81	Bayou Macon nr Wisner (08/02)	0.52	55.29
82	Fresh Water Bayou Canal (08/02)	0.48	87.03
83	Seventh Ward Canal	0.63	84.01
84	ICWW west of Bowman Locks (09/02)	0.47	49.90
85	Larto Lake (09/02)	0.53	75.69
86	Red River nr Marksville (09/02)	0.06	2.60
87	Upper Grand River (Outside Levee) (09/02)	0.94	75.81
88	Upper Grand River (09/02)	0.39	47.41
89	Boeuf Cocodrie Diversion Canal (09/02)	0.43	49.38
90	Amite River @ Port Vincent (09/02)	0.36	55.70
91	Colyell Bay (09/02)	1.07	193.42
92	Warren Canal (09/02)	0.81	102.70
93	North Prong Schooner Bayou (9/02)	0.74	54.66
94	Bayou Queue de Tortue (10/02)	0.89	67.29
95	Cheniere Brake (10/02)	1.64	205.86
96	Bussey Brake (10/02)	0.08	29.23
97	Bayou Bonne Idee nr Horseshoe Lake (10/02)	0.67	125.15
98	Turkey Creek Lake (10/02)	1.01	256.37
99	Catahoula Lake (10/02)	0.76	151.31
100	Bayou Bristow (10/02)	0.67	59.94
101	Caney Lake nr Minden (Upper) (10/02)	1.07	139.63

(Continued on next page)

Table 1. *(Continued)*

#	*Sample location and date (mm/yy)*	*MeHg µg/kg*	*THg µg/kg*
102	Caney Lake nr Minden (Lower) (10/02)	0.17	25.57
103	Ivan Lake (10/02)	0.92	113.26
104	Black Lake @Hosston (10/02)	0.36	92.20
105	Lake Fausse Pointe(11/02)	1.01	105.03
106	Eunice City Park Lake (11/02)	0.45	59.86
107	Henderson Lake (11/02)	1.88	140.37
108	Horseshoe Lake SE of Mer Rouge (11/02)	0.98	86.86
109	Amite River nr Clio (11/02)	1.07	124.87
110	Lake Chicot (11/02)	1.43	141.28
111	Calcasieu River @ Moss Bluff (12/02)	0.29	8.29
112	West Fork Calcasieu River (12/02)	0.63	57.62
113	Amite River Diversion Canal (12/02)	0.34	42.10
114	Tangipahoa River (0033) (12/02)	0.00	4.41
115	Spanish Lake nr New Iberia (01/03)	1.05	87.17
116	Blind River (01/03)	0.75	63.27
117	Lake Dauterive (01/03)	0.31	92.57
118	Lake Fausse Pointe (01/03)	0.93	119.84
119	Mermentau River (01/03)	0.77	124.22
120	Bayou Plaquemine Brule-LOI (01/03)	1.18	154.04
121	Vermilion River (Lafayette) (01/03)	1.27	76.66
122	Vermillon River nr Abbeville (01/03)	0.98	88.30
123	Upper Grand River nr Cow Island (01/03)	0.18	18.90
124	Lake Bartholomew (02/03)	0.92	72.48
125	Bayou Macon Cutoff # 2 (02/03)	1.81	94.64
126	Crew Lake (02/03)	0.35	52.95
127	Union Oil Canal System (02/03)	0.58	71.14
128	Minors Canal (02/03)	1.11	73.63
129	Lake Misere (02/03)	0.42	35.90
130	Grand Lake nr Hackberry Point (02/03)	0.34	39.86
131	Lake Vernon (02/03)	0.07	17.61
132	Bundick Lake (02/03)	0.74	104.31
133	Dubuisson Lake (02/03)	0.49	74.69
134	Bay Wallace (02/03)	1.89	153.00
135	Bayou Black (02/03)	0.69	24.40
136	Clear Lake (Lake Edwards) (03/03)	1.29	118.55
137	Cane River Lake (03/03)	1.90	200.61
138	Cane River nr Melrose (03/03)	1.04	31.46
139	Grand Bayou Reservoir (03/03)	2.38	65.24
140	Bayou Rigolettes nr Lafitte (03/03)	0.89	68.25
141	Bayou Perot (03/03)	1.77	48.58
142	Bayou Penchant (03/03)	1.63	39.37
143	Bayou Macon Cutoff #3 (03/03)	1.61	55.93
144	Lake Buhlow (03/03)	0.23	8.13
145	Spring Bayou (03/03)	0.97	40.62
146	Bayou Lacombe N of Lacombe (04/03)	1.46	68.90
147	Lake Pontchartrain nr Bayou Lacombe (04/03)	0.18	11.93
148	Bayou des Cannes-Sediment (04/03)	1.18	85.55
149	Hanson Canal (04/03)	8.23	338.42
150	Orange Grove Oil Canals (04/03)	2.72	112.49
151	Bayou Nezpique (04/03)	0.88	74.45
152	Anacoco Lake (04/03)	1.64	116.06
153	Ponchatoula Creek (05/03)	0.13	14.24
154	Cocodrie Lake (Evangeline Parish) (05/03)	2.82	132.15
155	Long Bayou (Concordia Parish) (05/03)	0.96	55.26
156	Franklin Canal (05/03)	0.81	65.87
157	Borrow Pit NE of Melville (05/03)	0.26	23.14
158	Bayou Lacassine nr Hayes (06/03)	1.49	68.44
159	New Iberia Southern Drainage Canal (06/03)	0.17	29.79
160	Bayou Plaquemine Brule (06/03)	0.51	67.44
161	Grand Lake (West) (06/03)	0.69	123.01
162	Bayou des Cannes- LOI (06/03)	0.47	56.73
163	7th Ward Canal (07/03)	0.46	44.98
164	Saline Bayou (Catahoula Parish) (07/03)	0.84	81.49
165	Lake Maurepas at North Pass (07/03)	0.43	91.97
166	Lake Pontchartrain at Pass Manchac (07/03)	0.62	44.59
167	Bayou LaBranche (07/03)	0.89	57.25
168	Lake Pontchartrain at Bonne Carre (07/03)	0.23	23.12
169	Bayou Plaquemine (07/03)	0.84	82.16
170	Bayou Grosse Tete (07/03)	1.05	91.16
171	White Lake @ Schooner Bayou (07/03)	0.75	58.95
172	Mermentau River S of Grand Lake (07/03)	0.56	52.29
173	Ouachita River nr Ark. State Line (07/03)	0.00	3.72
174	Philips Lake (07/03)	0.53	119.20
175	Boeuf River nr Columbia (07/03)	0.46	24.01
176	Lake Louis (07/03)	0.06	16.27
177	Boeuf River nr Oak Grove (07/03)	0.05	6.83
178	Turtle Bayou (08/03)	0.93	106.96
179	Bayou Chene nr Amelia (08/03)	0.51	41.59
180	Bayou Teche nr Franklin (08/03)	0.68	83.22
181	Bayou Bartholomew nr Twin Oaks (08/03)	0.13	13.58
182	Bayou Desiard nr LDWF (08/03)	0.44	42.24
183	Clear Lake near Start (08/03)	1.54	88.30
184	Long Lake (08/03)	1.26	64.28
185	Tangipahoa River nr Lee's Landing (08/03)	1.16	56.04
186	Natalbany River (08/03)	0.64	94.65
187	Bogue Falaya River (08/03)	0.20	9.41
188	Bayou Postillion (08/03)	1.06	111.18
189	Old River nr Pierre Part (08/03)	1.08	73.39
190	Big Fork Bayou (08/03)	4.75	239.70
191	Little Bayou Sorrel (08/03)	1.64	146.62
192	Six Mile Lake (09/03)	0.38	28.42
193	Big Alabama Bayou (09/03)	1.32	78.54
194	Bayou des Cannes (09/03)	1.61	58.48
195	Bayou Plaquemine Brule (09/03)	1.26	48.50
196	Bayou Long near Stephenville (09/03)	1.03	104.68

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Table 1. *(Continued)*

#	Sample location and date (mm/yy)	MeHg μg/kg	THg μg/kg
197	Bayou Petite Anse (09/03)	1.21	81.81
198	Pat Bay (09/03)	1.04	57.44
199	Little River near Archie (09/03)	0.78	51.54
200	Catahoula Lake Diversion Canal (09/03)	0.25	23.25
201	Sediment (Conway Bayou) (10/03)	1.45	104.41
202	Old River (10/03)	0.65	92.83
203	Bayou Rouge (10/03)	0.81	50.29
204	Crew Boat Chute @ Attakapas WMA (10/03)	0.60	28.41
205	Old River nr Niblett Bluff (10/03)	0.08	3.43
206	Bayou Lacassine near Lake Arthur (10/03)	0.38	95.97
207	Bayou L'Ourse (10/03)	1.66	85.07
208	Kepler Lake (11/03)	1.62	121.56
209	Lake Bisteneau (11/03)	1.72	189.73
210	Corney Lake (11/03)	0.97	126.35
211	Catahoula Lake (11/03)	2.80	64.14
212	Flat Lake (11/03)	0.44	46.89
213	Garden City Oilfield Canals (11/03)	0.67	52.97
214	Bayou Sale Oilfield Canals (11/03)	1.15	69.82
215	Big Slough Lake (11/03)	0.68	101.39
216	Lake Lafourche (11/03)	0.20	10.42
217	Lake Providence (11/03)	0.31	79.40
218	Bunch's Cutoff (11/03)	0.43	74.39
219	Bayou Dorcheat (11/03)	0.11	5.86
220	Lake Arthur (12/03)	0.77	79.16
221	Lake Claiborne (12/03)	0.59	118.55
222	Bayou Dorcheat (12/03)	0.10	15.94
223	Cross Lake (12/03)	0.26	109.82
224	Black Bayou Reservoir (12/03)	0.11	11.55
225	Bayou Rouge (12/03)	0.48	64.45
226	Bayou Bristow (Work Canal) (01/04)	0.19	20.83
227	I-10 Canal (EAB) (01/04)	0.27	80.48
228	Houston River (01/04)	1.65	149.34
229	Blind River nr Lake Maurepas (01/04)	0.18	41.77
230	Iatt Lake (01/04)	0.50	123.45
231	Petite Amite River (01/04)	0.59	116.30
232	Mean Lake (02/04)	0.26	72.51
233	Little Atchafalaya River (02/04)	0.53	43.24
234	Iatt Lake (03/04)	0.50	87.93
235	Lake Penchant (03/04)	0.29	97.77
236	Wallace Lake (Catahoula Parish) (03/04)	0.23	64.25
237	Tew Lake (03/04)	0.30	46.49
238	Amite River nr Baton Rouge (03/04)	0.16	10.27
239	Black Bayou Lake nr Lamkin (03/04)	0.83	154.14
240	Povery Point Lake (03/04)	0.35	40.05
241	Chatham Lake (03/04)	1.01	198.78
242	Caney Creek Lake (03/04)	1.69	69.36
243	Lake Bruin (03/04)	0.07	8.10
244	Mermentau River (03/04)	0.23	68.40
245	Minor's Canal @ Lake Hatch (03/04)	0.51	70.50
246	West Fork Calcasieu River nr De Quincy (03/04)	0.24	40.34
247	Calcasieu River nr Kinder (04/04)	0.04	10.47
248	Lake Boeuf (04/04)	0.49	102.80
249	Bayou Petite Caillou (04/04)	0.07	49.72
250	Boef Cocodrie Diversion Canal (04/04)	0.11	22.68
251	City Park Lake - N.O. (04/04)	0.21	204.23
252	Bayou Cocodrie (St. Landry Parish) (04/04)	0.14	24.82
253	Sibley Lake (04/04)	0.32	99.74
254	Black Lake nr Natchitoches (04/04)	1.14	178.83
255	Deer Lake (Atchafalaya Basin) (04/04)	0.32	79.48
256	Cabot Canal (Atchafalaya Basin) (04/04)	1.15	85.52
257	Red River nr Alexandria (05/04)	0.21	20.19
258	Lake Pontchartrain @ Tchefuncte (05/04)	0.42	35.17
259	Lake Pontchartrain nr S. Causeway (05/04)	0.19	65.72
260	Warren Canal (05/04)	0.18	19.82
261	Clear Lake near Clarence (05/04)	0.11	14.48
262	Saline Lake nr Clarence (05/04)	0.81	140.12
263	Black Lake @Hosston (05/04)	0.60	78.43
264	Bayou Dorcheat @ Hwy.2 (05/04)	2.17	202.76
265	White Lake @ Schooner Bayou (07/04)	0.39	84.90
266	Amite River nr Clio (07/04)	0.33	82.04
267	Lake Maurepas @ Amite River (07/04)	0.30	82.76
268	Blood River (07/04)	0.56	91.10
269	Lake Maurepas @ Tickfaw River (07/04)	0.41	98.14
270	Tchefuncte River @ Covington (07/04)	0.45	44.35
271	Tangipahoa River nr Robert (07/04)	0.03	3.39
272	Lake Palourde (07/04)	0.64	40.63
273	Lake Verret (08/04)	0.94	60.95
274	Bayou Teche @ Patterson (08/04)	0.57	45.44
275	North Prong Schooner Bayou (08/04)	0.61	25.58
276	Cow Island Lake (08/04)	0.77	68.87
277	Bayou Maringouin (Inside Levee) (08/04)	0.55	50.08
278	Bayou Maringouin (08/04)	0.25	21.33
279	Lake Fausse Pointe Cutoff (08/04)	0.16	17.66
280	Beau Bayou (08/04)	0.34	54.01
281	Ouachita River nr Jonesville (08/04)	0.20	23.96
282	Catahoula Lake (LaSalle Parish) (08/04)	0.28	118.52
283	Black River (08/04)	0.08	5.35
284	Bayou Bonne Idee (08/04)	0.25	32.88
285	Bayou Bartholomew nr Sterlington (08/04)	0.00	2.39
286	Big Creek (08/04)	0.76	10.71
287	Boeuf River (08/04)	0.54	26.32
288	Turkey Creek Lake (08/04)	1.18	127.07
289	Bayou Louis (08/04)	0.78	35.98
290	Red River nr Alexandria (08/04)	0.04	2.28
291	Cross Bayou (Catahoula Parish) (09/04)	0.46	53.10
292	Henderson Lake (09/04)	1.53	170.82
293	Bayou Liberty (09/04)	0.10	151.28
294	Bayou Bonfuoca (09/04)	0.35	68.40
295	Pearl River nr Slidell (09/04)	0.18	19.94
296	Bogue Chitto River nr Sun (09/04)	0.03	45.98

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Table 1. *(Continued)*

#	*Sample location and date (mm/yy)*	*MeHg μg/kg*	*THg μg/kg*	#	*Sample location and date (mm/yy)*	*MeHg μg/kg*	*THg μg/kg*
297	Tow O'Clock Bayou (09/04)	0.71	186.26	345	Beckwith Creek (03/05)	0.09	21.87
298	Bayou Petite Prairie (09/04)	0.88	109.16	346	Morengo Lake (03/05)	0.20	51.26
299	Atchafalaya River nr. Simmersport (09/04)	0.12	31.95	347	Hilliard's Coupe (03/05)	0.00	59.27
				348	Miller's Lake (03/05)	0.21	18.85
300	Calcasieu River @ Hwy. 190 (09/04)	0.16	6.29	349	Bayou Choctaw nr I-10 (03/05)	0.35	42.78
301	Dobb's Bay (10/04)	0.30	43.52	350	Bayou Toro (03/05)	0.09	3.51
302	Lower Sunk Lake (10/04)	0.60	37.86	351	Toledo Bend nr San Patrice (03/05)	0.45	58.08
303	Lake Chicot Oilfield Canals (10/04)	0.48	39.22	352	Black Bayou Lake (Red River Parish) (03/05)	0.15	2.22
304	Bayou Bristow (Work Canal) (10/04)	0.43	24.82				
305	West Lake Verret Oilfield Canals (10/04)	0.65	35.67	353	Saline Bayou (03/05)	0.03	2.30
306	Big Bayou Pigeon (10/04)	0.27	62.09	354	Grand Bayou Reservoir (03/05)	0.10	50.85
307	Crooked Creek Reservoir (10/04)	0.36	31.95	355	Black Lake nr Denson (04/05)	0.81	113.60
308	Bayou Desiard nr Frenchman's Bend (10/04)	0.82	178.60	356	Lake Maurepas@Pass Manchac (04/05)	0.84	58.92
				357	Little Tensas Bayou (04/05)	0.44	31.11
309	Bayou D'Loutre SW of Sterlington (10/04)	0.38	12.19	358	Wax Lake Outlet (04/05)	0.17	25.45
				359	Bayou Courtableau (04/05)	0.59	42.57
310	Eagle Lake (10/04)	0.31	47.01	360	Little River nr Marksville (04/05)	0.40	53.63
311	Lake Chotard (10/04)	0.44	42.05	361	Sutton Lake (04/05)	0.42	56.66
312	Bayou Macon Cutoff # 1 (10/04)	0.33	42.19	362	Lake Dogwood (04/05)	0.17	43.86
313	Bayou Gravenburg (11/04)	0.32	27.13	363	Caddo Lake nr HWY1 (04/05)	0.28	88.22
314	Flase River (11/04)	0.17	10.33	364	Caddo Lake nr HWY2 (04/05)	0.81	188.41
315	Lake Bistineau (11/04)	0.29	12.56	365	Bayou Chene (05/05)	0.44	47.62
316	Lake Bistineau (Upper Lake) (11/04)	0.71	167.83	366	Henderson Lake (05/05)	0.66	109.74
317	Caney Lake nr Minden (Upper) (11/04)	0.50	28.14	367	Bayou Rouge (05/05)	0.75	44.78
318	Caney Lake nr Minden (Lower) (11/04)	0.67	61.42	368	Cocodrie Lake (05/05)	0.45	102.49
319	Wallace Lake (11/04)	0.42	119.23	369	Lake Dubuisson (07/05)	0.22	45.43
320	Cotile Lake (11/04)	0.62	96.03	370	Bayou Lacassine nr Hayes (07/05)	0.80	74.24
321	Kincaid Reservoir (11/04)	0.37	52.00	371	Lake Misere (07/05)	1.00	76.77
322	Indian Creek Reservoir (12/04)	0.43	47.29	372	Little Bayou Sorrel (07/05)	0.28	67.18
323	Lake Chicot (12/04)	0.79	85.59	373	Corney Lake (07/05)	0.57	184.39
324	Blind River (12/04)	0.67	63.49	374	Bayou Dorcheat nr Sarepta (07/05)	1.20	112.74
325	Lac Des Allemands (12/04)	0.32	46.61	375	Lake Bisteneau W of Ringold (07/05)	0.36	42.75
326	Lake Boudreaux (12/04)	0.95	120.07	376	Clear Lake (Lake Edwards) (07/05)	0.11	36.20
327	Bayou Cocodrie (Lake Hackberry) (01/05)	1.53	188.71	377	Sediment (Miss. River @ St. Francisville) (07/05)	0.14	2.53
328	Bayou Copasaw (01/05)	1.70	179.83	378	Sediment (Bayou Plaquemine Brule) (07/05)	0.24	49.38
329	Bayou Chene (01/05)	0.89	98.41				
330	Spanish Lake nr Baton Rouge (01/05)	1.22	260.95	379	Sediment (Bayou Des Cannes) (07/05)	0.21	33.93
331	Bayou Queue de Tortue @ Hwy 13 (01/05)	0.07	32.10	380	Blind River nr Maurepas (08/05)	0.22	69.62
				381	Lake Maurepas nr Blind River (08/05)	0.24	79.44
332	Lake Martin (02/05)	0.52	102.10	382	Bayou Nezpique nr Hathaway (08/05)	0.80	84.97
333	Saline River nr Clarence (02/05)	0.28	41.72	383	Bayou Grosse Tete (08/05)	0.44	67.03
334	Black Lake Bayou nr Clarence (02/05)	0.11	20.92	384	I-10 Canal (08/05)	0.14	55.45
335	Bayou Pierre (02/05)	0.04	32.73	385	Bayou Benoit (08/05)	0.00	57.84
336	Poverty Point Lake (02/05)	0.44	69.62	386	Tickfaw River nr Hwy 22 (08/05)	0.10	80.14
337	Bayou Macon (02/05)	0.40	41.87	387	Old River nr Niblett Bluff (08/05)	0.00	8.42
338	Cheniere Brake Lake (02/05)	0.81	211.32	388	Big Alabama Bayou (08/05)	0.48	34.12
339	Bayou D'Arbonne Lake nr Dam (02/05)	1.51	88.16	389	Little Alabama Bayou (08/05)	0.31	48.56
340	Lake Rodemacher (02/05)	0.11	52.24	390	Old River nr Deer Park (08/05)	1.04	69.40
341	Bayou Choctaw nr Indian Village (03/05)	0.44	73.97	391	Lake Dauterive (08/05)	0.13	138.82
342	Lake St. John (03/05)	0.08	27.44	392	7th Ward Canal (09/05)	0.00	58.39
343	Sabine National Wildlife Refuge Canals (03/05)	0.06	30.75	393	Bayou Teche @ New Iberia (09/05)	0.69	97.84
				394	Kepler Lake (09/05)	0.15	15.59
344	Choupique Bayou (03/05)	0.54	52.93	395	Bayou Bodcau nr Springhill (09/05)	0.66	23.92

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Table 1. *(Continued)*

#	Sample location and date (mm/yy)	MeHg µg/kg	THg µg/kg
396	Red River nr Shreveport (09/05)	0.07	3.48
397	Big Creek N of Marksville (09/05)	0.08	59.12
398	Grand Lake (East) (09/05)	0.35	49.87
399	Lake Louis (Lovelace Lake) (10/05)	0.59	62.09
400	Boenf River nr Columbia (10/05)	0.13	4.78
401	Bayou Bartholoemew (10/05)	0.19	19.51
402	Philips Lake (10/05)	0.38	21.23
403	Little River nr Hwy 165 (10/05)	0.05	8.46
404	Grand Lake (West) (10/05)	0.28	25.64
405	Big Fork Bayou (11/05)	1.00	77.72
406	Bayou L'Ourse (11/05)	1.40	70.84
407	Little Bayou Pigeon (11/05)	0.24	54.81
408	Tew Lake (11/05)	0.57	44.39
409	Lake Peigneur (11/05)	0.68	54.75
410	Miller's Chute (12/05)	0.19	23.92
411	Bayou Amy (12/05)	0.72	64.18
412	Anacoco Lake (12/05)	0.29	77.63
413	Lake Vernon (12/05)	0.12	54.08
414	Saline Lake nr Clarence (12/05)	2.45	161.67
415	Saline Bayou (12/05)	0.28	9.52
416	Minor's Canal (12/05)	0.68	23.56
417	Catfish Bayou (01/06)	0.62	71.33
418	Bayou Des Glaises Diversion Canal (01/06)	0.68	16.20
419	Smith Bay (02/06)	0.27	9.64
420	Old River nr Marksville (02/06)	0.22	45.86
421	Iatt Lake (02/06)	0.39	28.23
422	Mystic Crew Bayou (02/06)	0.65	44.40
423	Lake Cataouatche (02/06)	0.68	91.03
424	Bayou Segnette (02/06)	0.87	53.94
425	The Pen (02/06)	0.68	39.65
426	Lake Salvador (East) (02/06)	0.10	41.89
427	Lake Salvador (Upper Mid Lake) (02/06)	0.65	51.84
428	University Lake (BR) (03/06)	0.21	128.35
429	Lake Salvador (West) (03/06)	1.01	167.12
430	Black Lake nr Natchitoches (03/06)	0.49	143.15
431	Lake Decade (03/06)	0.52	62.42
432	Houma Navigation Canal (03/06)	0.60	92.15
433	Fohs Canal (03/06)	0.60	96.04
434	Black River S of Jonesville Locks (03/06)	0.04	14.05
435	Bayou Grand Caillou nr Dulac (03/06)	0.69	93.52
436	Caernarvon Canal (04/06)	3.26	177.79
437	Bayou Macon nr Wisner (04/06)	0.11	35.03
438	Saddletree Lake (04/06)	0.38	89.41
439	Black River Lake (04/06)	0.35	54.41
440	City Park Lake (BR) (04/06)	0.53	205.02
441	Cocodrie Lake (Concordia Parish) (04/06)	0.12	143.64
442	Cocodrie Bayou nr Monterey (04/06)	0.26	112.68
443	Vermilion Bay (West) (04/06)	0.29	42.26
444	Ouachita River nr Harrisonburg (04/06)	0.06	15.38
445	Intracoastal Waterway S of Avery Island (05/06)	0.37	42.19
446	Sabine River nr I-10 (05/06)	0.04	64.69
447	Red River nr Natchitoches (05/06)	0.17	17.72
448	Sabine River nr Merryville (05/06)	0.02	17.00
449	Bayou Francis nr Sorrento (05/06)	0.65	140.79
450	Red River @ Brouillette (06/06)	0.03	11.14
451	Old River nr Vidalia (06/06)	0.89	164.90
452	Mississippi River nr Vidalia (06/06)	0.04	21.40
453	Red River nr RRWMA (06/06)	0.05	25.15
454	Little River @ Walkers Ferry (06/06)	0.03	13.28
455	Avoca Island Cutoff (06/06)	0.25	69.49
456	Lake St. Joseph (06/06)	1.32	58.02
457	Yucatan Lake (06/06)	0.00	8.86
458	Tangipahoa River nr Lees Landing (06/06)	0.24	44.82
459	Amite River @ Port Vincent (06/06)	0.08	46.58
460	Lake Fields (07/06)	0.71	144.89
461	Bayou Lafourche nr Lockport (07/06)	0.99	299.14
462	Henderson Lake (07/06)	1.74	226.63
463	Bayou Clear nr Woodworth (07/06)	0.27	39.49
464	Bayou Boeuf nr Woodworth (07/06)	0.68	55.26
465	Bayou Sorrel (07/06)	0.20	46.93
466	Murphy Lake (07/06)	0.23	42.66
467	Upper Grand River (Outside Levee) (07/06)	2.59	43.96
468	Upper Grand River (07/06)	0.26	35.20
469	Bayou Cowan (07/06)	0.61	168.00
470	Little River nr Bodie's Landing (07/06)	0.03	10.70
471	Big Saline Bayou (07/06)	0.34	53.22
472	Wild Cow Bayou (08/06)	0.22	56.86
473	Conway Bayou (08/06)	0.35	77.98
474	Grassy Lake (08/06)	0.81	84.62
475	Bayou Black (08/06)	0.33	67.83
476	Black Bayou (Cameron) (08/06)	0.04	19.54
477	Tensas River nr Jonesville (08/06)	0.18	50.80
478	Bogue Chitto River (08/06)	0.11	15.06
479	English Bayou (08/06)	0.58	137.58
480	Pearl River nr Bogalusa (08/06)	0.03	6.92
481	Bayou Queue de Tortue (09/06)	0.23	26.13
482	Bogue Falaya River (09/06)	0.19	22.97
483	Tensas River nr Cooter Point (09/06)	0.45	45.34
484	Ponchatoula Creek (09/06)	0.49	52.40
485	Lake Concordia (09/06)	0.55	21.80
486	Smithport Lake (09/06)	0.39	32.75
487	ICWW nr Bourg (09/06)	0.37	40.80
488	Buffalo Cove (10/06)	0.63	29.97
489	Bayou Lacassine nr Hwy 14 (10/06)	0.59	60.69
490	Toledo Bend nr Logansport (10/06)	0.04	7.14
491	Chicot Lake (10/06)	0.57	119.61
492	Amite River nr Baton Rouge (10/06)	0.41	3.50
493	Ouachita River @ Columbia (10/06)	0.31	32.69
494	Bayou Bonne Idee nr Horseshoe Lake (03/07)	<0.05	92.28

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Table 1. *(Continued)*

#	Sample location and date (mm/yy)	MeHg µg/kg	THg µg/kg	#	Sample location and date (mm/yy)	MeHg µg/kg	THg µg/kg
495	Horseshoe Lake nr Mer Rouge (03/07)	0.14	197.78	521	Lake Bistineau W of Ringold (07/07)	1.53	246.14
496	Bayou D'Arbonne (03/07)	0.09	71.40	522	Caney Lake nr Minden (Lower) (07/07)	0.32	367.68
497	Bayou Lafourche nr Columbia (03/07)	<0.05	62.17	523	Cross Lake @ Shreveport (07/07)	<0.05	24.27
498	Grand Bayou nr Pierre Part (03/07)	0.60	192.16	524	Pat Bay (07/07)	0.21	205.88
499	Chopin Chute nr Pierre Part (03/07)	0.11	58.93	525	Old River nr Pierre Part (07/07)	0.30	74.43
500	Vermilion Bay (East) (03/07)	0.63	338.64	526	Bayou Sale Oilfield Canals (07/07)	0.38	244.85
501	Weeks Bayou (03/07)	0.77	510.23	527	Atchafalaya River nr Melville (07/07)	0.08	27.70
502	Lake Killarney (04/07)	0.49	548.06	528	Vermilion River nr Lafayette (08/07)	1.22	108.14
503	Bayou Bartholomew nr Hwy 425 (04/07)	<0.05	67.08	529	Bayou Postillion (08/07)	0.75	95.70
504	Bayou de Loutre nr de Loutre (04/07)	0.58	141.81	530	Clear Lake nr Start (08/07)	0.43	899.76
505	Grand Bayou Reservoir (04/07)	0.47	111.97	531	Crew Lake (08/07)	0.61	625.14
506	Mill Creek Reservoir (04/07)	0.22	63.94	532	Bay Wallace (08/07)	0.36	609.88
507	ICWW W of Bowman Locks (04/07)	0.07	146.46	533	Bayou Chene nr Amelia (08/07)	1.01	501.47
508	Gulf of Mexico (T-Butte) (05/07)	0.03	91.17	534	Mississippi River nr Baton Rouge (08/07)	<0.05	12.58
509	East Cote Blanche Bay (05/07)	0.32	186.58	535	Little Bayou Long (08/07)	0.19	475.11
510	ICWW nr Belle Chasse (05/07)	0.06	168.64	536	Union Oil Canal System (08/07)	0.22	367.76
511	Harvery Canal (05/07)	0.13	422.17	537	Orange Grove Canals (08/07)	0.44	509.60
512	Red River nr Coushatta (05/07)	0.17	76.38	538	Bundick Lake (09/07)	0.12	96.59
513	Old River nr Bivens (05/07)	0.20	101.10	539	Long Lake SE of Columbia (09/07)	0.19	101.19
514	Henderson Lake (05/07)	0.31	38.83	540	Lake Bartholomew (09/07)	0.20	233.54
515	Bayou Bristow (Work Canal)	0.97	138.85	541	Ouachita River nr Riverton (09/07)	<0.05	63.60
516	Ouachita River nr Jonesville (06/07)	0.19	95.94	542	Blind River (09/07)	1.37	424.44
517	Little River nr Jonesville (06/07)	0.36	320.11	543	Crew Boat Chute @ Attakapas (09/07)	0.32	113.42
518	I-10 Canal (East Atchafalaya Basin) (06/07)	0.50	278.21		Average	0.68	92.30
					Stdev	0.80	95.10
519	Bayou Petite Prairie (06/07)	1.33	199.28		Min	0.00	0.70
520	Big Alabama Bayou (07/07)	0.33	349.74		Max	8.49	899.76

(Tables 1, 2). Methyl Hg accounted for an average 0.73% of the total Hg in sediment.

DeLaune et al.[10] in recent studies determined total Hg and methyl Hg at 292 sites along a salinity gradient in a coastal Louisiana estuary (Pontchartrain Basin) and reported the average total Hg level decreased with increasing salinity. Lake Maurepas, Lake Pontchartrain and Lake Borgne/Chandeleur Sound sediment contained 98 μg kg^{-1}, 67 μg kg^{-1}, and 24 μg kg^{-1}, respectively. The average total Hg content in our study which represented mostly interior Louisiana freshwater streams and water bodies by comparison was 92.3 μg kg^{-1}, which is similar to values for Lake Maurepas which is located in the upper reach of the Pontchartrain estuary.

Table 2. Average concentrations of methyl Hg and total Hg and various parameters in sediment samples of Louisiana water bodies (N = 543).

	Average	*Stdev*
MeHg (μg kg^{-1})	0.68	0.8
THg (μg kg^{-1})	92.3	95.1
P (ppm)	446.2	420.8
K (ppm)	1983.0	2342.7
Ca (ppm)	4079.1	8420.6
Mg (ppm)	2549.9	2700.4
Na (ppm)	363.1	704.0
S (ppm)	952.7	1889.4
pH	6.3	0.8
Eh (mV)	−4.3	159.2
O.M (%)	4.0	3.1
Sand (%)	30.8	29.6
Silt (%)	34.3	18.9
Clay (%)	34.9	19.8

In the Pontchartrain Basin study,[10] average methyl Hg values for Lake Maurepas, Lake Pontchartrain and Lake Borgne/Chandeleur Sound sediment was 0.80 μg kg^{-1}, 0.55 μg kg^{-1} and 0.21 μg kg^{-1}, respectively. By comparison we reported average methyl Hg content over 0.68 μg kg^{-1} in this study. Again the levels are more closely associated with the more freshwater sites (Lake Maurepas) reported for the northern portion of the Pontchartrain estuary.[10]

Huggett et al.[11] in a study of north Mississippi lakes reported total mean Hg concentration in sediment from Enid Lake in 1997 was 154 μg kg^{-1} while in 1998 sediment concentration in Sardis, Enid and Grenola Lakes was 112, 88 and 133 μg kg^{-1} respectively. Rood et al.[12] reported the sediment concentration of total Hg in the Florida Everglades was 120 μg kg^{-1}.

In a comparable study of 579 sediment samples from various water bodies across northeast United States[13],

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total Hg in surface sediment ranged from <0.01 to 3700 μg kg^{-1}, and the overall average concentration was 190 μg kg^{-1}. Methyl Hg ranged from 0.015 to 2.1 μg kg^{-1}, and the mean concentration was 0.38 μg kg^{-1}.

The U.S. National Oceanic and Atmospheric Administration[14] and Environment Canada[15] provide sediment quality guidelines for freshwater sediment. For total Hg, the values corresponding to these guidelines are 174, 486, and 560 μg kg^{-1}, respectively for threshold effects level (TEL), probable effects level (PEL) and upper effects threshold (UET). With each increasing effects level, toxicity to benthic aquatic organisms is increasingly likely.

In our study, evaluating the data set with the guidelines indicated that total Hg concentration in 87.5% of samples were below the threshold effects level, 11.2% of the sediments had concentrations between the threshold and probable effects level, and 1.3% of the sediment samples were in excess of the probable effects level. Only 0.55%, one sample, was above the upper effects threshold of 560 μg kg^{-1}.

The above percentage values for the threshold level were less than reported by Kamman et al.[13] for water bodies in the northeast United States which reported 55% of samples were below the threshold effects, 43% were between the threshold and probable effects level, and 2% exceeded the probable effects level.

In our study, methyl Hg content of the sediment sample was significantly correlated to total Hg content (r = 0.331**), organic matter content (r = 0.178**), and clay content (r = 0.167**). Methyl Hg was inversely correlated with sand content (r = −0.172**) and pH (r = −0.132**) (Table 3).

Total Hg content of sediment was significantly correlated with methyl Hg (r = 0.331**), organic matter content (r = 0.536**), clay (r = 0.154**), and silt (r = 0.159**) content of sediment. Total Hg was inversely correlated with sand content of sediment (r = −0.205**), pH (r = −0.149*) and Eh (r = −0.155**) (Table 3).

Table 3. Relationship between various soil parameter with methyl Hg and total Hg in sediment samples (n = 543).

Parameter	*MeHg*	*THg*
MeHg	—	0.331**
THg	0.331**	—
OM	0.178**	0.536**
Sand	−0.172**	−0.205**
Silt	0.093*	0.159**
Clay	0.167**	0.154**
pH	−0.132**	−0.149**
Eh	−0.085*	−0.155**
P	0.044	0.204**
K	−0.197**	0.127**
Ca	−0.050	0.019
Mg	−0.171**	0.100*
Na	−0.027	0.054
S	−0.050	0.294**

**Correlation is significant at the 0.01 level (2-tailed test).
*Correlation is significant at the 0.05 level (2-tailed test).

By comparison, in a study of total Hg and methyl Hg along a salinity gradient in the Louisiana Pontchartrain basin estuary, methyl Hg content of sediment was significantly correlated to total Hg (r = 0.648**), organic matter content (r = 0.349**) and inversely correlated to salinity (r = −0.427**).[10] Methyl Hg was also high in sediment with high clay and silt content, but inversely related to sand content.

Kannan et al.[16] in a study of total Hg and methyl Hg in water, sediment, and fish from South Florida estuaries reported methyl Hg concentrations were not correlated with total Hg or organic carbon content in sediments. Kamman et al.[13] in a study of freshwater sediment of water bodies in the Northeast United States reported that methyl Hg was weakly and positively correlated to wetland area and weakly and negatively correlated to drainage area.

In our study we did not examine wetland area or drainage area. Evaluation of the total Hg and methyl Hg data presented in this paper could perhaps be expanded to look at the relationship of drainage area/wetland area and location in relation to potential Hg sources such as power generation facilities in the state.

Sediment levels and fish-eating advisories

The Louisiana Department of Environmental Quality has identified all or designated parts of 40 particular water bodies or systems for which it has issued "Fish Consumption Advisories Caused by Mercury Contamination" for the entire state. This information is given in their web site (http://www.deq.louisiana.gov/portal/tabid/287/Default.aspx) under Mercury Risk Reduction Plan. These include specific lakes, reservoirs, rivers, river drainage basins, bayous, and canals. Though the particular fish species for which the advisories apply varies from water body to water body, more than a dozen fish species are mentioned individually for the 40 water bodies, with bowfin, large mouth bass, and freshwater drum appearing most frequently in the advisories. These advisories are set up for two segments of the population: (1) women of child bearing age and children under 7 years of age, and, (2) other adults and children over the age of 7. By particular types of fish, the advisories recommend the times a month a person can eat fish from these water bodies including the frequencies 0, 1, 2, 4 times, and no restrictions, depending on the water body and the type of fish. For all 40 water body advisories, the date of advisory issue or revision ranged from 29 May 2003 to 8 March 2006.

A comparison was made to determine if there is a relationship between water bodies with fishing advisories and total Hg and methyl Hg in sediments reported in this paper, both sets of data covering the entire state. Table 1 includes levels of total Hg and methyl Hg in 543 sediment samples collected by the Louisiana Department of Environmental Quality between October, 2001 and September, 2007. Some

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Table 4. Mean and standard deviation of total Hg and methyl Hg content in selected sediment samples from fish-eating advisory and non-fish-eating advisory water bodies (>40% of 543 sediment samples included).

Advisory water bodies		*Non-advisory water bodies*	
Sediment Total Hg (μg kg^{-1})	Sediment Methyl Hg (μg kg^{-1})	Sediment Total Hg (μg kg^{-1})	Sediment Methyl Hg (μg kg^{-1})
76 (55)	0.76 (0.85)	98 (70)	0.79 (0.75)

of the 543 sediment samples represent single samples of a site collected during this effort while many sites were sampled multiple times during this period and reported here as the same water body sampled at different dates.

In time sequence of sampling (starting with sediment sample #1 in Table 1), the total Hg and methyl Hg content reported from the sediment sampling sites was put in 1 of 2 data sets, one being sediment samples not associated with water bodies having fish-eating advisories, and the other set including sediment samples associated with fish-eating advisory bodies of water (Table 4). Where a particular sediment sampling site was sampled multiple times during the course of the sampling, data from the entire sampling period were included. Thus some water body sediment sampling sites are represented only once in each data set and others several times. Just over 40% of the 543 sediment sampling sites were included in the advisory data set and no fish-eating advisory data set, thus we feel for this preliminary effort a representative sampling of the sediment Hg data was obtained for making a comparison.

Also in this preliminary study, for the fish species reported most frequently in the advisories (bowfin, largemouth bass, and freshwater drum) for each sediment sampling site, we ranked the frequency of monthly fish eating restrictions to observe possible trends between sediment Hg concentrations and the level of eating restrictions.

In our evaluation of the sediment Hg levels and fish eating advisories, we observed no trends between the two. In the just over 40% of sediment samples included in the data set by the selection process mentioned above, there was no significant difference in sediment Hg levels divided among advisory and non-advisory water bodies.

While there may not be a correlation between sediment levels of Hg and Hg content in fish for sediments containing near background levels of Hg as these sediments apparently do, it is also likely that many sources of variability would make it difficult to find significant correlations should they exist. Sources of variability in sampling fish would include particular sites of water bodies sampled, possible differences in age of fish, time of sampling, and possibly other factors. Sources of variability in reported levels of total Hg and methyl Hg in sediments and the degree to which they are representative of the water body would also include how well particular sampling sites represent the sediment conditions of a water body, time of sampling, and other factors. Thus while the fish-eating advisories are important from a human health perspective based on best sampling and analysis methods available, correlating the advisory water bodies to their total Hg and methyl Hg content is expected to be a difficult task for water bodies with near background levels of Hg.

Conclusion

This study of total Hg and methyl Hg in sediment of Louisiana water bodies showed concentration in most samples were below reported threshold level where toxicity to benthic organisms would occur. The average total Hg content was 92.3 ± 95.1 μg kg^{-1} and the average methyl Hg content in the 543 sediment samples was 0.68 ± 0.80 μg kg^{-1}. These concentrations suggested no significant anthropogenic contamination source. A strong correlation of total Hg and methyl Hg to sediment properties was observed. Even though there are many water bodies in the fish eating advisories where there are data on total Hg and methyl Hg levels in sediment, there was no statistical difference in total Hg and methyl Hg in sediments from these water bodies as compared to other locations with no fish consumption advisories.

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