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PHASE 2 REPORT - REVIEW COPY
FURTHER SITE CHARACTERIZATION AND ANALYSIS

VOLUME 2D - REVISED BASELINE MODELING REPORT

HUDSON RIVER PCBs REASSESSMENT RI/FS

JANUARY 2000

For

U.S. Environmental Protection Agency
Region 2
and
U.S. Army Corps of Engineers
Kansas City District

Volume 2D - Book 4 of 4
Bioaccumulation Models

TAMS Consultants, Inc.
Limno-Tech, Inc.
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Tables

Table 2-1. A Comparison of the BAF Range Predicted by Gobas and Thomann Models

The ratio of the 90th to the 10th percentile of Bioaccumulation Factors (BAF) predicted by the Gobas and Thomann models for a piscivorous fish for a log n-octanol/water partition coefficient (K_{ow}) of 6.5 using the uncertainties of the individual input parameters.

Parameter	Input parameter uncertainty (C.V.,%) (assumed distribution)	Ratio of 90th to 10th percentile predicted BAF/[a]	
		Gobas Model	Thomann Model
K_{ow}	0.2% (log normal)	1.41	2.88
Temperature	10% (normal)	1.15	Not used
Sediment organic carbon	63% (normal)	1.00	Not used
Π_{socw} [A]	15% (log normal)	3.09	2.19
Weight of Piscivorous Fish	50% (normal)	1.05	1.00
Lipid Content of Piscivorous Fish	5% (normal)	1.12	1.10
Feeding Preference of Smelt (Fish)	40% (normal)	1.58	1.05

[A] Ratio of the concentration of chemical in sediment organic carbon to the concentration in overlying water.

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Table 4-1 Count of NYSDEC Hudson River Fish Samples for PCB Aroclor Quantitation Collected between River Miles 142 and 193 by Laboratory and Year

	"Hazleton" (Warnia, Raltech, Hazleton, HES, EnChem)	NYSDEC Hale Creek Field Station	Other Laboratories
1975	0	0	65
1976	0	0	49
1977	179	0	10
1978	142	0	0
1979	163	0	0
1980	216	0	0
1981	149	0	0
1982	194	0	0
1983	203	0	24
1984	249	0	2
1985	166	0	0
1986	209	0	0
1987	65	0	74
1988	246	0	0
1989	45	0	0
1990	132	0	3
1991	0	349	34
1992	10	492	0
1993	302	8	0
1994	225	0	0
1995	251	0	0
1996	182	0	0
1997	20	6	0

Source: 11/17/1998 update to NYSDEC database.

Table 4-2 Aroclor Standards and NYSDEC Rules for Calculating Total PCBs from Analyses Reported by Hazleton and Hale Creek for Upper Hudson River Samples

Laboratory	Years	Aroclor Standards	Total PCB Calculation
Hazleton	1977 - 1990	1221, 1016, 1254	1016 + 1254
Hale Creek	1990 - 1993	1016, 1254/60	1016 + 1254/60
Hazleton	1993 - 1997	1248, 1254, 1260	1248 + 1254 + 1260

Note: A 1242 standard was applied in 1994 (only) by Hazleton for analysis of Lower Hudson fish (not used in this analysis).

Source: Butcher et al. (1997) and personal communications from Ron Sloan (NYSDEC).

Table 4-3 Packed-Column Peaks Used by NYSDEC Contract Laboratory "Hazleton" and Associated PCB Congeners for Upper Hudson Fish Sample Aroclor Quantitation

Year	Aroclor	Packed-Column Peaks (RRT)	Associated PCB Congeners (BZ #)
1977	1016	.37	25,26,28,29,31
		.47	47,48,49,52,75
	1254	1.04	77,110
		1.25	82,107,118,135,144, 149,151
1979	1016	.32	16,24,27,32
		.37	25,26,28,29,3
	1254	.98	85,87,97,119,136
		1.04	77,110
		1.25	82,107,118,135,144, 149,151
		1.46	105,132,146,153
		1.74	129,138,158,175,178
1983	1016	.37	25,26,28,29,31
		.40	20.22.33.45.51.53
	1254	1.25	82,107,118,135,144, 149,151
		1.46	105,132,146,153
		1.74	129,138,158,175,178
1992	1248	.37+.40	20,22,23,25,26,28,29, 31,45,52,53
		.28	15,17,18
		.32	16,24,27,32
	1254	1.25	82,107,118,135,144, 149,151
		1.46	105,132,146,153
		1.74	129,138,158,175,178
		2.03	128,167,183,185,187
	1260	3.72	189,196,198,199,201, 203
		4.48	195,208
		5.28	194,206

Note: Aroclor 1221 quantitations are not used in this analysis and are therefore omitted from this table.

Source: Butcher et al. (1997) and analysis of sample quantitation sheets provided by NYSDEC.

Table 4-4 Weight Percents of Congeners in Packed-Column Peaks Used for "Hazleton" Aroclor Quantitation Schemes, based on Capillary Column Analyses of Aroclor Standards

Year	Aroclor	Weight Percent of PCB Congeners in Quantitation Peaks (%)
1977	1016	32.3
	1254	42.8
1979	1016	27.7
	1254	51.4
1983	1016	34.4
	1254	30.7
1992	1248	23.6
	1254	33.2
	1260	8.2

Table 4-5 NYSDEC Upper Hudson Fish Concentrations as mg/kg-lipid Converted to Tri+ PCBs for Bivariate BAF Analysis

Brown Bullhead

Group	1			2			3			4		
Year	Mean	Median	Count	Mean	Median	Count	Mean	Median	Count	Mean	Median	Count
1977				1987	1852	30				745	667	30
1978										395	385	11
1979				1606	1313	30				373	387	22
1980				1763	1677	30				201	145	21
1981										204	173	30
1982				459	408	20				185	191	10
1983				600	552	20				225	192	24
1984				536	511	20				148	139	19
1985				546	506	19				93	81	18
1986	1513	1299	20	673	568	23				69	62	16
1987	1247	879	24									
1988	1106	1091	20	370	324	20				88	77	23
1989												
1990	1010	734	20	418	278	20						
1991	372	284	18	142	145	20	228	228	2	44	39	3
1992	772	626	20	358	272	24				109	109	2
1993	942	866	9	244	278	8				136	136	5
1994	718	422	19	164	108	15						
1995	341	321	19	162	145	20				100	71	20
1996	356	391	3	114	99	6				92	81	4
1997	250	226	24	515	162	3						

Goldfish

Group	1			2			3			4		
Year	Mean	Median	Count	Mean	Median	Count	Mean	Median	Count	Mean	Median	Count
1977				5710	3863	14						
1978				5385	2644	30				757	277	30
1979												
1980				1462	1244	30						
1981												
1982				357	241	20						
1983				383	269	20						
1984				437	405	11						
1985				364	288	18						
1986	534	537	9	289	289	2						
1987												
1988	410	347	20									
1989												
1990	380	338	9	178	199	4						
1991												
1992	583	567	4									
1993										65	59	4
1994												
1995												
1996												
1997												

Table 4-5 (continued)

Largemouth Bass

Group	1			2			3			4		
Year	Mean	Median	Count	Mean	Median	Count	Mean	Median	Count	Mean	Median	Count
1977				4844	4514	14				1170	1170	2
1978				3497	3260	30						
1979							1516	1215	30			
1980				2084	2125	25						
1981												
1982				1121	998	20						
1983				1166	940	20						
1984	2246	2124	30	957	654	20						
1985	1586	1459	20	1101	931	21						
1986	1603	1647	18	930	825	21						
1987												
1988	1331	1060	20	941	971	20				378	372	19
1989												
1990	2416	2311	20	828	783	20						
1991	1572	1248	6	4 5	456	8	436	403	11	269	275	5
1992	1686	1319	20	438	475	20	217	173	12	264	268	9
1993	2215	1931	20	502	464	20				340	351	6
1994	1236	1128	20	479	447	19						
1995	1077	1100	20	557	543	20				229	196	20
1996	778	771	20	347	312	8				228	174	9
1997	568	569	33	264	223	6				211	181	5

Pumpkinseed

Group	1			2			3			4		
Year	Mean	Median	Count	Mean	Median	Count	Mean	Median	Count	Mean	Median	Count
1977												
1978										608	647	7
1979				1309	1326	16				387	376	22
1980				831	812	25				514	512	26
1981				542	576	49				247	249	38
1982				438	446	43				271	206	37
1983				592	588	45				243	234	53
1984				388	377	25				179	181	25
1985				357	335	22				132	142	8
1986				353	340	21				97	94	24
1987	227	127	11									
1988	338	154	41	242	257	25				68	66	7
1989	954	1007	15	419	434	15				119	115	15
1990	382	310	4									
1991	566	479	11	176	178	12	150	151	10	125	107	11
1992	636	603	12	525	532	17	268	284	8	114	98	15
1993	647	578	21	182	175	36				30	32	3
1994	379	380	29	220	222	31				67	63	10
1995	155	138	24	240	228	20				89	94	16
1996	309	293	31	164	161	30				55	49	12
1997	123	125	30	72	71	8						

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Table 4-5 (continued)

White Perch

Group	1			2			3			4		
Year	Mean	Median	Count	Mean	Median	Count	Mean	Median	Count	Mean	Median	Count
1977										1081	887	30
1978										765	749	30
1979												
1980										376	359	30
1981										516	462	30
1982										382	292	20
1983										340	281	20
1984										349	275	20
1985												
1986												
1987												
1988												
1989												
1990										248	185	20
1991							229	213	18	154	120	17
1992							203	192	21	215	206	20
1993										139	126	20
1994										278	250	19
1995												
1996										103	92	20
1997										126	73	3

Yellow Perch

Group	1			2			3			4		
Year	Mean	Median	Count	Mean	Median	Count	Mean	Median	Count	Mean	Median	Count
1977				2848	2473	30				1772	1150	20
1978										2857	1364	4
1979												
1980				1168	1134	7						
1981												
1982				507	507	2						
1983												
1984				653	589	7						
1985												
1986												
1987												
1988												
1989												
1990												
1991	964	844	10	182	174	12	66	66	2	133	139	6
1992	1433	964	12	513	481	12	362	307	10	283	266	10
1993	2723	2032	20	319	287	4				190	190	2
1994												
1995												
1996												
1997	432	358	3	171	94	3						

Notes: All concentrations converted to consistent estimate of Tri+ PCBs as described in text.
Single-fish samples have been dropped from analysis.
Key to Groups: Group 1 Lower Thompson Island Pool, River Mile 188-193
Group 2 Stillwater area, River Mile 168-176
Group 3 Waterford area, River Mile 155-157
Group 4 Below Federal Dam, River Mile 142-152

Source: Hudson River Database Release 4.1b and NYSDEC November 17, 1998 update to fish database.

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Table 4-6 Assignment of Water Column Concentrations to Fish Sampling Locations in the Upper Hudson River

Year	Thompson Is. Pool RM 188-193	Stillwater RM 168-176	Waterford RM 155-157	Below Federal Dam RM 142-152
1977	USGS-Stillwater	USGS Stillwater	USGS Waterford	USGS Waterford
1978	x 1.292 x CF			x 0.585
1979				
1980				
1981				
1982				
1983				
1984				
1985				
1986				
1987	USGS Ft. Miller			
1988	X 1.0 x CF			
1989				
1990				
1991	GE TID-West	GE Stillwater Bridge	GE Rt. 4 Bridge	GE Rt. 4 Bridge
1992				x 0.585
1993		EPA Stillwater	EPA Waterford FA	EPA Green Island
1994		USGS Stillwater	USGS Waterford	USGS Waterford
1991				x 0.585
1996				
1997		GE Rt. 29 Bridge	GE Rt. 29 Bridge	GE Rt. 29 Bridge
1998		x 0.912	x 0.746	x 0.436

Notes: GE TID-West observations represent nearshore conditions. Estimates for the Thompson Island Pool prior to 1991 from downstream USGS monitoring are corrected to a consistent nearshore basis via a correction factor (CF). CF is set to 1.14 when flow at Fort Edward is less than 4,000 cfs, and 1.0 when flow at Fort Edward is greater than 4,000 cfs.

Source: Hudson River Database Release 4.1b and GE database update of 10/12/1998, Thurston (1998).

Table 4-7 Summer Average Water Column Concentrations of Tri+ PCBs (ng/l) used for Bivariate BAF Analysis

Year	Thompson Is. Pool RM 189-193	Stillwater RM 168-175	Waterford RM 155-160	Below Federal Dam RM 142-155
1977	993.0	681.5	355.0	207.7
1978	755.1	535.7	447.4	261.7
1979	752.7	516.7	364.7	213.3
1980	475.0	323.5	303.8	177.7
1981	266.2	183.3	143.8	84.1
1982	156.0	106.7	135.7	79.4
1983	591.0	447.2	207.7	121.5
1984	373.0	280.0	118.3	69.2
1985	169.9	116.0	98.3	57.5
1986	34.0	24.6	22.5	13.2
1987	30.0	45.0	42.0	24.6
1988	25.2	21.0	23.8	13.9
1989	36.9	42.1	23.2	13.6
1990	56.8	68.8	50.0	29.3
1991	140.4	55.5	37.8	22.1
1992	316.6	129.0	118.3	69.2
1993	106.6	45.4	48.2	24.5
1994	92.3	15.0	20.0	11.7
1995	87.0	34.7	28.7	16.8
1996	43.6	24.3	21.0	12.3
1997	55.9	34.9	28.5	16.7
1998	42.7	38.1	31.2	18.2

Source: Hudson River Database Release 4.1b and GE database update of 10/12/1998, Thurston (1998).

Table 4-8 Annual Average Surface Sediment Tri+ PCB Concentrations (µg/g-OC) used in Bivariate BAF Analysis

Year	Group 1	Group 2	Group 3	Group 4
1977	7221	1429	829	145
1978	6339	1061	693	149
1979	5593	876	598	176
1980	5011	788	539	125
1981	4535	698	491	181
1982	4074	595	437	132
1983	3538	506	389	129
1984	3145	422	345	93
1985	2814	393	316	99
1986	2492	337	281	113
1987	2261	287	250	132
1988	1961	247	225	71
1989	1774	221	202	28
1990	1492	183	179	46
1991	1328	163	162	64
1992	1306	180	158	75
1993	1142	176	150	74
1994	1023	161	137	66
1995	976	154	128	64
1996	868	131	117	50
1997	765	109	105	43

Notes: See text for computation methods.
Key to Groups:
Group 1 Lower Thompson Island Pool, River Mile 188-193
Group 2 Stillwater area, River Mile 168-176
Group 3 Waterford area, River Mile 155-157
Group 4 Below Federal Dam, River Mile 142-152

Source: Output from HUDTOX model as described in the text, except for Group 4, where concentrations through 1992 are estimated from High Resolution Core 11 (Hudson River Database Release 4.1b)

Table 4-9 BAF Models of Mean Tri+ PCB Concentration in NYSDEC Hudson River Fish Samples (mg/kg-Lipid) Regressed on Water Column Concentration Only

Species	Coefficients		Adjusted Multiple R^2 (%)	Standard Error	Log-10 BAF (L/kg-lipid)
	Constant	Water (ppt)			
Brown Bullhead	80.49	1.92	42.1	39.6	6.28
Goldfish	135.5	1.62	33.7	36.8	6.21
Largemouth Bass	287.3	4.20	50.5	51.3	6.62
Pumpkinseed	75.91	1.87	70.9	33.0	6.27
White Perch	111.6	2.21	65.8	20.6	6.34
Yellow Perch	- 0.20*	4.03	71.2	31.7	6.61

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Table 4-10. BAF Models of Mean Tri+ PCB Concentration in NYSDEC Hudson River Fish Samples (mg/kg-Lipid) Regressed on Sediment Concentration Only

Species	Coefficients		Adjusted Multiple R^2 (%)	Standard Error
	Constant	Sediment (μg/g-OC)		
Brown Bullhead	94.9	0.56	52.1	36.0
Goldfish	166.6	0.20*	15.8	41.4
Largemouth Bass	340.8	0.77	51.2	50.9
Pumpkinseed	133.3	0.29	22.0	54.0
White Perch	41.7*	2.19	26.0	30.2
Yellow Perch	38.8*	1.27	54.4	39.9

Notes: * Coefficient not statistically different from zero at 95% confidence level.
Estimates based on 1977-1997 samples from River Miles 142 to 195.
Goldfish model calculated with two outliers deleted (see text)

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Table 4-11. Bivariate BAF Models of Mean Tri+ PCB Concentration in NYSDEC Upper Hudson Fish Samples (mg/kg-Lipid) Regressed on Water Column and Sediment Concentration

Species	Coefficients			Adjusted Multiple R^2 (%)	Standard Error	Log-10 BAF (L/kg-lipid)
	Constant	Sediment (µg/g-OC)	Water (ppt)			
Brown Bullhead	16.4*	0.44	1.38	71.9	27.6	6.14
Goldfish	37.6*	0.19	1.56	50.4	31.8	6.19
Largemouth Bass	192.0	0.55	2.96	72.4	38.3	6.47
Pumpkinseed	55.7	0.13	1.70	74.7	30.7	6.23
White Perch	85.4*	0.37*	2.06	63.8	21.1	6.31
Yellow Perch	-29.2*	0.49*	3.03	74.1	30.0	6.48

Notes: * Coefficient not statistically different from zero at 95% confidence level.
Estimates based on 1977-1997 samples from River Miles 142 to 195.

Table 4-12. Percentage of Variance, Beta Coefficients, and Elasticities for Water and Sediment as Explanatory Variables for Fish PCB Tri+ Body Burden (mg/kg-Lipid) in the Bivariate BAF Models

		Fish Species					
		Brown Bullhead	Goldfish	Largemouth Bass	Pumpkinseed	White Perch	Yellow Perch
Percentage of Variance	Water (ng/l)	42.7	45.6	44.8	68.3	54.6	46.5
	Sediment (mg/g-OC)	52.7	31.0	45.6	14.9	1.7	15.3
Normalized Beta Coefficients	Water (ng/l)	0.47	0.60	0.51	0.77	0.77	0.66
	Sediment (mg/g-OC)	0.58	0.44	0.52	0.22	0.09	0.31
Elasticities	Water (ng/l)	0.46	0.49	0.37	0.57	0.52	0.77
	Sediment (mg/g-OC)	0.46	0.37	0.31	0.16	0.14	0.36

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Table 5-1: Coefficient of Variation in Forage Fish Samples by River Mile from US EPA Dataset

Wet Weight PCB		Lipid Normalized PCB		Lipid Content	
River Mile (*n*)	Coeff of Var	River Mile	Coeff of Var	River Mile	Coeff of Var
113.8 (3)	1.9	113.8	10.0	113.8	11.9
25.8 (3)	9.4	47.3	10.4	47.3	13.3
58.7 (6)	13.1	137.2	11.4	137.2	18.2
47.3 (3)	13.6	122.4	15.8	25.8	20.0
159 (3)	14.6	25.8	17.0	100	20.1
143.5 (7)	18.4	100	21.7	143.5	28.1
191.5 (3)	19.3	143.5	22.9	196.9	34.6
100 (3)	23.2	159	27.1	159	37.7
137.2 (3)	25.6	191.5	29.1	169.5	40.8
88.9 (8)	29.1	169.5	31.0	88.9	42.0
122.4 (3)	29.8	189.5	48.8	122.4	46.0
169.5 (6)	47.0	88.9	61.0	191.5	50.8
189.5 (10)	54.9	TIP	61.4	189.5	65.1
TIP (24)	81.9	194.1	66.2	194.1	69.2
194.1 (11)	91.5	58.7	87.0	TIP	70.0
196.9 (16)	146.1	196.9	95.9	58.7	94.6

Hudson River Database Release 4.1b MCA/TetraTech

Table 5-2: Final Distributions Used in Empirical Probabilistic Model

Ratio	Geometric Mean	Geometric Standard Deviation
BSAF: Biota:Sediment Accumulation Factor	0.74	0.34
Water BAF: Water:Water Column Invertebrate Accumulation Factor*	13.25	0.29
FFBAF: Forage Fish: Diet Accumulation Factor	1.08	1.7
Brown Bullhead BSAF (RM 189)	0.8	0.45
Brown Bullhead BSAF (RM 168)	0.45	0.33
Brown Bullhead BSAF (combined)	0.56	0.59
PiscBAF: Largemouth Bass:Pumpkinseed Accumulation Factor	2.7	1.45

* Water BAF given as LN(average)
All distributions characterized as lognormal

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Table 5-3: Relative Percent Difference Between Predicted and Observed for Empirical Probabilistic Model

River Mile -->>	Largemouth Bass Lipid Normalized 189	Largemouth Bass Lipid Normalized 168	Largemouth Bass Lipid Normalized 155	Brown Bullhead Lipid Normalized 189	Brown Bullhead Lipid Normalized 168	Pumpkinseed Lipid Normalized 189	Pumpkinseed Lipid Normalized 168
1977		-48%					
1978		-46%					
1979			-43%				
1980		-40%					-37%
1981							-8%
1982		-2%					-14%
1983	240%	24%					1%
1984	-25%	47%					5%
1985	-18%	-19%					-11%
1986	-46%	-28%					-34%
1987			-79%			-37%	
1988	-33%	-33%	-68%			-55%	-14%
1989						-72%	-51%
1990	-74%	-20%	-67%			-32%	
1991	-59%	-44%	0%				
1992	-61%	-7%	-46%	-4%	-20%		
1993	-71%	-11%	-50%	-5%	50%	-60%	5%
1994	-55%	-3%		-18%	198%	-49%	-38%
1995	-57%	-28%	-57%	-6%	108%	29%	-38%
1996	-51%	10%	-61%	1%	206%	-50%	-22%
1997							

303913

Table 6-1: Initial Empirical Distributions for FISHRAND

	<<--Triangular Distribution-->>		
Pumpkinseed	MIN	MODE	MAX
Diet: Water (percent)	70	80	90
Diet: Sediment (percent)	10	20	30
Lipid (percent)	0.8	3.3	6.6
Weight (grams)	3.4	18.5	33
Largemouth Bass	MIN	MODE	MAX
Diet: Water (percent)	0	5	10
Diet: Sediment (percent)	5	10	15
Diet:Fish (50% pksd and 50% spottail) (percent)	75	85	90
Lipid (percent)	0.1	1	6.5
Weight (grams)	200	830	2500
Brown Bullhead	MIN	MODE	MAX
Diet: Water (percent)	0	10	15
Diet: Sediment (percent)	85	90	95
Diet:Fish (50% pksd and 50% spottail) (percent)	0	0	5
Lipid (percent)	0.1	2.8	13
Weight (grams)	50	421	970
Spottail Shiner	MIN	MODE	MAX
Diet: Water (percent)	40	70	75
Diet: Sediment (percent)	15	25	60
Diet:Phytoplankton (percent)	0	5	10
Lipid (percent)	0.4	1.2	4
Weight (grams)	0.3	1.5	4
Yellow Perch	MIN	MODE	MAX
Diet: Water (percent)	40	75	90
Diet: Sediment (percent)	10	25	60
Lipid (percent)	1.0	3.4	7.0
Weight (grams)	45	165	610
White Perch	MIN	MODE	MAX
Diet: Water (percent)	0	25	50
Diet: Sediment (percent)	50	75	100
Lipid (percent)	0.5	3.0	14
Weight (grams)	100	157	2200
Phytoplankton	% MIN	% MODE	% MAX
Organic carbon (percent)	0.5	1	5
Benthic invertebrates	% MIN	% MODE	% MAX
Lipid (percent)	0.2	2.2	6
Water column invertebrates	% MIN	% MODE	% MAX
Lipid (percent)	0.00	0.21	0.80
Tri+ PCBs	MIN	MODE	MAX
Log K_{ow}	5.12	6.60	8.30
Sediment	% MIN	% MODE	% MAX
Total organic carbon outside TIP (percent)	0.002	1.86	3.6
Total organic carbon inside TIP (percent)	0.002	2.19	6.9

Bold and italicized parameters indicate calibration parameters

Table 6-2: Empirical, Prior, and Posterior Distributions for RM 189 (Thompson Island Pool)

	Empirical Distribution (Triangular)			Corrected Prior Distribution (LogNormal)			Posterior Distribution (LogNormal)		
Pumpkinseed	MIN	MODE	MAX	Geo. Mean	Stdev		Geo. Mean	Stdev	
Lipid (percent)	0.8	3.3	6.6	3.0	1.2		3.0	1.2	
Largemouth Bass	MIN	MODE	MAX	Geo. Mean	Stdev		Mean[1]	Stdev[1]	
Lipid (percent)	0.1	1.4	11.8	1.4	1.2		1.1	0.3	
				MIN	MODE	MAX	MIN	MODE	MAX
Growth Rate Coefficient[2]		0.01		0	0.008	0.05	0	0.008	0.05
Brown Bullhead	MIN	MODE	MAX	Geo. Mean	Stdev		Geo. Mean	Stdev	
Lipid (percent)	0.1	2.8	13	2.4	1.3		2.3	1.2	
Spottail Shiner	MIN	MODE	MAX	Geo. Mean	Stdev		Geo. Mean	Stdev	
Lipid (percent)	0.4	1.2	4	2.4	1.3		1.4	1.4	
Yellow Perch	MIN	MODE	MAX	Geo. Mean	Stdev		Geo. Mean	Stdev	
Lipid (percent)	1.0	3.4	7.0	1.1	2.1		0.9	1.9	
Tri+ PCBs	MIN	MODE	MAX	MIN	MODE	MAX	MIN	MODE	MAX
Log K_{ow} (189)	5.12	6.60	8.30	5.12	6.60	8.30	5.12	6.60	8.30
Sediment	% MIN	% MODE	% MAX	% MIN	% MODE	% MAX	% MIN	% MODE	% MAX
Total organic carbon inside TIP (percent)	0.5	4.7	10	0.5	4.7	10	0.5	4.7	10

Notes:

1: Largemouth bass posterior lipid distribution is normally distributed.

2: Largemouth bass growth rate coefficient defined as triangular.

Table 6-3: Empirical, Prior, and Posterior Distributions Defined in FISHRAND for RM 168 (Stillwater)

	Empirical Distribution (Triangular)			Corrected Prior Distribution (LogNormal)			Posterior Distribution		
Pumpkinseed	MIN	MODE	MAX	Geo. Mean	Stdev		Geo. Mean	Stdev	
Lipid (percent)	0.8	3.3	6.6	2.7	1.1		2.7	1.1	
				Mean	Stdev		Mean	Stdev	
Growth Rate (Normal Distribution)		0.01		0.01	0.02		0.004	0.001	
Largemouth Bass	MIN	MODE	MAX	Geo. Mean	Stdev		Geo. Mean	Stdev	
Lipid (percent)	0.1	1.4	11.8	0.5	1.2		0.6	1.0	
				Mean	Stdev		Mean	Stdev	
Growth Rate (Normal Distribution)		0.01		0.03	0.009		0.032	0.004	
Brown Bullhead	MIN	MODE	MAX	Geo. Mean	Stdev		Geo. Mean	Stdev	
Lipid (percent)	0.1	2.8	13	2.5	1.2		2.3	1.1	
				Mean	Stdev		Mean	Stdev	
Growth Rate (Normal Distribution)		0.01		0.04	0.02		0.05	0.006	
Spottail Shiner	MIN	MODE	MAX	Geo. Mean	Stdev		Geo. Mean	Stdev	
Lipid (percent)	0.4	1.2	4	0.6	1.5		2.3	1.1	
				Mean	Stdev		Mean	Stdev	
Growth Rate (Normal Distribution)		0.01		0.02	0.02		0.04	0.006	
Yellow Perch	MIN	MODE	MAX	Geo. Mean	Stdev		Geo. Mean	Stdev	
Lipid (percent)	1.0	3.4	7.0	0.6	1.3		0.6	1.2	
				Mean	Stdev		Mean	Stdev	
Growth Rate (Normal Distribution)		0.01		0.02	0.02		0.04	0.008	
Tri+ PCBs	MIN	MODE	MAX	MIN	MODE	MAX	MIN	MODE	MAX
Log K_{ow}	5.12	6.60	8.30	6.30	7.11	8.30	5.12	6.47	8.30
Sediment	% MIN	% MODE	% MAX	MIN		MAX	Avg[1]	Stdev[1]	
Total organic carbon (Uniform)	0.002	1.86	3.6	0.05		2.7	0.91	0.37	

Notes:

1: Posterior TOC distribution defined as Normal with parameters mean and standard deviation.

Table 6-4: Summary of Relative Percent Difference Between Modeled and Observed for FISHRAND

	<<<< ------------		Largemouth Bass		-------------- >>>>		<<<<<< -----------------		Yellow Perch		----------------- >>>>>>>	
River Mile ->	Lipid-Normalized 189	Wet Weight 189	Lipid-Normalized 168	Wet Weight 168	Lipid-Normalized 155	Wet Weight 155	Lipid-Normalized 189	Wet Weight 189	Lipid-Normalized 168	Wet Weight 168	Lipid-Normalized 155	Wet Weight 155
1977			-32%	55%					5%	-2%		
1978			-4%	82%								
1979					11%	31%						
1980			21%	0%								
1981												
1982									65%	-4%		
1983	220%	34%	-7%	-5%								
1984	-8%	1%	45%	-2%					10%	-18%		
1985	58%	48%	62%	-2%								
1986	-22%	13%	26%	-2%								
1987					-35%	-8%						
1988	25%	36%	1%	100%	20%	4%						
1989												
1990	-68%	-12%	-6%	26%	9%	-28%						
1991	-56%	100%	-17%	90%	104%	100%	-1%	53%	2%	57%		
1992	-29%	4%	35%	-36%	-9%	-10%	4%	27%	-5%	-44%	-57%	-38%
1993	24%	-8%	53%	-3%	-7%	-49%	3%	13%	-11%	-61%		
1994	-2%	-16%	45%	-2%								
1995	-30%	-16%	14%	-8%	45%	-23%						
1996	-21%	3%	42%	3%	2%	-3%						

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Table 6-4: Summary of Relative Percent Difference Between Modeled and Observed for FISHRAND

	<<<< --------------		Brown Bullhead		------------------ >>>>	
	Lipid-Normalized	Wet Weight	Lipid-Normalized	Wet Weight	Lipid-Normalized	Wet Weight
River Mile ->	189	189	168	168	155	155
1977			-16%	-56%		
1978			184%	7%		
1979						
1980			-39%	9%		
1981						
1982			49%	39%		
1983			-3%	-6%		
1984			-5%	1%		
1985			12%	-2%		
1986	6%	5%	7%	-11%		
1987	44%	38%			42%	22%
1988	5%	41%	16%	1%		
1989						
1990	14%	2%	2%	-30%		
1991	38%		-8%	34%	24%	188%
1992	-39%	12%	-24%	-38%		
1993	-29%	-11%	-1%	-6%		
1994	53%	8%	78%	30%		
1995	89%	-1%	23%	-1%		
1996	29%	6%	66%	-5%		

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Table 6-4: Summary of Relative Percent Difference Between Modeled and Observed for FISHRAND

	<<-- White Perch -->>		<<< ------ Pumpkinseed ------ >>>			
River Mile ->	Lipid-Normalized 155	Wet Weight 155	Lipid-Normalized 189	Wet Weight 189	Lipid-Normalized 168	Wet Weight 168
1977						
1978						
1979						
1980					-10%	-1%
1981					18%	-3%
1982					28%	36%
1983					-9%	12%
1984					21%	19%
1985					22%	18%
1986					-2%	14%
1987	7%	1%	26%	60%		
1988			-10%	22%	0%	3%
1989			-56%	-53%	-49%	-18%
1990			38%	14%		
1991	26%	-10%				
1992	-71%	-32%				
1993			16%	4%	19%	26%
1994			26%	7%	-18%	-18%
1995					-26%	-22%
1996			-15%	-9%	-10%	-8%

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Table 6-5: Posterior Distributions Defined in FISHRAND for RM 168 (Stillwater) Using Full Dataset and pre-1990 Only Dataset in Partial Validation

	Posterior Distribution Using Full Dataset			Posterior Distribution Using pre-1990 Data		
Pumpkinseed	Geo. Mean	Stdev		Geo. Mean	Stdev	
Lipid (percent)	2.7	1.1		2.7	1.1	
	Mean	Stdev		Mean	Stdev	
Growth Rate (Normal Distribution)	0.004	0.001		0.004	0.001	
Largemouth Bass	Geo. Mean	Stdev		Geo. Mean	Stdev	
Lipid (percent)	0.6	1.0		***0.6***	***1.5***	
	Mean	Stdev		Mean	Stdev	
Growth Rate (Normal Distribution)	0.032	0.004		0.032	0.004	
Brown Bullhead	Geo. Mean	Stdev		Geo. Mean	Stdev	
Lipid (percent)	2.3	1.1		2.3	1.1	
	Mean	Stdev		Mean	Stdev	
Growth Rate (Normal Distribution)	0.05	0.006		0.05	0.006	
Spottail Shiner	Geo. Mean	Stdev		Geo. Mean	Stdev	
Lipid (percent)	2.3	1.1		2.3	1.1	
	Mean	Stdev		Mean	Stdev	
Growth Rate (Normal Distribution)	0.04	0.006		0.04	0.006	
Yellow Perch	Geo. Mean	Stdev		Geo. Mean	Stdev	
Lipid (percent)	0.6	1.2		0.6	1.2	
	Mean	Stdev		Mean	Stdev	
Growth Rate (Normal Distribution)	0.04	0.008		0.04	0.008	
Tri+ PCBs	MIN	MODE	MAX	MIN	MODE	MAX
Log K_{ow}	5.12	6.47	8.30	5.12	***6.34***	8.30
Sediment	Avg[1]	Stdev[1]		Avg[1]	Stdev[1]	
Total organic carbon	0.91	0.37		***1.65***	***1.30***	

Notes:

1: Posterior TOC distribution defined as Normal with parameters mean and standard deviation.

Bold and italicized values indicate differences between full dataset and partial dataset.

Table 6-6: Difference in Wet Weight ppm Between Forecasts using Partial Dataset Calibration Results as Compared to Concentrations Obtained Using Full Dataset Calibration Results

Year	LMB 25th	LMB median	LMB 95th	BB 25th	BB median	BB 95th	YP 25th	YP median	YP 95th
1998	0.65	1.55	2.58	-0.23	0.43	2.56	-0.19	0.10	1.01
1999	0.36	1.18	2.37	-0.11	0.36	2.37	-0.21	0.06	0.71
2000	0.22	1.01	2.06	-0.05	0.33	1.97	-0.14	0.15	0.86
2001	0.22	0.82	1.71	-0.06	0.28	1.67	-0.16	0.09	0.59
2002	0.17	0.74	1.52	-0.06	0.23	1.48	-0.15	0.04	0.46
2003	0.31	0.69	1.40	-0.10	0.17	1.47	-0.06	0.06	0.54
2004	0.25	0.70	1.34	-0.08	0.18	1.38	-0.10	0.04	0.40
2005	0.18	0.63	1.25	-0.06	0.18	1.22	-0.10	0.07	0.41
2006	0.18	0.53	1.12	-0.07	0.15	1.12	-0.08	0.05	0.38
2007	0.17	0.48	1.02	-0.07	0.14	1.05	-0.08	0.05	0.34
2008	0.18	0.52	0.99	-0.06	0.13	1.02	-0.08	0.02	0.30
2009	0.18	0.49	0.95	-0.06	0.13	0.93	-0.07	0.04	0.28
2010	0.11	0.41	0.84	-0.04	0.12	0.82	-0.07	0.04	0.27
2011	0.14	0.37	0.79	-0.05	0.11	0.75	-0.05	0.04	0.25
2012	0.09	0.35	0.72	-0.04	0.10	0.67	-0.07	0.01	0.18
2013	0.17	0.37	0.69	-0.06	0.06	0.69	-0.03	0.04	0.28
2014	0.15	0.38	0.70	-0.06	0.09	0.76	-0.03	0.04	0.28
2015	0.13	0.36	0.68	-0.05	0.08	0.76	-0.03	0.04	0.27
2016	0.13	0.38	0.69	-0.05	0.09	0.75	-0.06	0.03	0.23
2017	0.19	0.40	0.67	-0.05	0.09	0.70	-0.05	0.04	0.22
2018	0.12	0.29	0.59	0.00	0.10	0.84	0.00	0.07	0.32
2019	0.12	0.34	0.65	-0.04	0.08	0.71	-0.04	0.02	0.20
2020	0.11	0.30	0.59	-0.04	0.08	0.68	-0.04	0.02	0.20
2021	0.09	0.29	0.53	-0.04	0.07	0.64	-0.05	0.01	0.18
2022	0.12	0.29	0.54	-0.04	0.06	0.60	-0.03	0.03	0.19
2023	0.11	0.29	0.55	-0.04	0.07	0.60	-0.03	0.02	0.17
2024	0.09	0.27	0.50	-0.03	0.07	0.57	-0.05	0.01	0.15
2025	0.09	0.25	0.46	-0.03	0.06	0.53	-0.04	0.01	0.15
2026	0.10	0.23	0.44	-0.03	0.05	0.49	-0.02	0.03	0.18
2027	0.09	0.24	0.46	-0.03	0.05	0.50	-0.03	0.02	0.15
2028	0.09	0.23	0.45	-0.03	0.05	0.49	-0.03	0.02	0.15
2029	0.09	0.22	0.44	-0.03	0.05	0.48	-0.03	0.02	0.15
2030	0.08	0.22	0.42	-0.02	0.06	0.48	-0.04	0.01	0.12
2031	0.10	0.22	0.42	-0.03	0.04	0.42	-0.01	0.03	0.16
2032	0.08	0.21	0.41	-0.03	0.04	0.43	-0.03	0.02	0.14
2033	0.08	0.20	0.40	-0.03	0.04	0.43	-0.03	0.02	0.14
2034	0.08	0.20	0.39	-0.03	0.04	0.42	-0.02	0.02	0.14
2035	0.08	0.19	0.38	-0.03	0.04	0.41	-0.03	0.02	0.13
2036	0.07	0.20	0.37	-0.02	0.05	0.41	-0.03	0.01	0.11
2037	0.07	0.20	0.37	-0.02	0.04	0.38	-0.02	0.02	0.11
2038	0.08	0.18	0.35	-0.03	0.03	0.34	-0.01	0.03	0.16
2039	0.11	0.20	0.37	-0.03	0.03	0.31	-0.01	0.03	0.17
2040	0.12	0.24	0.46	-0.03	0.04	0.38	-0.01	0.04	0.19
2041	0.09	0.26	0.49	-0.03	0.06	0.48	-0.04	0.02	0.13

Table 6-6: Difference in Wet Weight ppm Between Forecasts using Partial Dataset Calibration Results as Compared to Concentrations Obtained Using Full Dataset Calibration Results

Year	LMB 25th	LMB median	LMB 95th	BB 25th	BB median	BB 95th	YP 25th	YP median	YP 95th
2042	0.10	0.27	0.49	-0.03	0.06	0.47	-0.03	0.02	0.14
2043	0.10	0.24	0.46	-0.04	0.04	0.37	-0.02	0.02	0.18
2044	0.10	0.24	0.45	-0.04	0.06	0.43	-0.02	0.03	0.19
2045	0.10	0.25	0.47	-0.04	0.06	0.53	-0.02	0.03	0.18
2046	0.09	0.24	0.46	-0.04	0.05	0.54	-0.03	0.02	0.16
2047	0.10	0.24	0.45	-0.04	0.05	0.47	-0.02	0.03	0.20
2048	0.09	0.25	0.46	-0.04	0.05	0.51	-0.03	0.03	0.19
2049	0.09	0.25	0.47	-0.03	0.06	0.55	-0.03	0.02	0.16
2050	0.09	0.23	0.45	-0.03	0.05	0.52	-0.03	0.02	0.15
2051	0.07	0.22	0.41	-0.03	0.05	0.49	-0.04	0.01	0.13
2052	0.08	0.22	0.42	-0.03	0.04	0.46	-0.02	0.03	0.16
2053	0.08	0.21	0.41	-0.03	0.04	0.45	-0.02	0.02	0.14
2054	0.08	0.21	0.40	-0.03	0.04	0.44	-0.02	0.02	0.13
2055	0.08	0.20	0.39	-0.03	0.04	0.42	-0.02	0.02	0.14
2056	0.07	0.20	0.38	-0.03	0.04	0.42	-0.03	0.01	0.13
2057	0.08	0.20	0.38	-0.03	0.04	0.42	-0.02	0.02	0.14
2058	0.07	0.20	0.38	-0.03	0.04	0.41	-0.02	0.02	0.13
2059	0.06	0.18	0.34	-0.02	0.04	0.40	-0.03	0.01	0.11
2060	0.06	0.18	0.34	-0.02	0.04	0.38	-0.03	0.01	0.11
2061	0.07	0.18	0.34	-0.02	0.04	0.36	-0.02	0.02	0.12
2062	0.06	0.18	0.32	-0.02	0.04	0.35	-0.02	0.01	0.11
2063	0.06	0.17	0.32	-0.02	0.03	0.35	-0.02	0.01	0.10
2064	0.07	0.18	0.32	-0.02	0.03	0.33	-0.01	0.03	0.12
2065	0.06	0.18	0.33	-0.02	0.04	0.36	-0.03	0.01	0.10
2066	0.08	0.17	0.33	-0.02	0.03	0.33	-0.01	0.03	0.14
2067	0.07	0.19	0.32	-0.07	-0.01	0.34	-0.01	0.02	0.12

Values shown are the difference between forecasts predicted using partial dataset calibration results and concentrations obtained using full dataset calibration results expressed as ppm wet weight.

Table 6-7: Relative Importance of Sediment vs. Water Pathways from FISHRAND Regression

		Combined Results				
		Brown Bullhead	Largemouth Bass	Pumpkinseed	White Perch	Yellow Perch
Percent Contributions	Water (ng/l)	4.6	27.3	76.7	NA	63.8
	Sediment (mg/kg)	95.4	72.7	23.3	NA	36.2
Normalized Beta Coefficients	Water (ng/l)	0.09	0.30	0.85	NA	0.72
	Sediment (mg/kg)	0.88	0.68	0.20	NA	0.35
Elasticities	Water (ng/l)	0.09	0.31	0.81	NA	0.67
	Sediment (mg/kg)	0.94	0.71	0.19	NA	0.32

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Table 7-1: Asymptotic Tri+ PCB Concentrations for Standard Fillet Approached by Fish Body Burden Forecasts

	<< ----- Largemouth Bass ----->>				<<----- Brown Bullhead ----->>				<<----- Yellow Perch[1] ----->>			
	Median	Confidence Interval[2]	95th percentile	Confidence Interval[2]	Median	Confidence Interval[2]	95th percentile	Confidence Interval[2]	Median	Confidence Interval[2]	95th percentile	Confidence Interval[2]
River Mile 189												
0 ng/L	0.05	(0.03 - 0.08)	0.1	(0.05 - 0.2)	0.1	(0.06 - 0.12)	0.2	(0.1 - 0.24)	0.05	(0.03 - 0.06)	0.1	(0.05 - 0.11)
10 ng/L	1.5	(0.8 - 2.3)	3.4	(1.7 - 5.1)	0.7	(0.4 - 0.8)	1.1	(0.6 - 1.3)	1.4	(0.7 - 1.5)	3.5	(1.8 - 3.9)
30 ng/L	3.5	(1.8 - 5.3)	8.1	(4.1 - 12.2)	1.8	(1.0 - 2.2)	2.6	(1.4 - 3.1)	3.8	(1.9 - 4.2)	6.1	(3.1 - 6.7)
River Mile 168					<<----- Brown Bullhead ----->>				<<----- Yellow Perch[1] ----->>			
0 ng/L	0.02	(0.005 - 0.06)	0.03	(0.008 - 0.09)	0.02	(0.01 - 0.04)	0.03	(0.015 - 0.06)	0.01	(0.005 - 0.02)	0.02	(0.01 - 0.04)
10 ng/L	0.3	(0.08 - 0.9)	0.4	(0.1 - 1.2)	0.6	(0.3 - 1.2)	0.9	(0.5 - 1.8)	0.2	(0.1 - 0.4)	0.3	(0.15 - 0.6)
30 ng/L	1	(0.3 - 3)	2.3	(0.6 - 7)	1.5	(0.8 - 3.0)	2.6	(1.4 - 5.2)	0.7	(0.4 - 1.4)	1.5	(0.8 - 3.0)
River Mile 154					<<----- Brown Bullhead ----->>				<<----- White Perch[1] ----->>			
0 ng/L	0.01	(0.007 - 0.02)	0.01	(0.007 - 0.02)	0.01	(0.005 - 0.02)	0.02	(0.01 - 0.04)	0.01	(0.005 - 0.02)	0.02	(0.01 - 0.04)
10 ng/L	0.1	(0.07 - 0.2)	0.2	(0.1 - 0.4)	0.2	(0.1 - 0.4)	0.3	(0.15 - 0.6)	0.2	(0.1 - 0.4)	0.4	(0.2 - 0.8)
30 ng/L	0.4	(0.3 - 0.8)	0.5	(0.3 - 1.0)	0.6	(0.3 - 1.2)	0.9	(0.5 - 1.8)	0.6	(0.3 - 1.2)	1.2	(0.6 - 2.4)

Notes:
1 -- Yellow Perch for river miles 189 and 168; white perch for river mile 154.
2 -- Confidence intervals estimated from maximum and minimum relative percent difference (Table 6-2)

Table 7-2: Year by Which Selected Targets Levels are Achieved Under the 10 ng/L Upstream Boundary Condition Using FISHRAND

		Geometric Mean				95th Percentile			
Species	River Mile	2.0	1.1	0.2	0.02	2.0	1.1	0.2	0.02
Largemouth Bass	189	2010 - 2026 (2017)	2038[a]	--	--	2059[b]	--	--	--
Largemouth Bass	168	1998 - 2005 (2002)	2003 - 2010 (2006)	2058[a]	--	2000 - 2007 (2003)	2005 - 2020 (2010)	--	--
Largemouth Bass	155	2000[b]	2005[b]	2016 - 2029 (2022)	--	b	1998 - 2005 (2000)	2028 - 2037 (2032)	--
Brown Bullhead	189	2009 - 2020 (2013)	2017 - 2030 (2020)	--	--	2014 - 2030 (2021)	2025 - 2050 (2030)	--	--
Brown Bullhead	168	2001 - 2010 (2005)	2008 - 2027 (2015)	--	--	2006 - 2024 (2015)	2020 - 2035 (2025)	--	--
Brown Bullhead	155	2001[b]	1998 - 2006 (2003)	2020 - 2024[c]	--	2002 - 2005 (2003)	2004 - 2013 (2008)	2040[a]	--
Yellow Perch	189	2006 - 2020 (2018)	2020[a]	--	--	2010 - 2025 (2014)	2050[a]	--	--
Yellow Perch	168	2002[b]	2010[b]	2055 - 2067 (2060)	--	1998 - 2013 (2005)	2002 - 2020 (2012)	2045[a]	--
Yellow Perch	155	b	2002[b]	2007 - 2020 (2012)	--	2003[b]	1998 - 2009 (2002)	2020 - 2039 (2030)	--
White Perch	155	2000[b]	2001 - 2006 (2003)	2025 - 2045 (2032)	--	2002 - 2008 (2005)	2009 - 2015 (2012)	2050[a]	--

Notes:
Value in parentheses represents best estimate. Range shown reflects uncertainty in the best estimate.
--: does not achieve specified level by end of modeling period (2067)
a: Lower bound approaches column value asymptotically starting this year; best estimate and upper bound asymptote slightly exceed this value (see Table 7-1)
b: Median concentrations already at this level at start of modeling period (1998); year shown represents upper error bound
c: Predicted concentrations approach this column value asymptotically (see Table 7-1); years shown are earliest and latest this is predicted to occur

303925

Table 8-1: Results of Sensitivity Analysis for Spearman Rank Correlation -- Lipid Normalized

Mile	Species	Fish % Lipid	Epiphyte % Lipid	Benthic % Lipid	Kow	Organic Carbon in Sediment	Percent Diet
189	YP	**-0.516**	0.434	0.223	0.207	-0.277	-0.120 (E)
	PK	-0.477	**0.534**	0.185	0.343	-0.199	----
	LMB	**-0.620**	0.247	0.151	-0.083	-0.193	0.056 (B)
	SPOT	**-0.541**	0.266	0.254	0.180	-0.273	0.084 (P)
	BB	-0.418	----	0.341	-0.182	-0.366	----
	WP	**-0.502**	0.103	0.311	-0.128	-0.357	-0.052 (E)
168	YP	**-0.515**	**0.531**	0.113	0.376	-0.065	----
	PK	-0.425	**0.574**	0.073	0.464	----	----
	LMB	**-0.630**	0.318	0.078	----	-0.065	----
	SPOT	**-0.580**	0.366	0.134	0.379	-0.09	0.110 (P)
	BB	**-0.535**	0.059	0.393	-0.163	-0.264	----
	WP	**-0.623**	0.204	0.294	----	-0.225	----
157	YP	-0.493	**0.540**	0.080	0.403	----	----
	PK	-0.411	**0.580**	----	0.486	----	----
	LMB	**-0.621**	0.33	0.054	----	----	----
	SPOT	**-0.561**	0.377	0.089	0.416	-0.058	0.119 (P)
	BB	**-0.556**	0.086	0.375	-0.124	-0.250	----
	WP	**-0.628**	0.245	0.25	0.061	-0.195	0.059 (E)
154	YP	-0.496	**0.520**	0.096	0.372	-0.050	----
	PK	-0.403	**0.556**	0.065	0.441	----	----
	LMB	**-0.624**	0.323	0.070	----	-0.061	----
	SPOT	**-0.538**	0.353	0.119	0.363	-0.080	0.109 (P)
	BB	**-0.541**	0.067	0.387	-0.149	-0.261	----
	WP	**-0.622**	0.219	0.278	----	-0.219	----

Notes:
(E): Percent of diet consisting of water column invertebrates
(B): Percent of diet consisting of benthic invertebrates
(P): Percent of diet consisting of phytoplankton

303926

Table 8-2: Results of Sensitivity Analysis for Partial Rank Correlation -- Lipid Normalized

Mile	Species	Fish % Lipid	Epiphyte % Lipid	Benthic % Lipid	Kow	Organic Carbon in Sediment	Percent Diet
189	YP	**-0.525**	**0.503**	0.269	0.291	-0.286	-0.098 (E)
	PK	-0.463	**0.54**	0.219	0.393	-0.220	0.055 (B)
	LMB	**-0.818**	0.327	0.227	-0.084	-0.223	----
	SPOT	**-0.618**	0.304	0.288	0.298	-0.287	0.091 (P)
	BB	**-0.562**	0.073	0.490	-0.255	-0.457	----
	WP	**-0.675**	0.158	0.418	-0.130	-0.400	----
168	YP	**-0.516**	**0.567**	0.150	0.459	-0.115	----
	PK	-0.414	**0.579**	0.114	0.540	-0.066	----
	LMB	**-0.832**	0.408	0.139	----	-0.084	----
	SPOT	**-0.612**	0.365	0.172	0.471	-0.117	0.103 (P)
	BB	**-0.684**	0.135	0.497	-0.205	-0.318	----
	WP	**-0.775**	0.265	0.360	----	-0.246	----
157	YP	-0.488	**0.578**	0.109	**0.503**	-0.086	----
	PK	-0.389	**0.579**	0.078	**0.566**	----	----
	LMB	**-0.819**	0.425	0.104	0.087	-0.066	----
	SPOT	**-0.585**	0.377	0.122	**0.518**	-0.084	0.109 (P)
	BB	**-0.71**	0.173	0.467	-0.151	-0.301	----
	WP	**-0.776**	0.311	0.309	0.081	-0.214	0.077 (E)
154	YP	**-0.502**	**0.564**	0.134	0.467	-0.111	----
	PK	-0.395	**0.563**	0.098	**0.542**	-0.061	----
	LMB	**-0.814**	0.415	0.122	0.060	-0.085	----
	SPOT	**-0.573**	0.359	0.155	0.477	-0.109	0.111 (P)
	BB	**-0.689**	0.147	0.488	-0.191	-0.315	----
	WP	**-0.771**	0.281	0.345	----	-0.235	----

Notes:
(E): Percent of diet consisting of water column invertebrates
(B): Percent of diet consisting of benthic invertebrates
(P): Percent of diet consisting of phytoplankton

303927

Table 8-3: Results of Sensitivity Analysis for Spearman Rank Correlation -- Wet Weight

Mile	Species	Fish % Lipid	Epiphyte % Lipid	Benthic % Lipid	Kow	Organic Carbon in Sediment	Percent Diet
189	YP	**0.584**	0.297	0.276	-0.363	0.133 (B)	----
	PK	**0.641**	0.232	0.411	-0.251	0.057 (B)	----
	LMB	0.497	0.382	-0.195	-0.429	0.052 (P)	----
	SPOT	0.386	0.368	0.254	-0.398	0.137 (P)	0.087
	BB	0.052	0.483	-0.295	**-0.563**	----	----
	WP	0.136	0.463	-0.214	**-0.550**	-0.103 (E)	----
168	YP	**0.706**	0.144	**0.502**	-0.097	----	----
	PK	**0.684**	0.098	**0.551**	-0.056	----	----
	LMB	0.246	0.246	----	-0.157	0.081 (P)	----
	SPOT	**0.546**	0.212	**0.553**	-0.132	0.182 (P)	0.079
	BB	0.149	**0.685**	-0.318	-0.495	----	----
	WP	0.426	**0.596**	----	-0.446	----	----
157	YP	**0.703**	0.098	**0.528**	-0.060	0.061 (E)	----
	PK	**0.679**	0.066	**0.566**	----	----	----
	LMB	**0.800**	0.175	0.111	-0.109	0.088 (P)	----
	SPOT	**0.551**	0.145	**0.597**	-0.081	0.178 (P)	0.073
	BB	0.209	**0.685**	-0.264	-0.491	0.051 (E)	----
	WP	**0.529**	**0.515**	0.110	-0.379	----	----
154	YP	**0.686**	0.121	0.492	-0.084	----	----
	PK	**0.650**	0.080	**0.516**	----	----	----
	LMB	**0.749**	0.197	0.073	-0.140	0.078 (P)	----
	SPOT	0.496	0.173	**0.501**	-0.103	0.176 (P)	0.076
	BB	0.167	0.680	-0.300	-0.495	----	----
	WP	0.456	0.557	----	-0.421	0.070 (E)	----

Notes:
(E): Percent of diet consisting of water column invertebrates
(B): Percent of diet consisting of benthic invertebrates
(P): Percent of diet consisting of phytoplankton

303928

Table 8-4: Results of Sensitivity Analysis for Partial Rank Correlation -- Wet Weight

Mile	Species	Fish % Lipid	Epiphyte % Lipid	Benthic % Lipid	Kow	Organic Carbon in Sediment	Percent Diet
189	YP	**0.611**	0.319	0.338	-0.336	0.119 (B)	----
	PK	**0.638**	0.244	0.447	-0.253	----	----
	LMB	**0.593**	0.400	-0.153	-0.390	0.059 (P)	----
	SPOT	0.434	0.388	0.364	-0.371	0.127 (P)	0.112
	BB	0.078	**0.636**	-0.318	**-0.586**	----	----
	WP	0.234	**0.608**	-0.186	**-0.578**	----	----
168	YP	**0.684**	0.173	**0.541**	-0.122	----	----
	PK	**0.662**	0.118	**0.599**	-0.080	----	----
	LMB	**0.781**	0.248	0.085	-0.151	0.065 (P)	----
	SPOT	**0.529**	0.222	**0.594**	-0.147	0.139 (P)	0.09
	BB	0.182	**0.750**	-0.299	-0.475	----	----
	WP	0.464	**0.614**	----	-0.416	0.075 (E)	----
157	YP	**0.681**	0.122	**0.580**	-0.087	----	----
	PK	**0.655**	0.081	**0.624**	-0.055	----	----
	LMB	**0.801**	0.181	0.158	-0.109	0.068 (P)	----
	SPOT	**0.530**	0.152	**0.648**	-0.101	0.131 (P)	0.081
	BB	0.251	**0.736**	-0.229	-0.468	0.061 (E)	----
	WP	**0.544**	**0.525**	0.141	-0.362	0.132 (E)	----
154	YP	**0.670**	0.155	**0.546**	-0.115	----	----
	PK	**0.638**	0.103	**0.594**	-0.076	----	----
	LMB	**0.771**	0.217	0.109	-0.139	0.063 (P)	----
	SPOT	0.494	0.190	**0.577**	-0.127	0.144 (P)	0.091
	BB	0.202	**0.740**	-0.277	-0.472	----	----
	WP	0.481	**0.583**	----	-0.395	0.084 (E)	----

Notes:
(E): Percent of diet consisting of water column invertebrates
(B): Percent of diet consisting of benthic invertebrates
(P): Percent of diet consisting of phytoplankton

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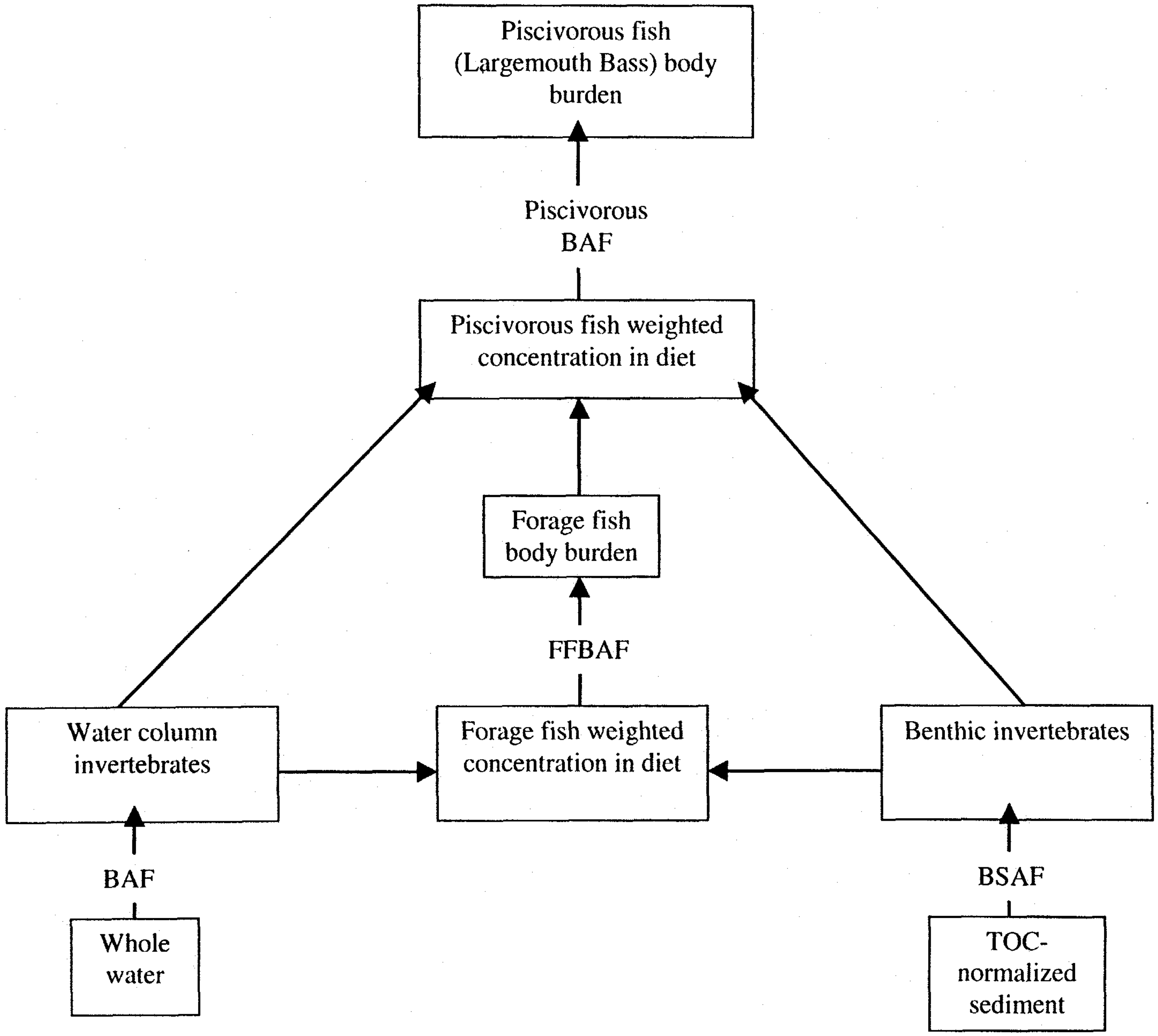
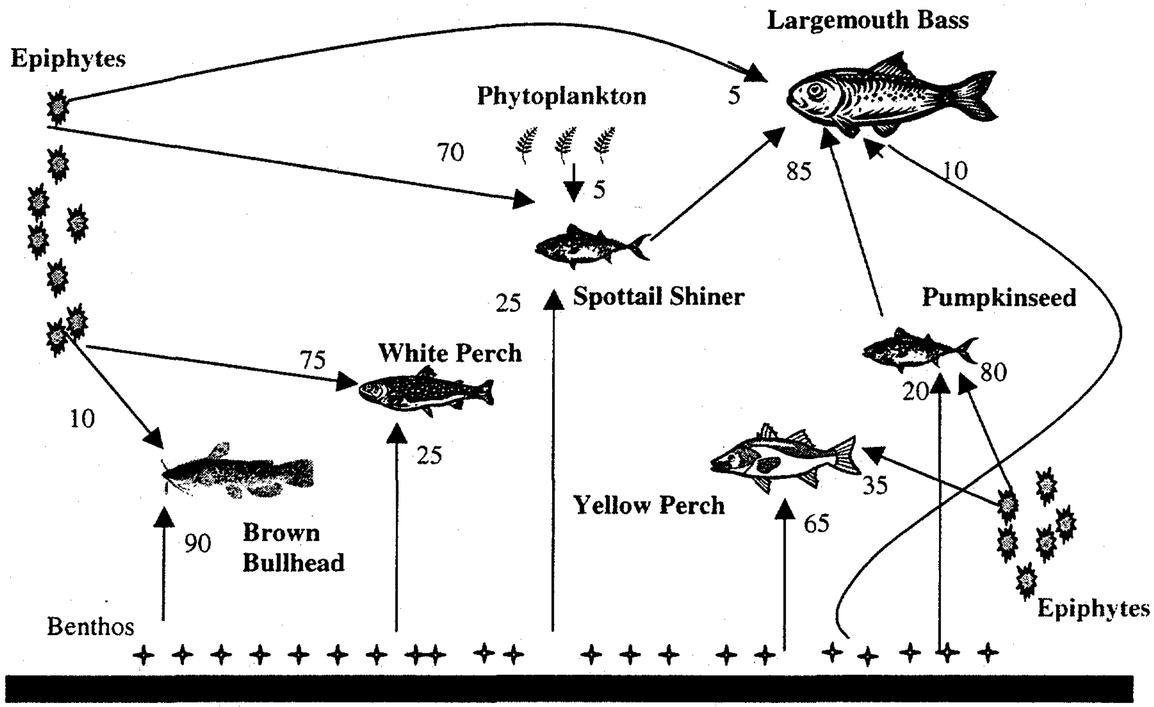
Figures

Figure 3-1: Conceptual Framework for Empirical Probabilistic Model



MCA/TetraTech

Figure 3-2 Conceptual Schematic of FISHRAND Model



Epiphytes	
Benthic Invertebrates	
Phytoplankton	

NOTE: Icons for fish species are for descriptive purposes; resemblance to actual species is not implied.

303932

Figure 3- 3 Comparison of FISHRAND, FISHPATH and Gobas Field Measurements for Lake Ontario

Mean water temperature , C..

Organic content of the water, kg/l...................................

Organic carbon content of the sediments, %...............

Density of lipids, kg/l...

Density of organic carbon, kg/l......................................

Metabolic transformation rate constant, 1/day...........

Octanol-water partition coefficient ....

Total water concentration, ng/l......................................

Sediment concentration, ng/g dw...............................

Phytoplankton

Lipid content,%...

Zooplankton

Lipid content,%...

Pontoreia

Lipid content,%...

Oligochaetes

Lipid content,%...

Sculpin

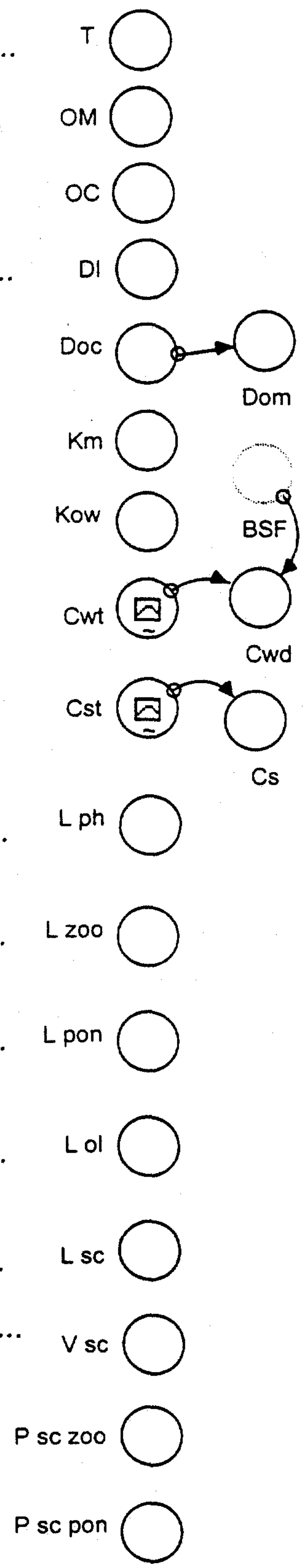
Lipid content,%...

Weight, g...

Diet,%

Zooplankton..

Pontoreia...



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Alewife

Lipid content,%.. L ale ◯

Weight, g.. V ale ◯

Diet,%

Zooplankton... P ale zoo ◯

Pontoreia... P ale pon ◯

Smelt

Lipid content,%.. L sm ◯

Weight, V sm ◯

Diet,%

Zooplankton... P sm zoo ◯

Pontoreia... P sm pon ◯

Sculpin... P sm sc ◯

Salmonids

Lipid content,%.. L sal ◯

Weight, g.. V sal ◯

Diet,%

Sculpin... P sal sc ◯

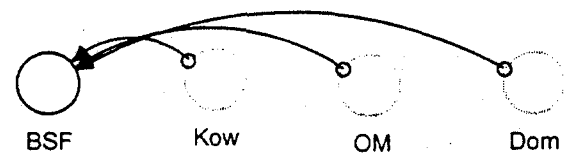
Alewife... P sal ale ◯

Smelt... P sal sm ◯

303934

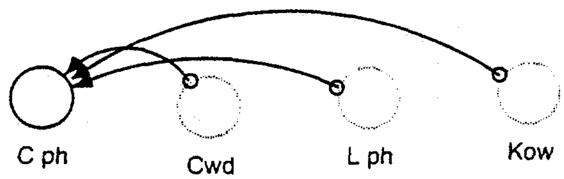
BIOAVAILABILITY:

BSF	4.75e-001

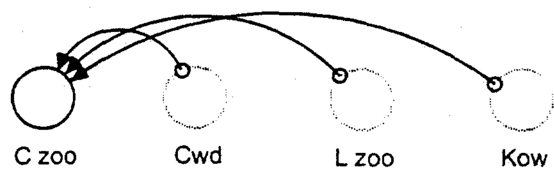


BIOACCUMULATION IN AQUATIC MICROPHYTES:

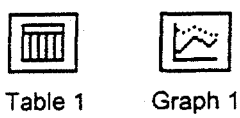
Cp=Cwd*(Lp/100)*Kow [kg/kg]



Phytoplankton



Zooplankton



Gobas,1993, ug/g

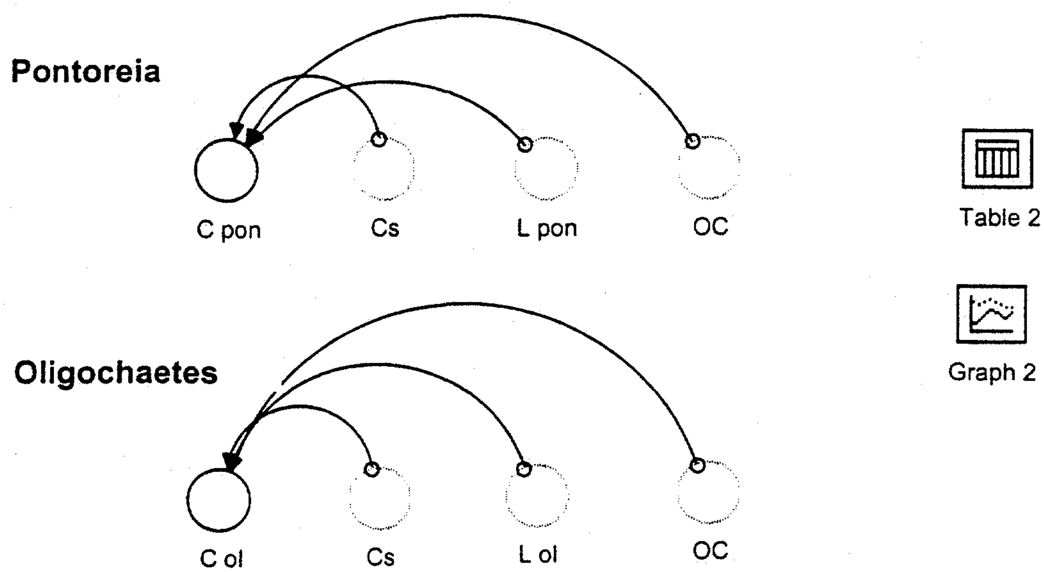
	Predicted	Observed	FISHRAND, Steady-State
Phytoplankton	0.011	0.05	0.0104
Mysids	0.11	0.33	0.104

FISHPATH, Steady-State
kg/kg

C ph	1.04e-008
C zoo	1.04e-007

303935

BIOACCUMULATION IN BENTHIC INTERBRATES: Cb=Cs*Lb/OC [kg/kg]



Gobas,1993, 1e-6g/g

	Predicted	Observed	FISHRAND, Steady-State
Pontoreia	0.86	0.79	0.855
Oligochaetes	0.29	0.18	0.285

FISHPATH, Steady-State
kg/kg

C pon	8.55e-007
C ol	2.85e-007

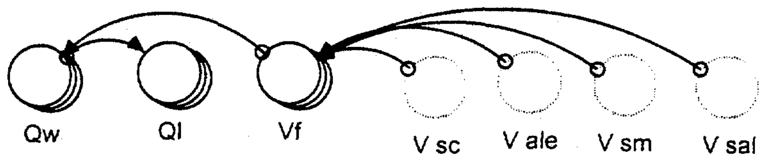
303936

BIOACCUMULATION IN FISH   Cf [kg/kg] :

Note: we use one dimensional array to describe various fish species

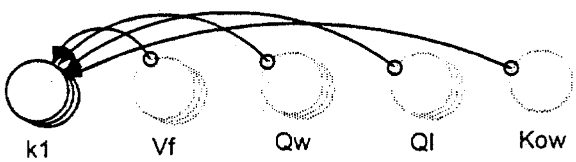
1) Transport rates in aqueous and lipid phases [liters/day]

Qw=88.3*Vf^0.6;   Ql=Qw/100;   Vf in kg



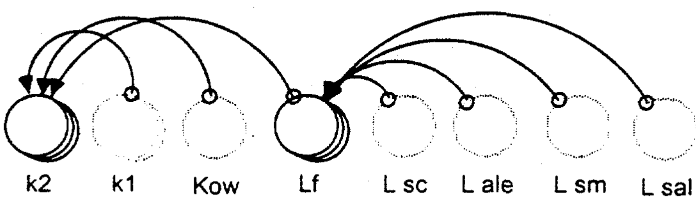
Qw[Sculpin]	3.85e+000
Qw[Alewife]	1.12e+001
Qw[Smelt]	7.39e+000
Qw[Salmonides]	1.50e+002

2) Gill uptake rate constant   k1=1/(Vf/Qw+Vf/(Ql*Kow))) [l/kg/day]



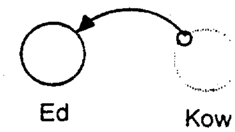
k1[Sculpin]	7.13e+002
k1[Alewife]	3.50e+002
k1[Smelt]	4.62e+002
k1[Salmonides]	6.21e+001

3) Gill elimination rate constant   k2=k1/(Lf*Kow) [1/day]



k2[Sculpin]	2.24e-003
k2[Alewife]	1.26e-003
k2[Smelt]	2.90e-003
k2[Salmonides]	9.75e-005

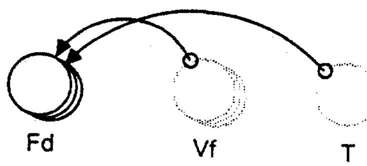
4) Dietary uptake rate constant: kd=Ed*Fd/Vf [1/day]



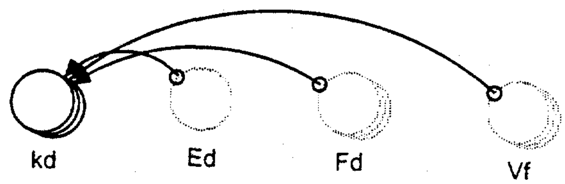
Uptake efficiency Ed=1/(5.3e-8*Kow+2.3)

Ed	3.98e-001

Food ingestion rate [kg food/day] Fd=0.022*Vf^0.85*exp(0.06*T)

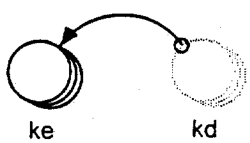


Fd[Sculpin]	4.20e-004
Fd[Alewife]	1.91e-003
Fd[Smelt]	1.06e-003
Fd[Salmonides]	7.51e-002



kd[Sculpin]	3.10e-002
kd[Alewife]	2.37e-002
kd[Smelt]	2.63e-002
kd[Salmonides]	1.24e-002

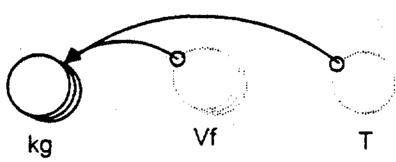
5) Fecal egestion rate constant : ke=0.2*kd [1/day]



ke[Sculpin]	6.20e-003
ke[Alewife]	4.75e-003
ke[Smelt]	5.27e-003
ke[Salmonides]	2.48e-003

6) Growth rate constant [1/day] : kg=0.01*Vf^(-0.2), T>10C

kg=0.002*Vf^(-0.2), T<=10C



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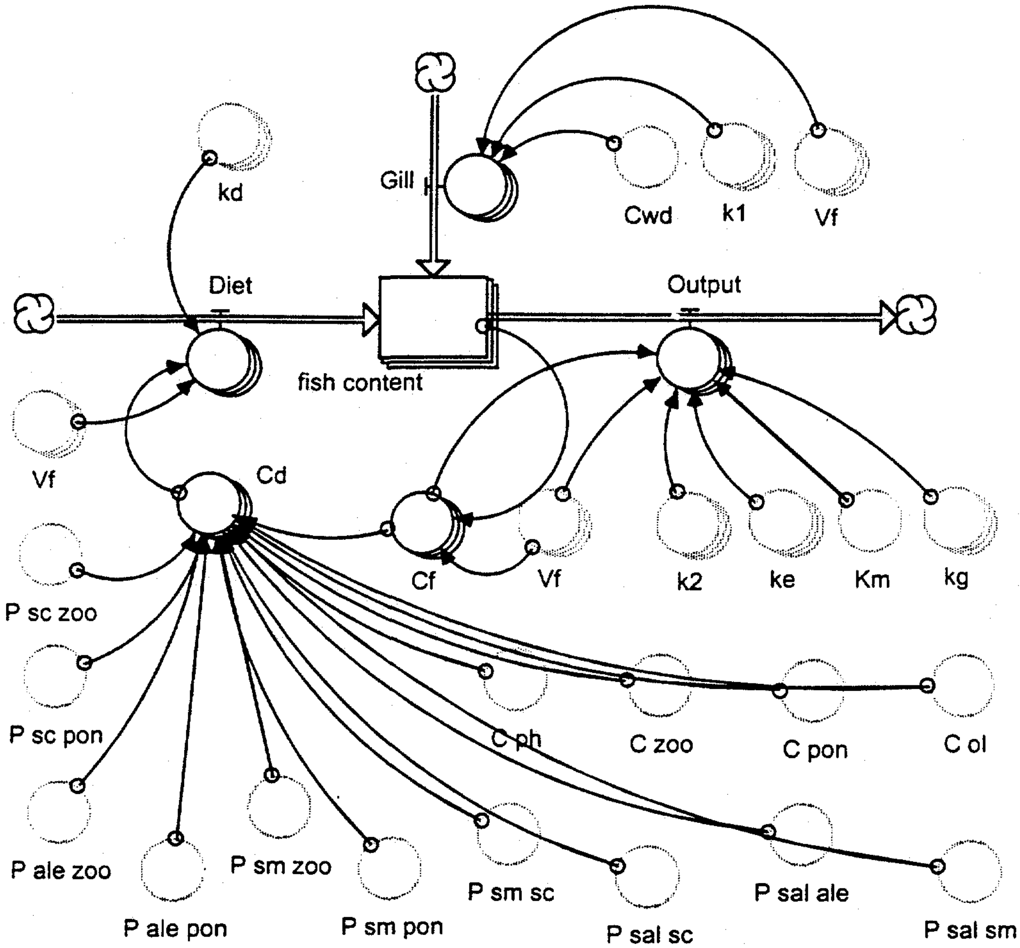
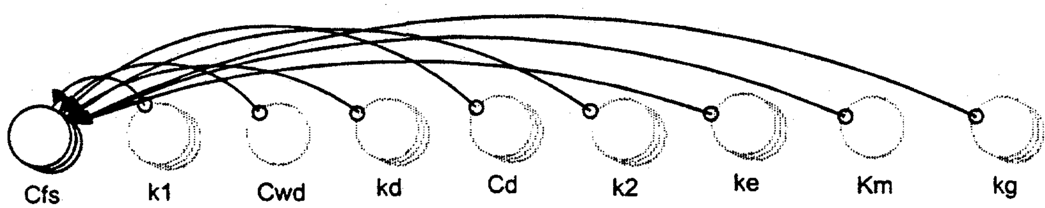
7) Finally Cf [ng/g] : dCf/dt=k1*Cwd+kd*Cd-(k2+ke+km+kg)*Cf



8) Steady-state solution [kg/kg]: Cfs=(k1*Cwd+kd*Cd)/(k2+ke+km+kg)



Gobas,1993, ug/g:			FISHRAND
	Predicted	Observed	
Steady-State			
Sculpin	1.6	1.6	1.61
Alewife	0.99	1.3	0.98
Smelt	1.4	1.4	1.34
Salmonids	3.5	4.3	3.46

FISHPATH
Steady-State , kg/kg

Cfs[Sculpin]	1.61e-006
Cfs[Alewife]	9.80e-007
Cfs[Smelt]	1.34e-006
Cfs[Salmonides]	3.46e-006

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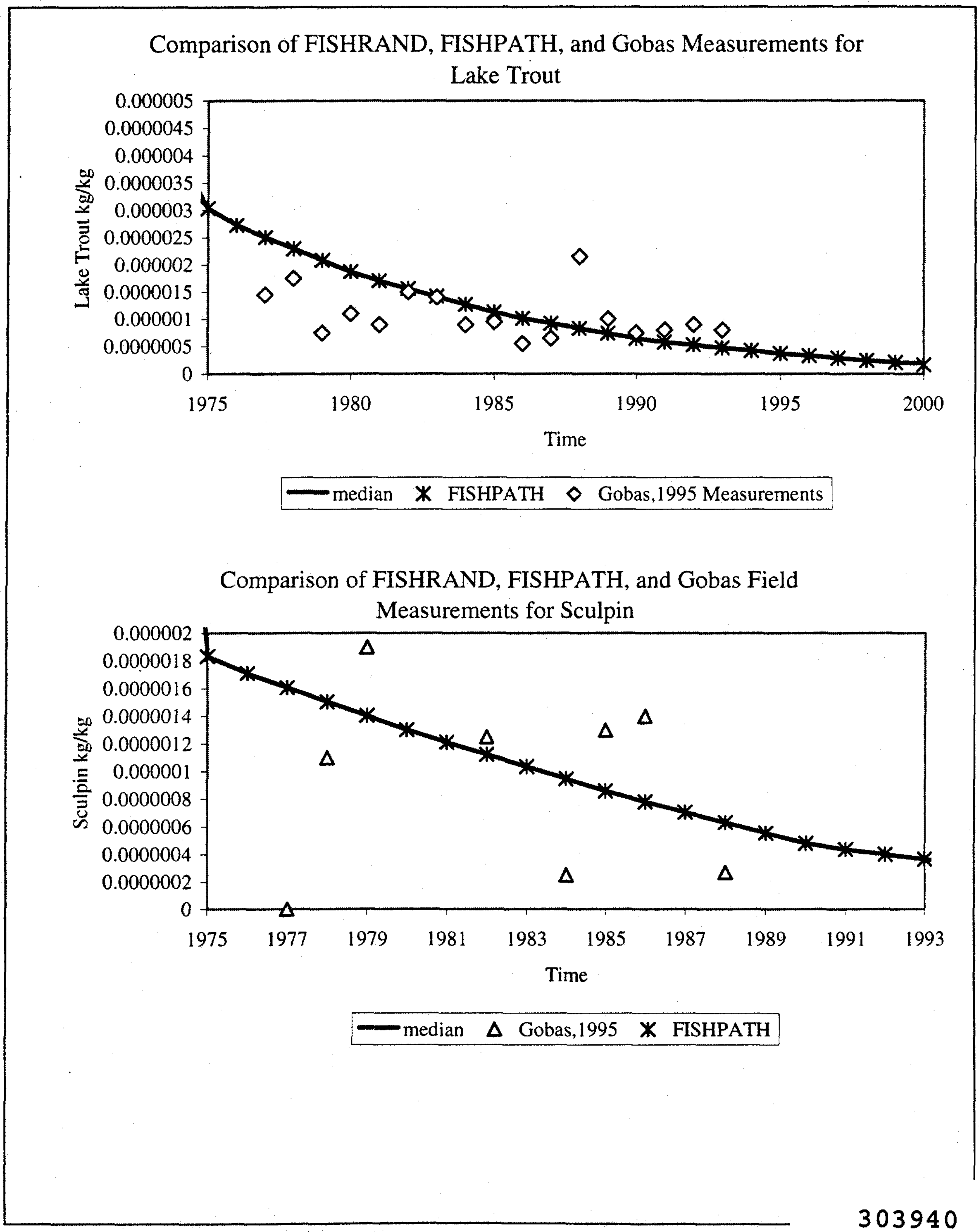
Figure 3-4 Comparison of FISHRAND and FISHPATH for Gobas Dynamic Model



303940

Figure 3-4 Comparison of FISHRAND and FISHPATH for Gobas Dynamic Model, continued

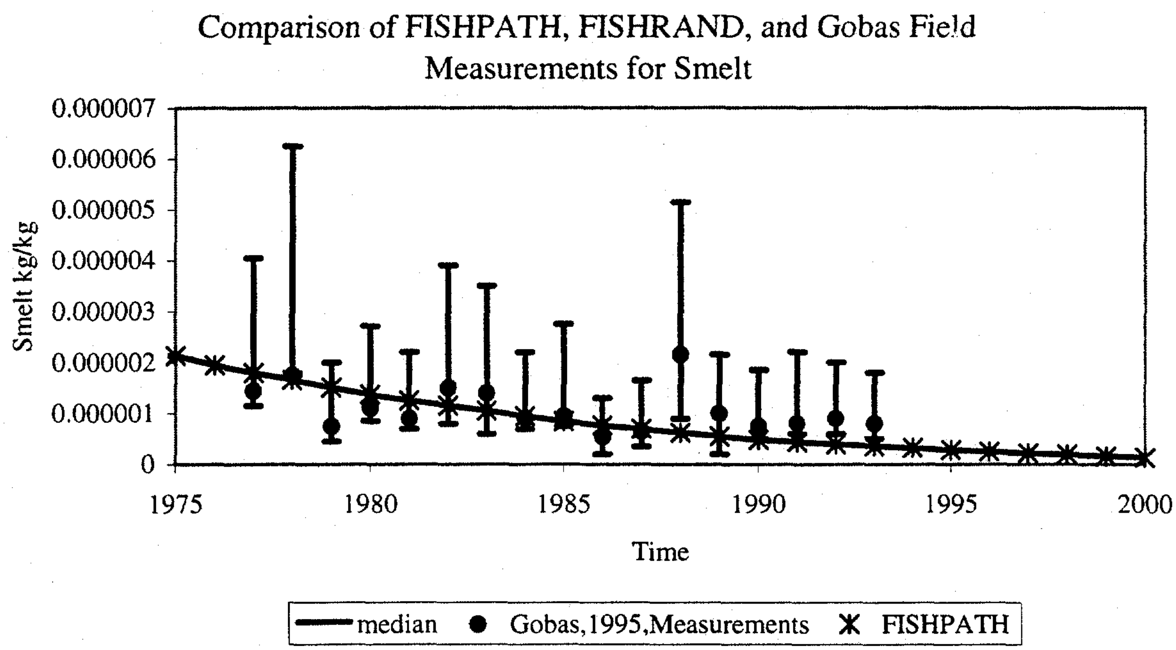


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Figure 3-5: Flow Chart for Bayesian Monte Carlo Simulation Procedure in FISHRAND

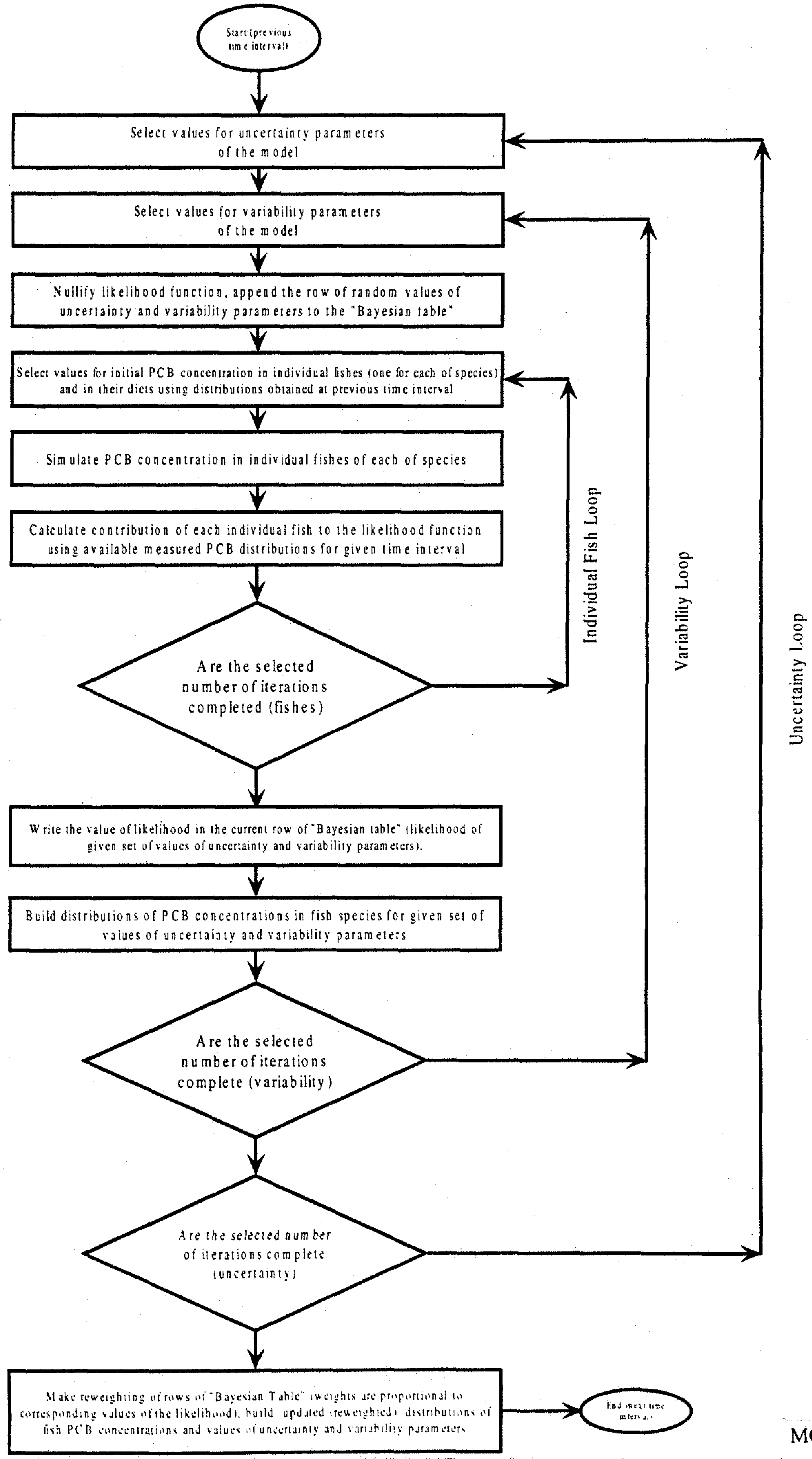

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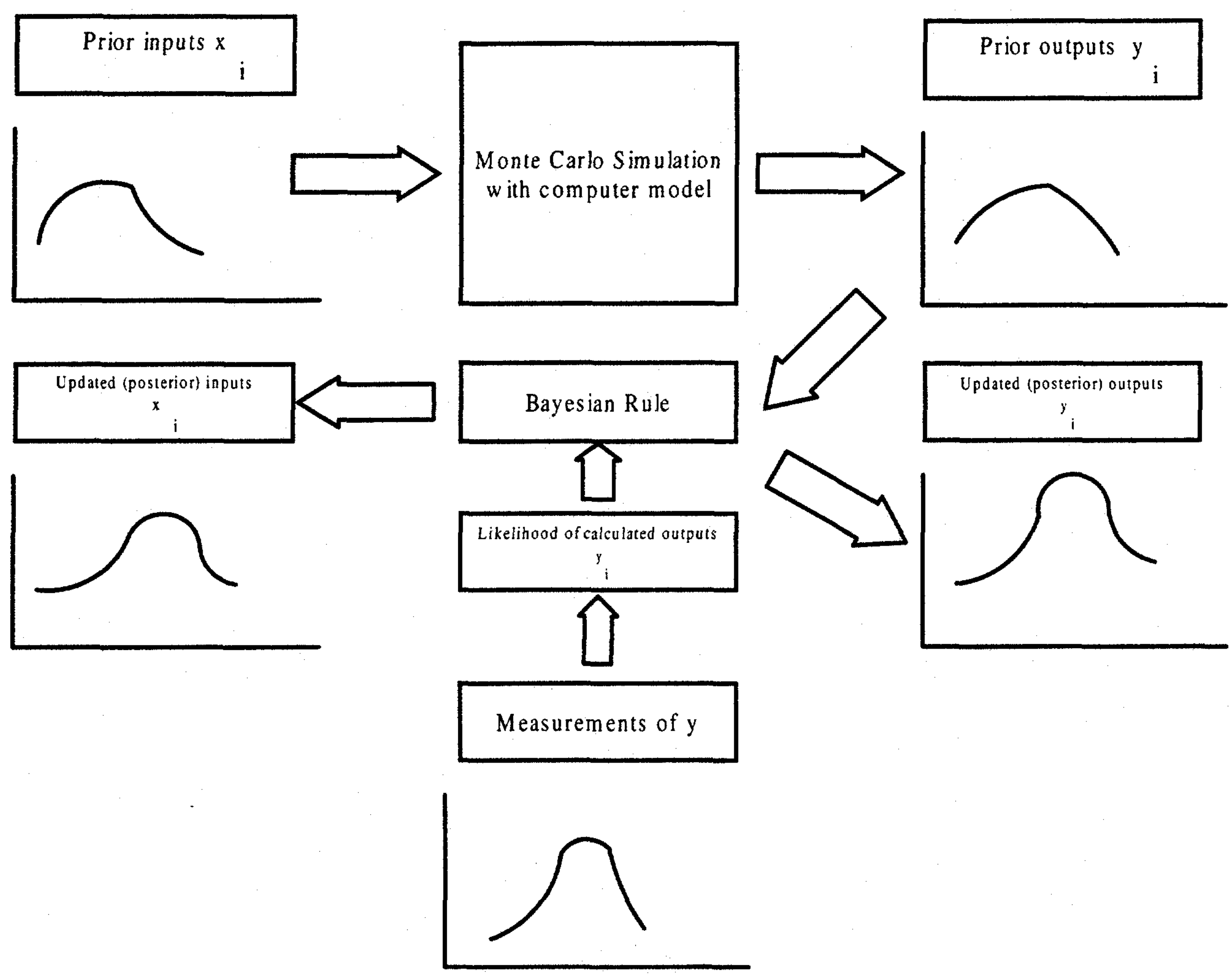
Figure 3-6: Schematic for Bayesian Updating Procedure



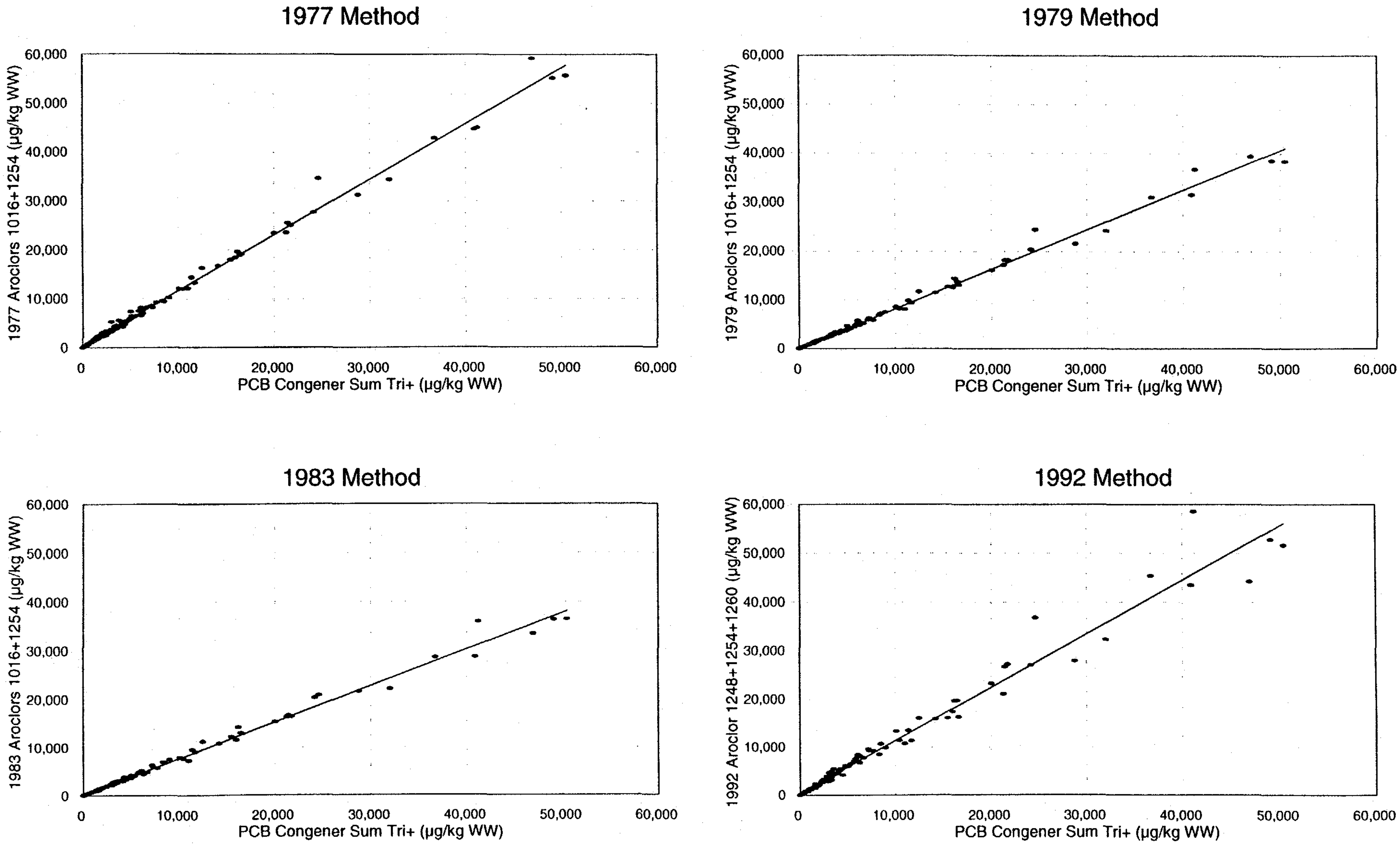


Figure 4-1. Comparison of Hazleton PCB Quantitations and Sum of Tri+ Congeners

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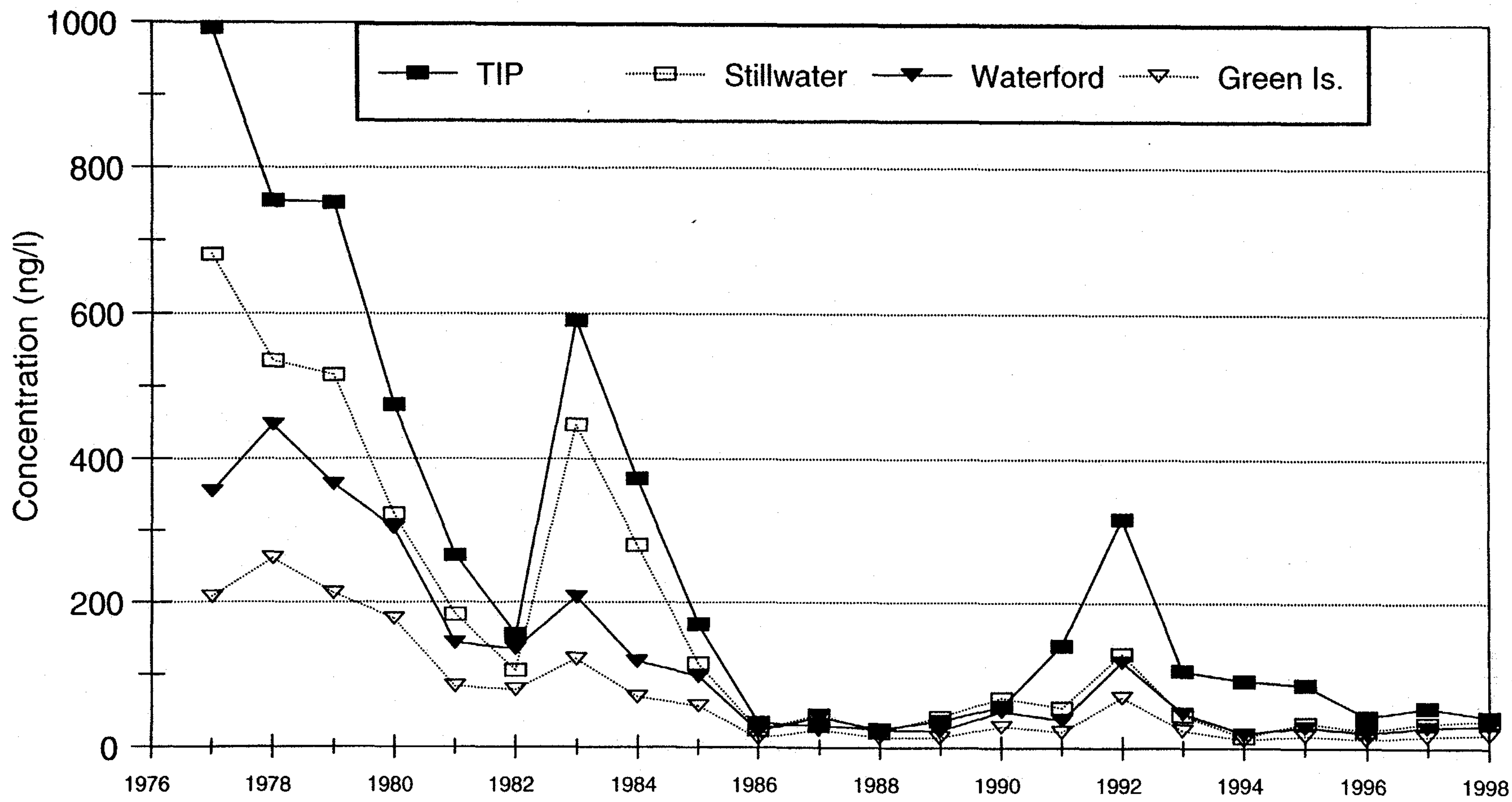

Figure 4-2. Summer Average Water Column Exposure Concentration, Tri+ PCBs

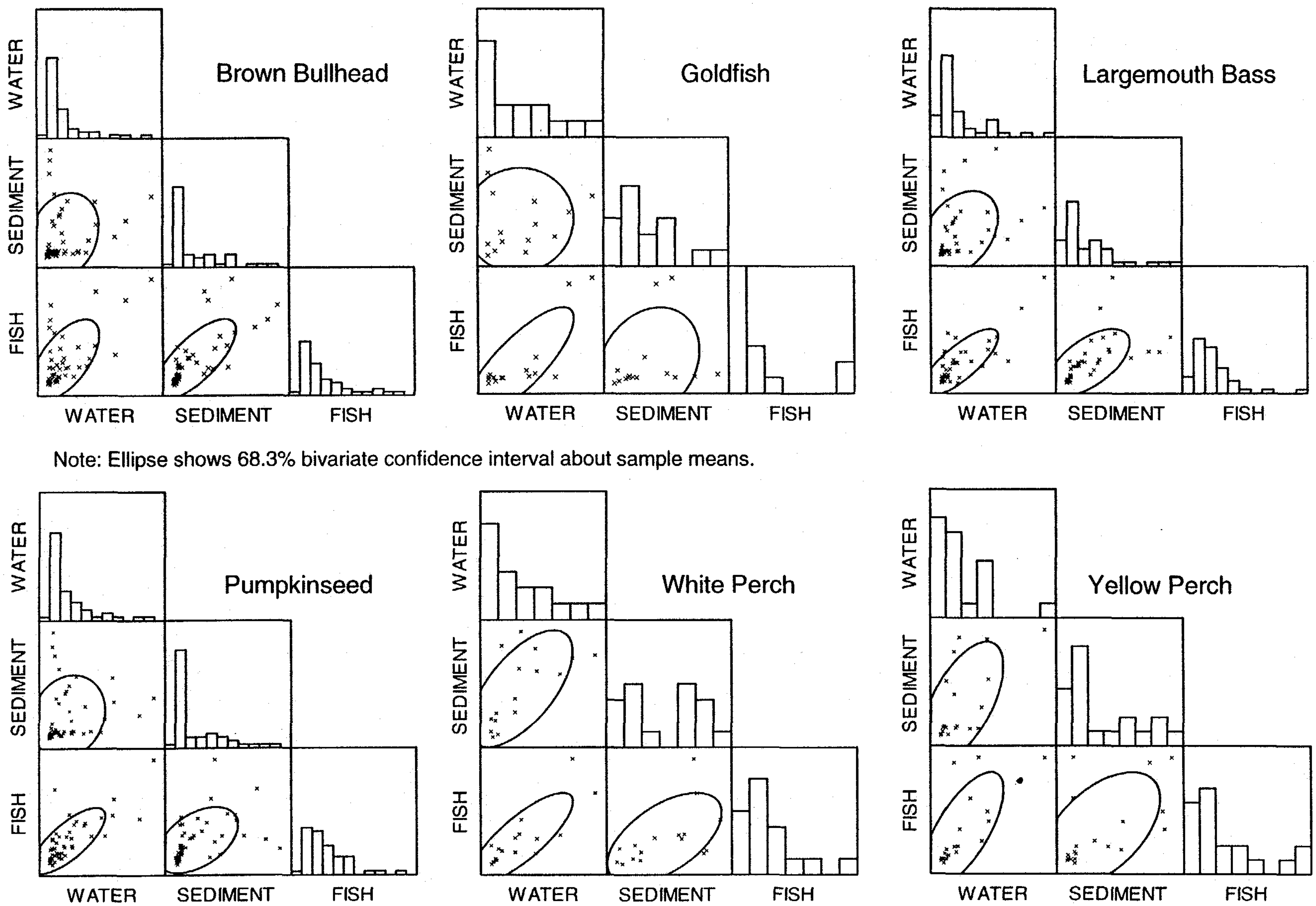

Figure 4-3. Scatterplot Matrices for Fish Lipid, Sediment, and Water Tri+ PCB Concentrations in the Upper Hudson River, 1977-1997

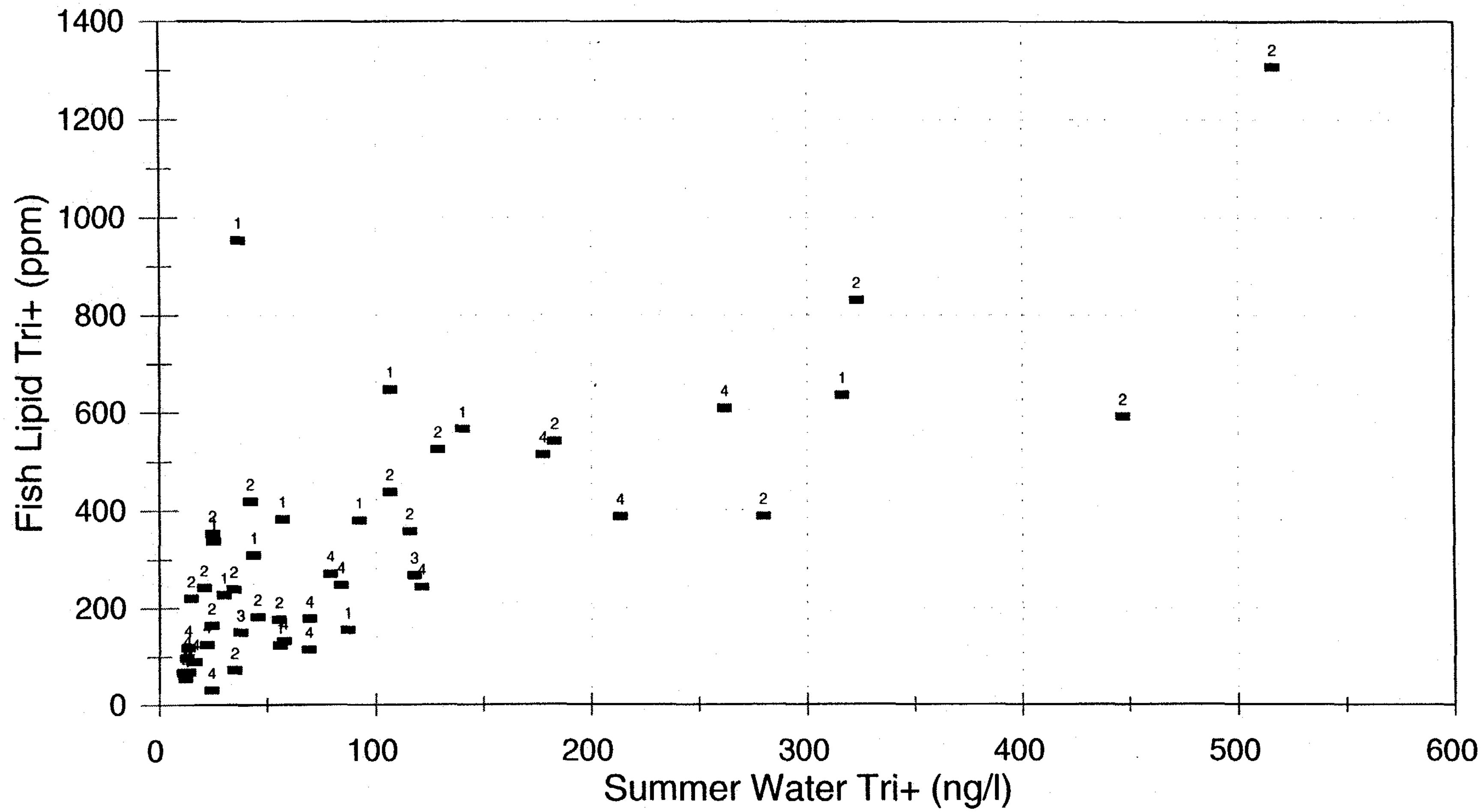

Figure 4-4. Relation of Mean Tri+ Concentration in Pumpkinseed to Summer Average Water Column Concentration

Note: Labels show River Mile groups (see text).

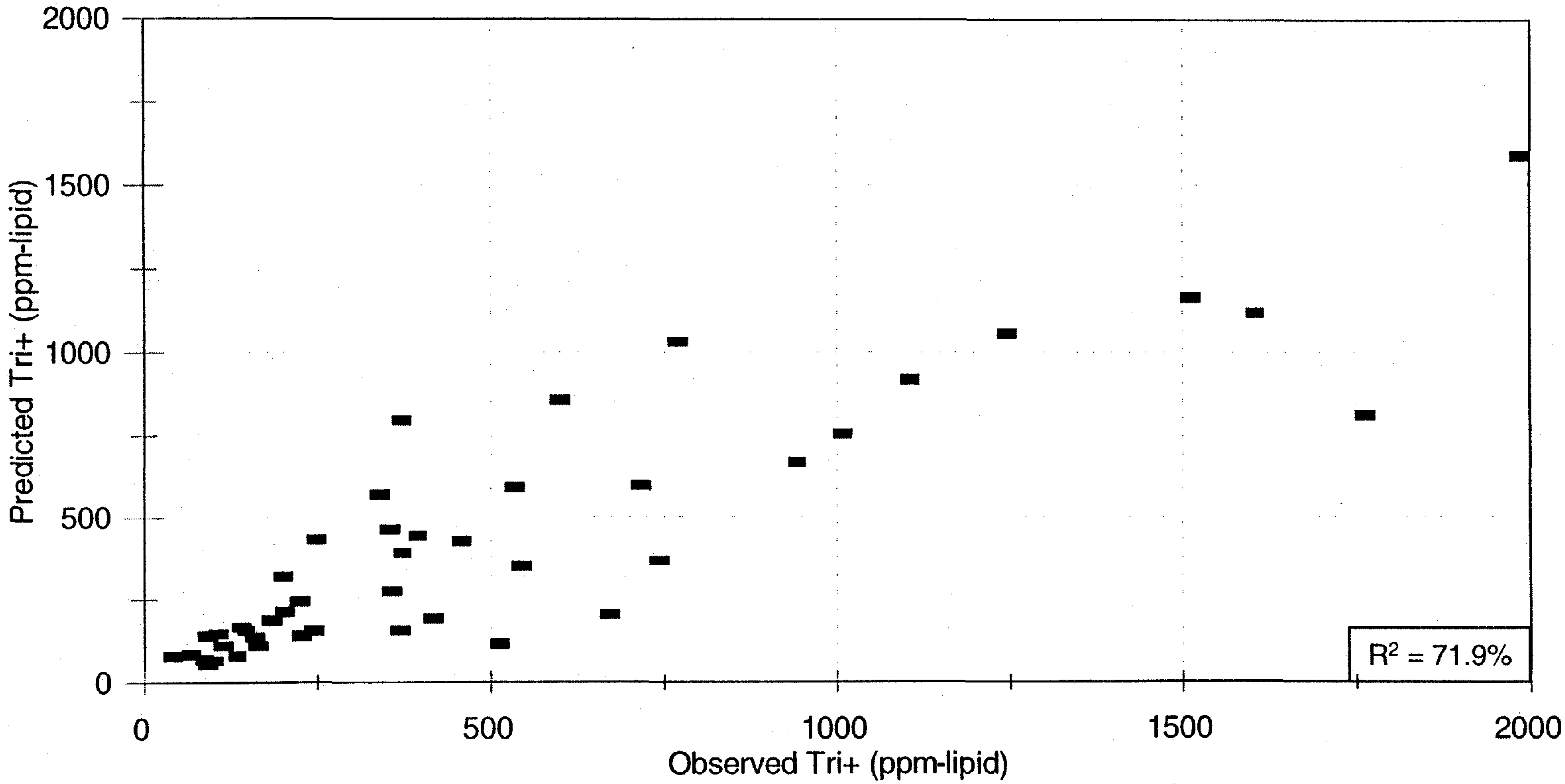

Figure 4-5. Observed versus Predicted Concentrations of Tri+ PCBs for Brown Bullhead from Bivariate BAF Model

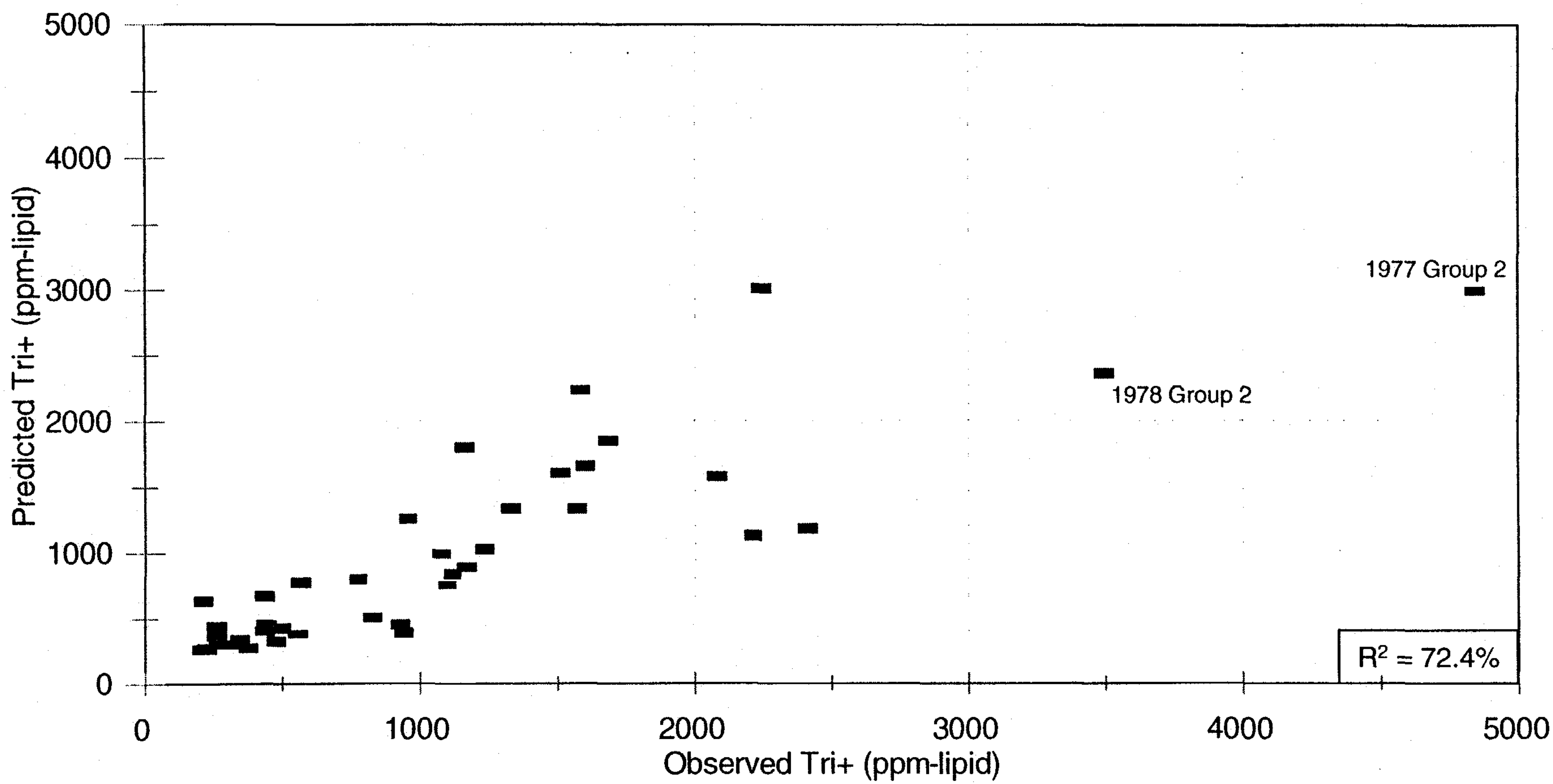

Figure 4-6. Observed versus Predicted Concentrations of Tri+ PCBs for Largemouth Bass from Bivariate BAF Model

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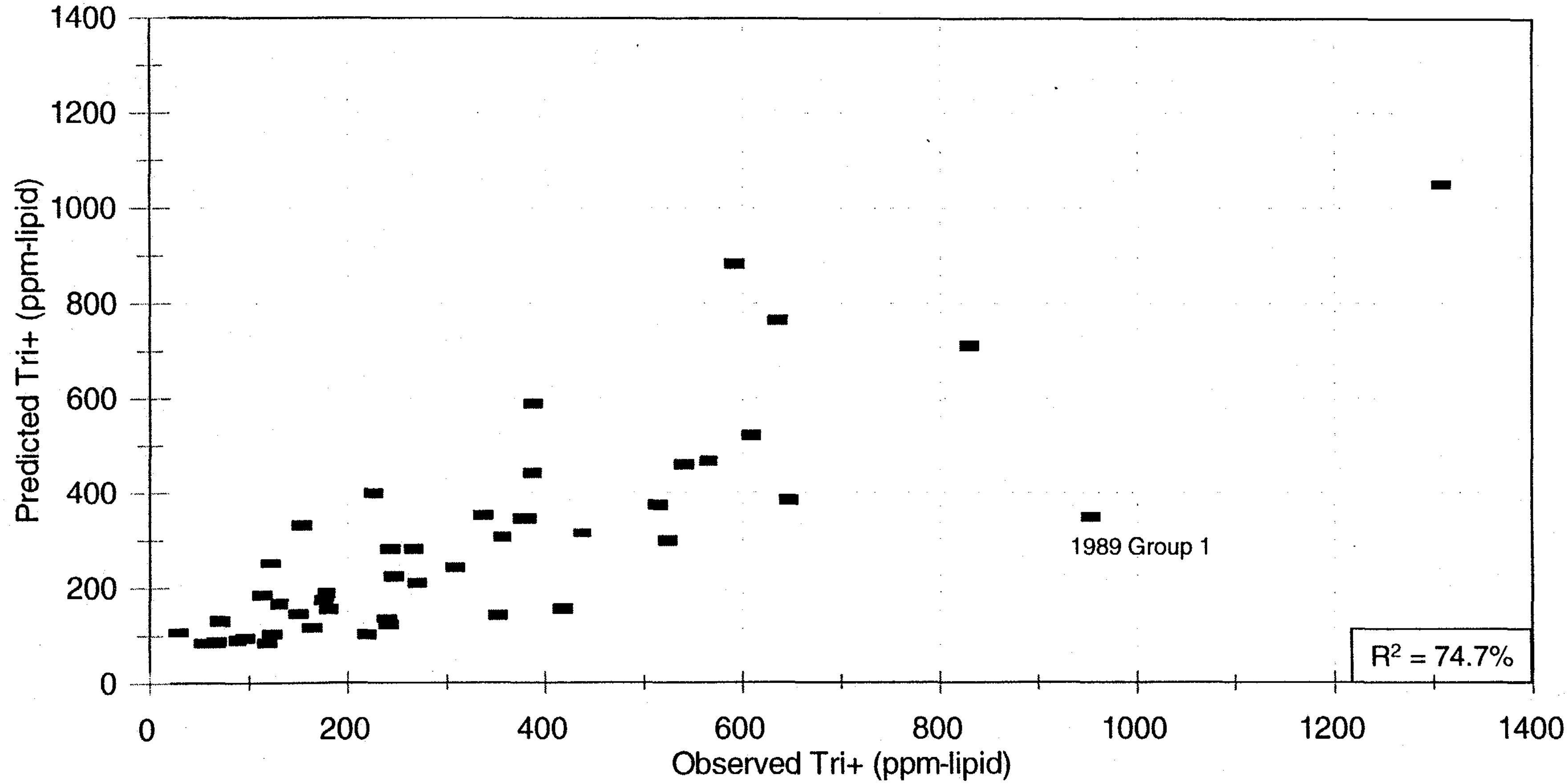

Figure 4-7. Observed versus Predicted Concentrations of Tri+ PCBs for Pumpkinseed from Bivariate BAF Model

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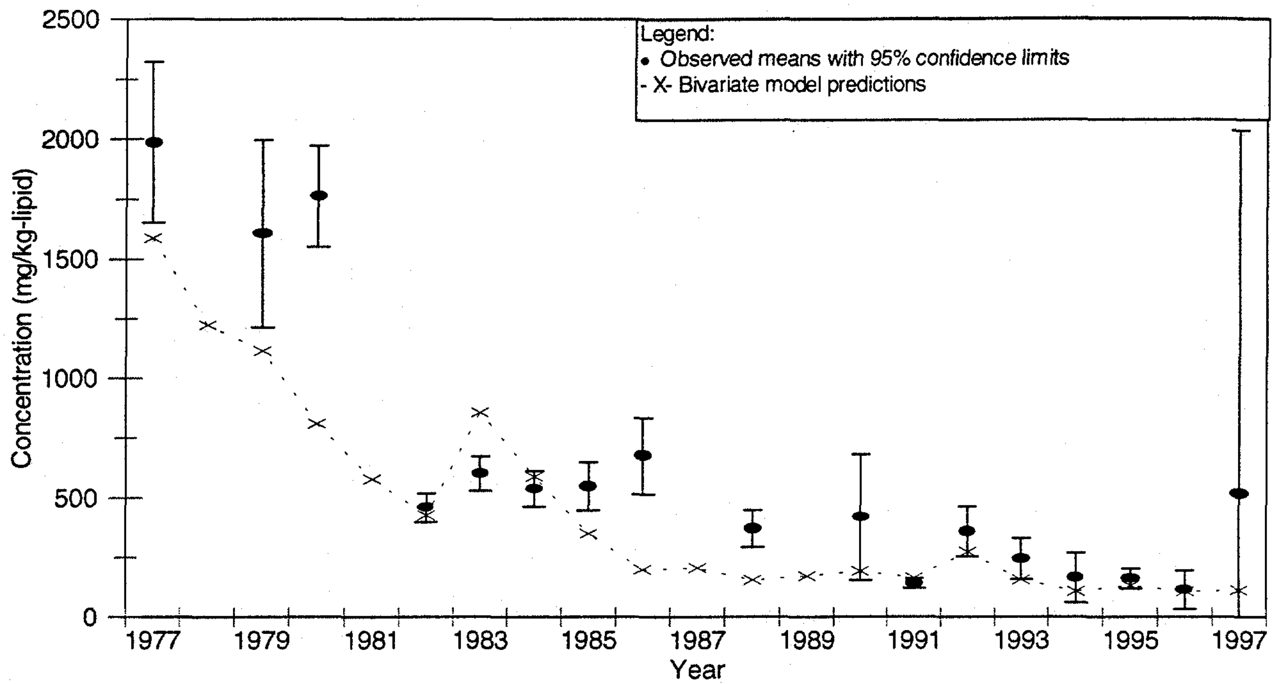
Group 2: River Miles 168-176



Group 4: River Miles 142-152

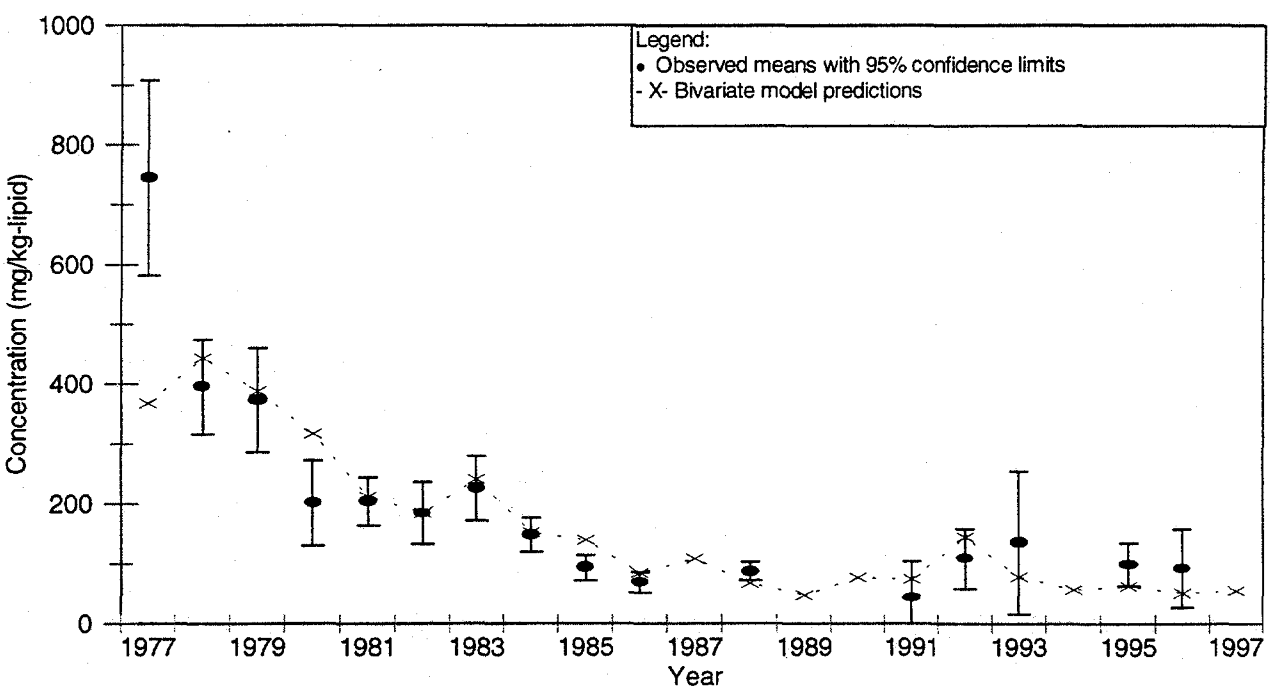


Figure 4-8. Comparison of Bivariate BAF Model Predictions and Observations of Mean Summer Body Burden of Tri+ PCBs in Brown Bullhead

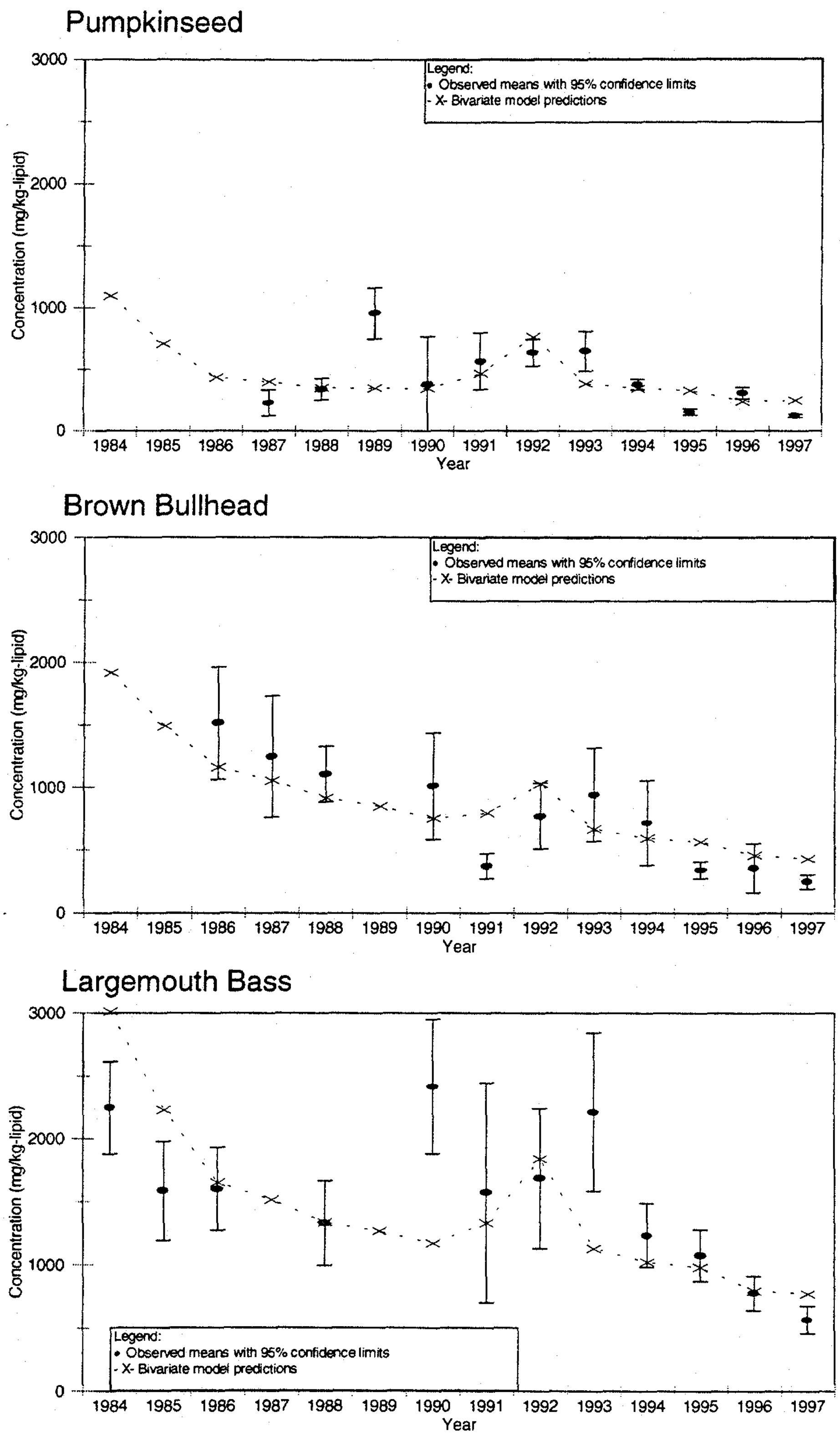
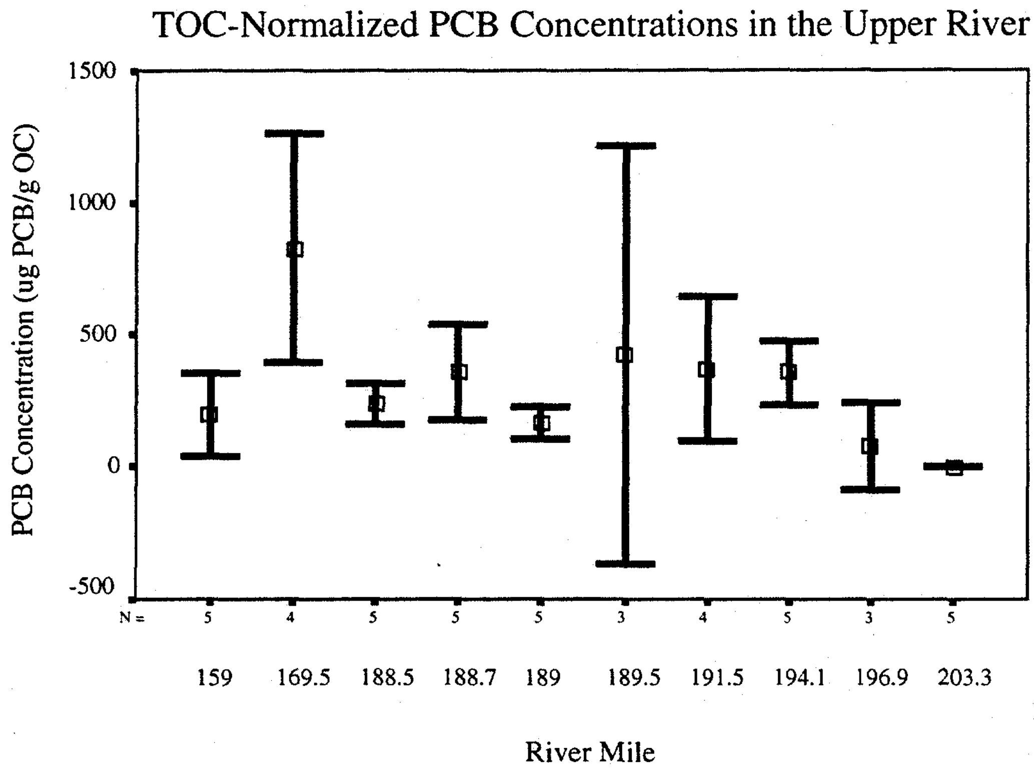


Figure 4-11. Comparison of Bivariate BAF Model Predictions and Observations of Mean Summer Body Burden of Tri+ PCBs for Thompson Island Pool

Figure 5-1: TOC-Normalized PCB Concentration in the Hudson River Based on Phase 2 1993 Data



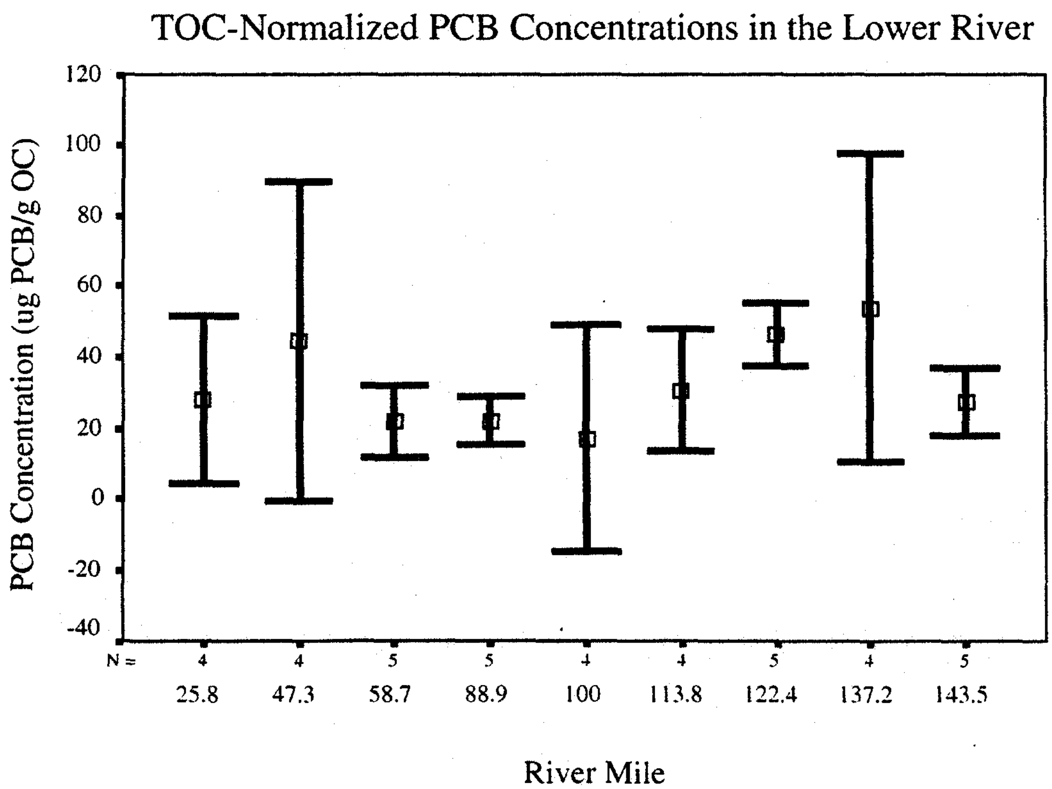


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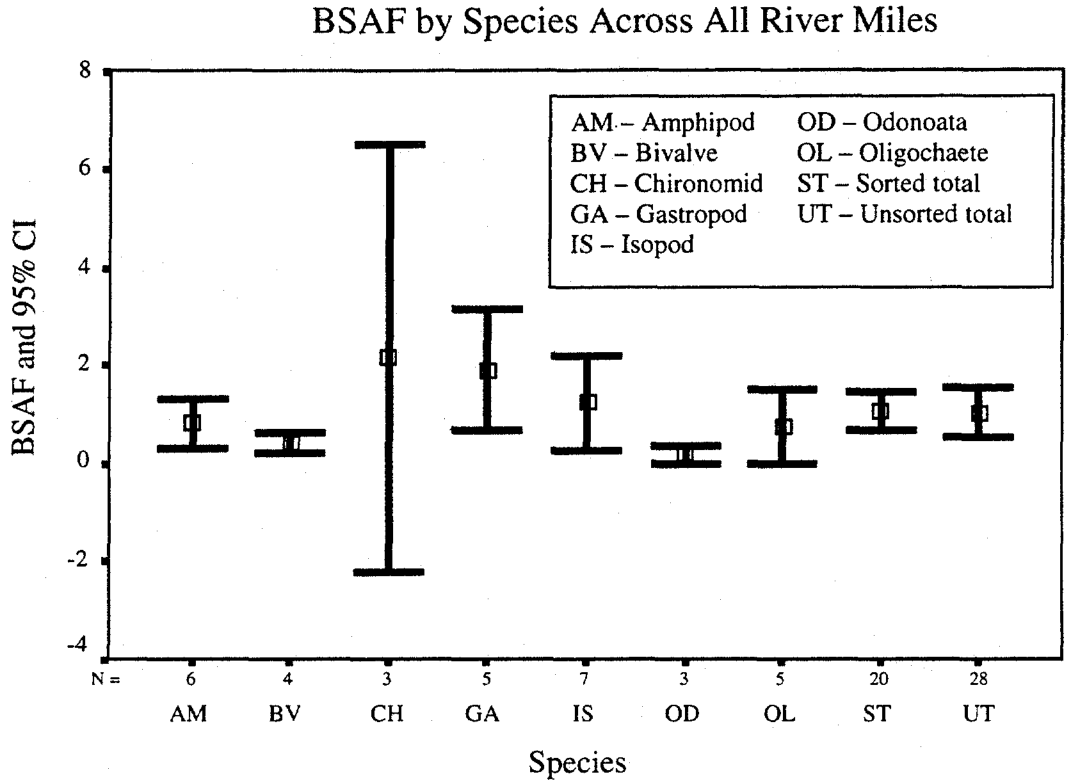
Figure 5-2 BSAF Results



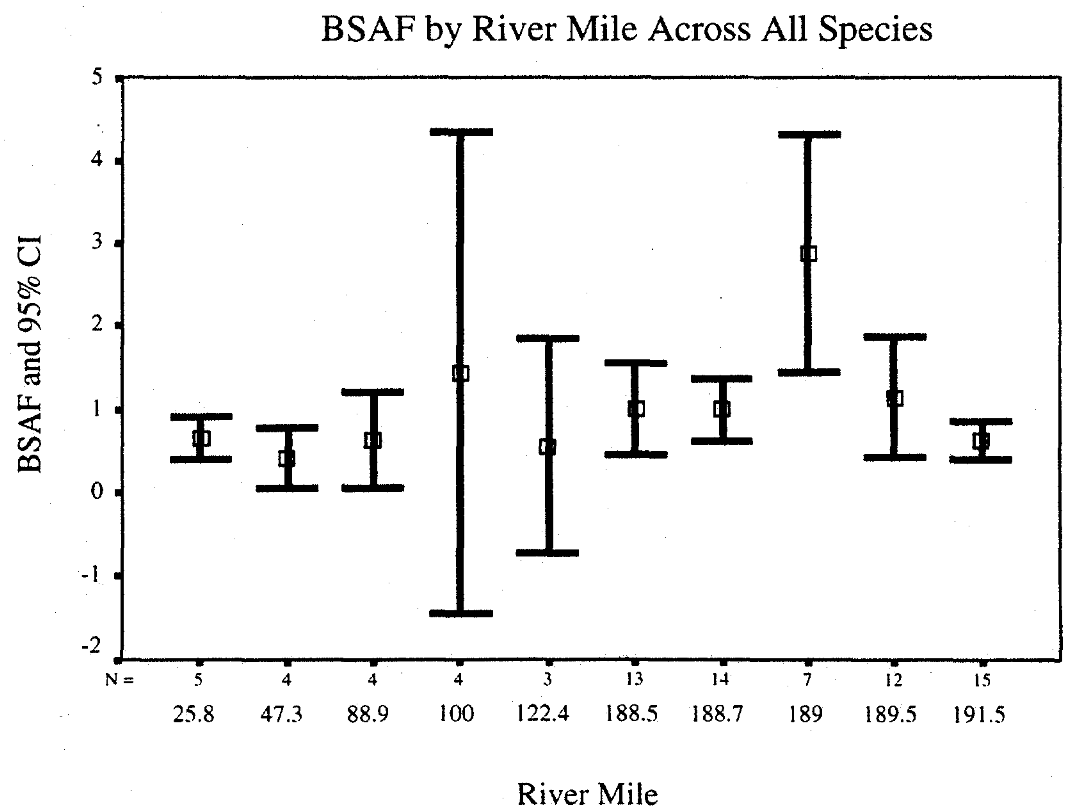


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Figure 5-3: Cumulative Distribution Function for BSAF

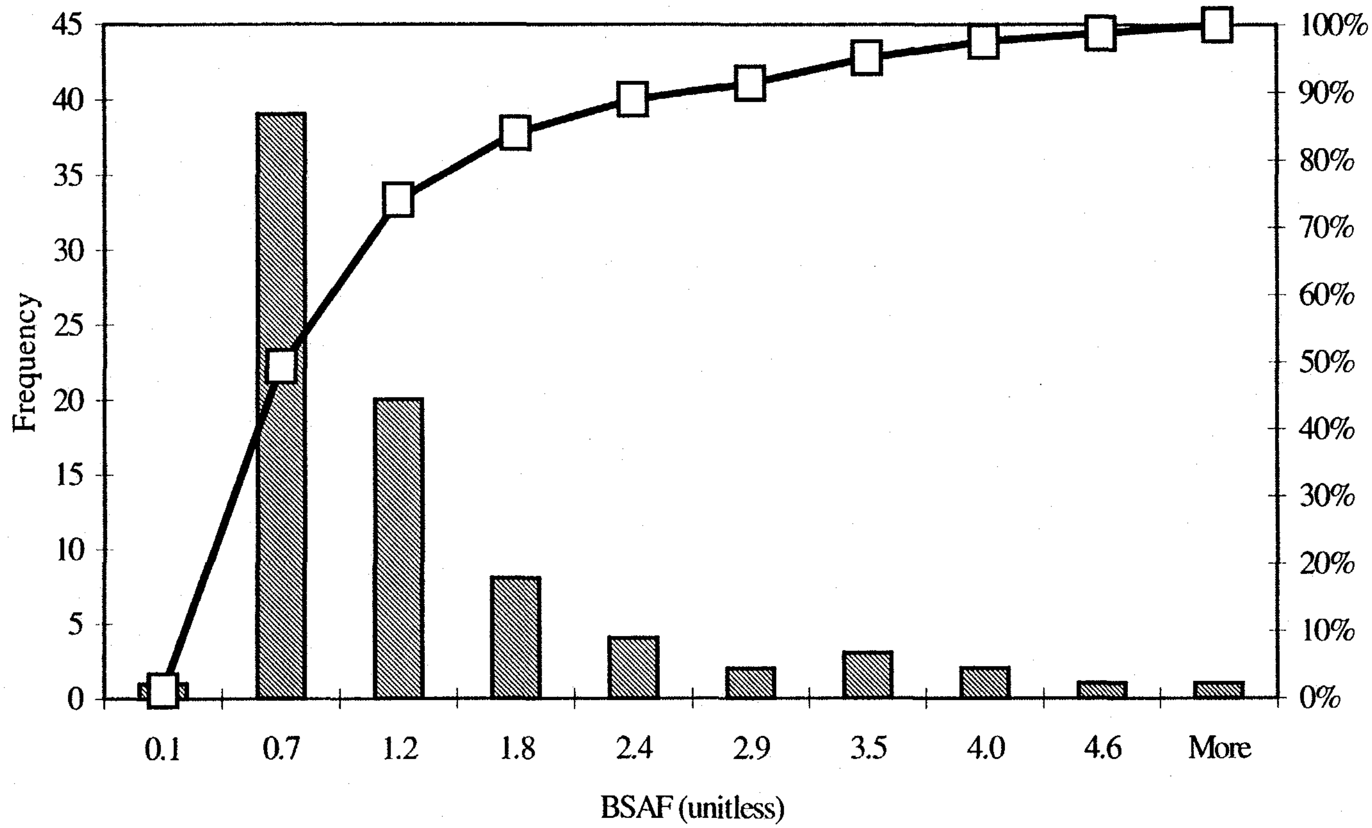

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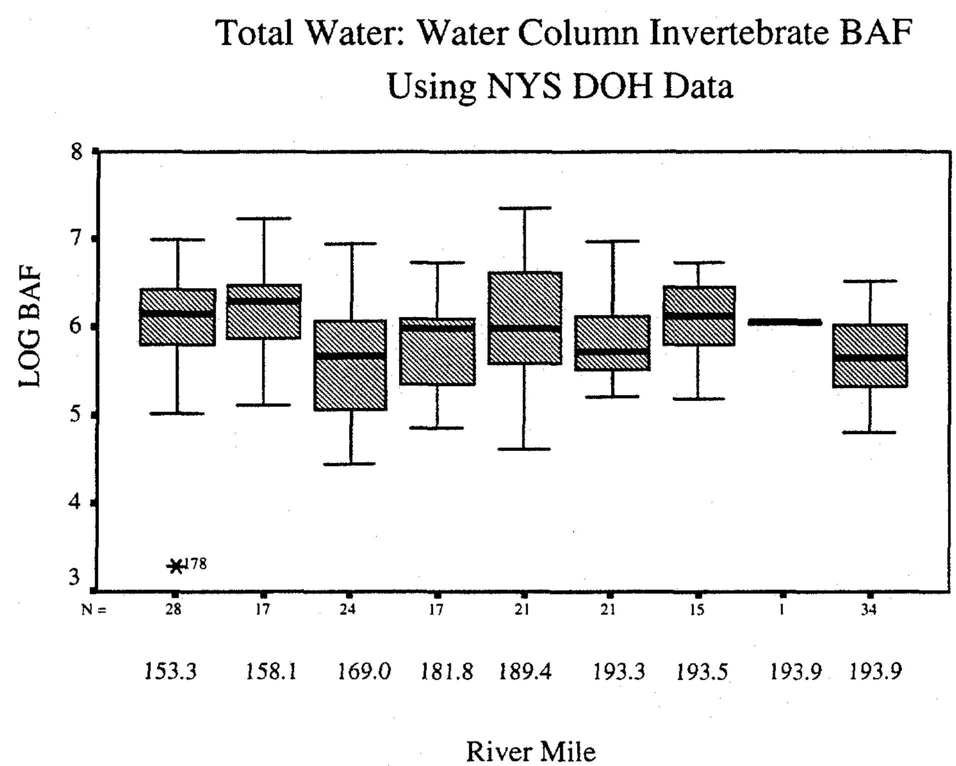
Figure 5-4 Water Column to Water Column Invertebrate BAF Results



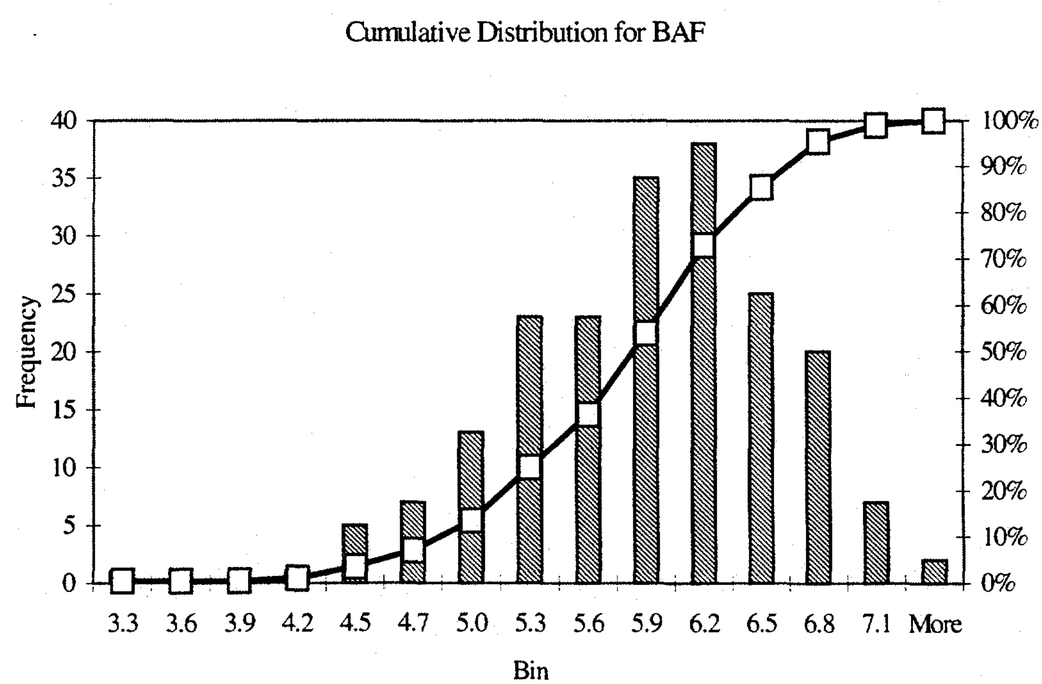


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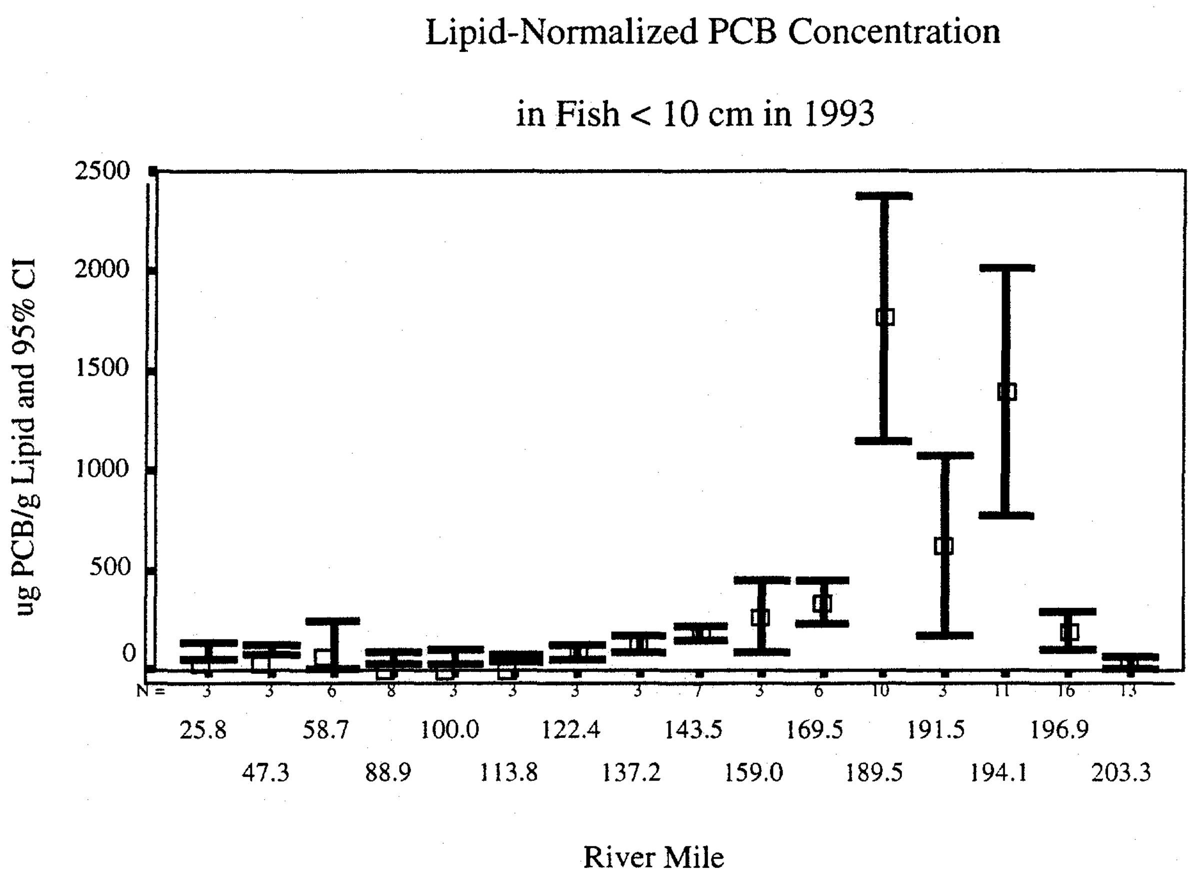
Figure 5-5 Forage Fish Concentrations and FFBAF Results



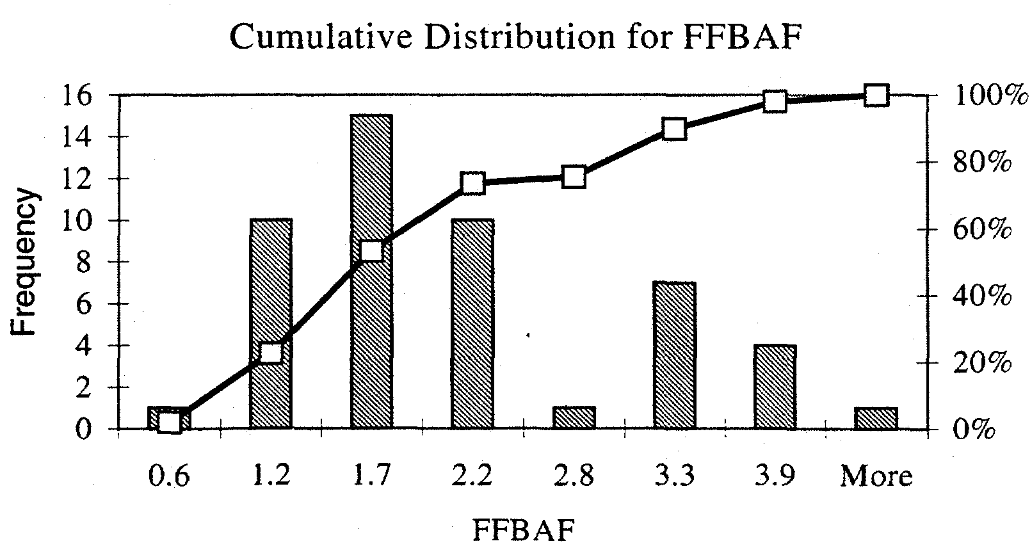


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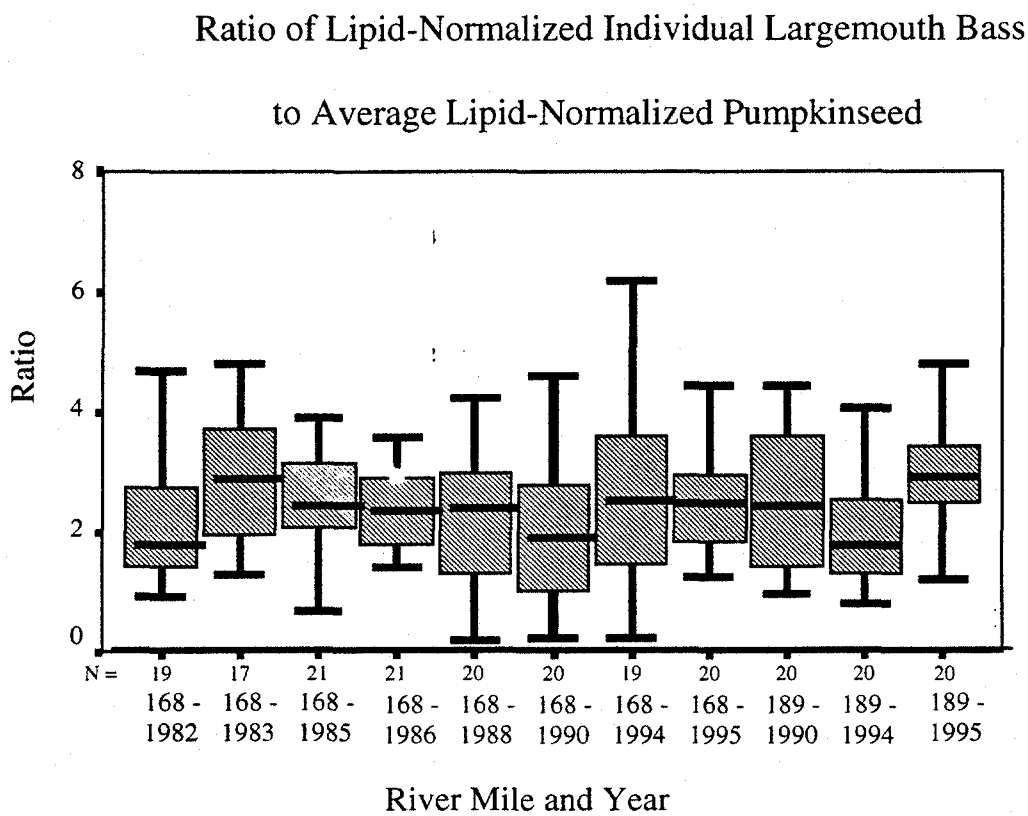
Figure 5-6 Summary of Largemouth Bass to Pumpkinseed Ratios



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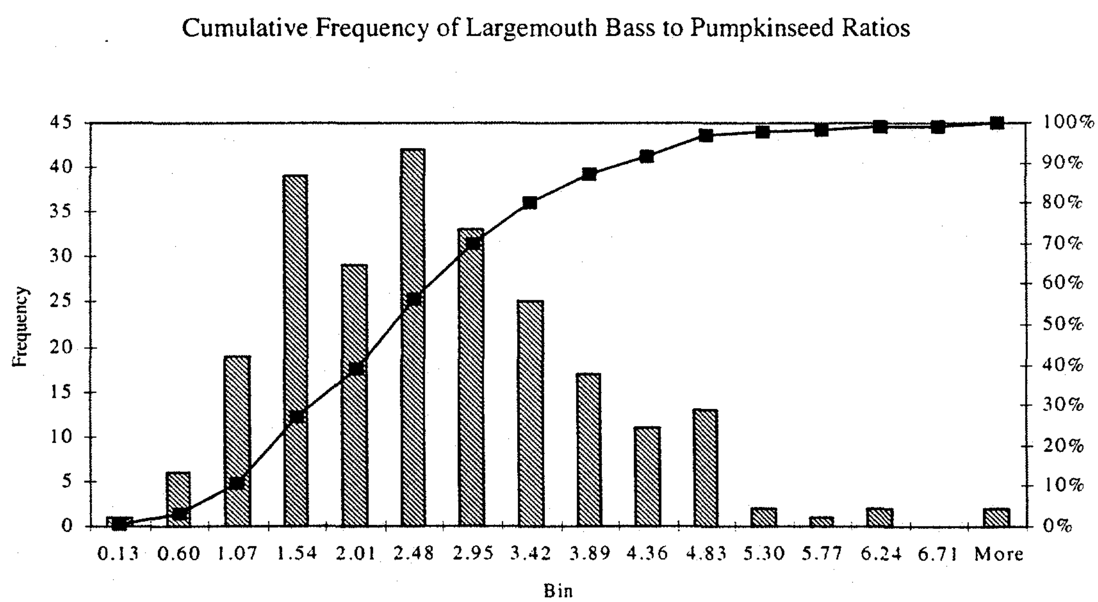

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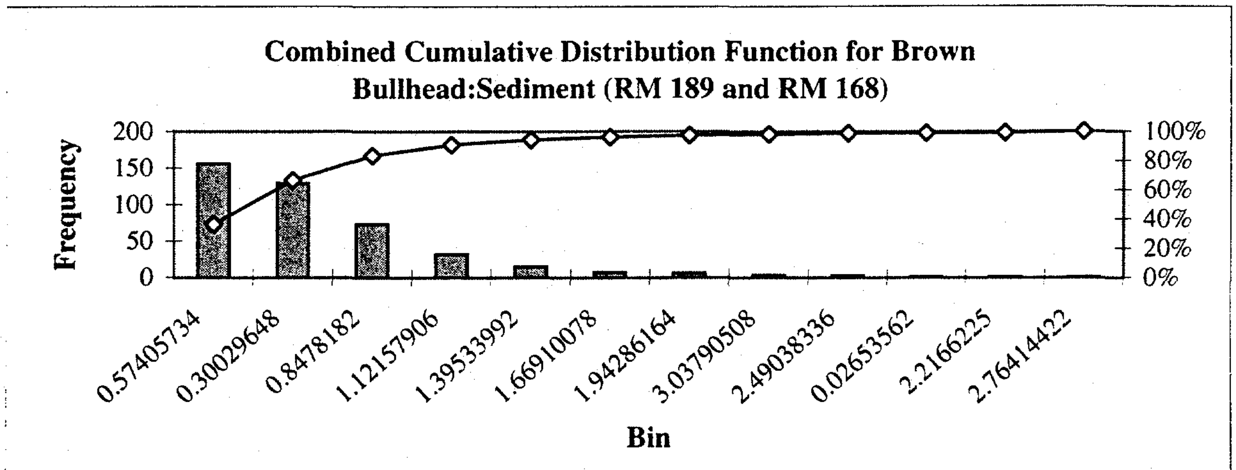
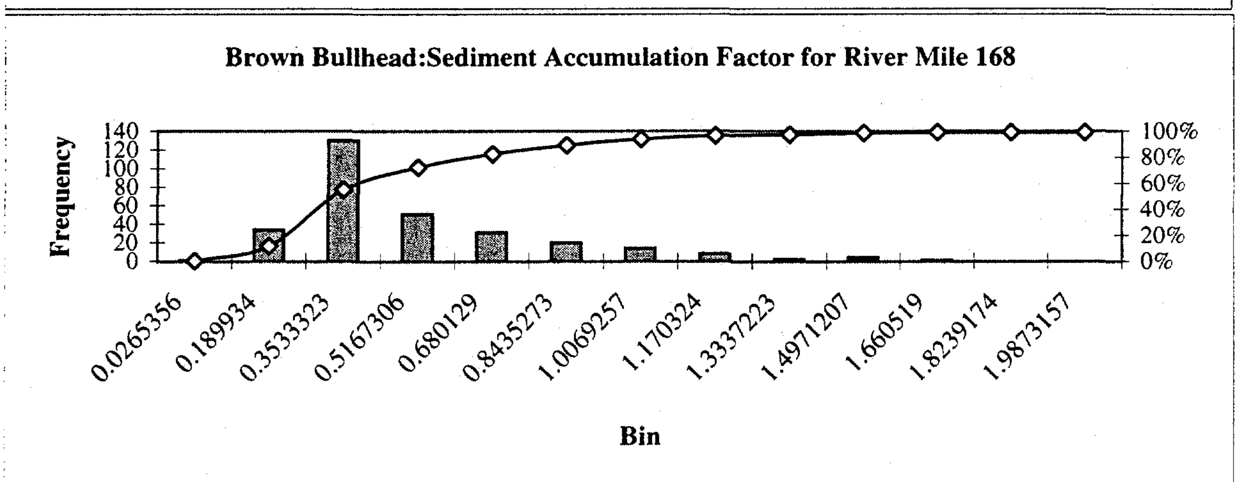
Figure 5-7: Summary of Brown Bullhead to Sediment Accumulation Factors





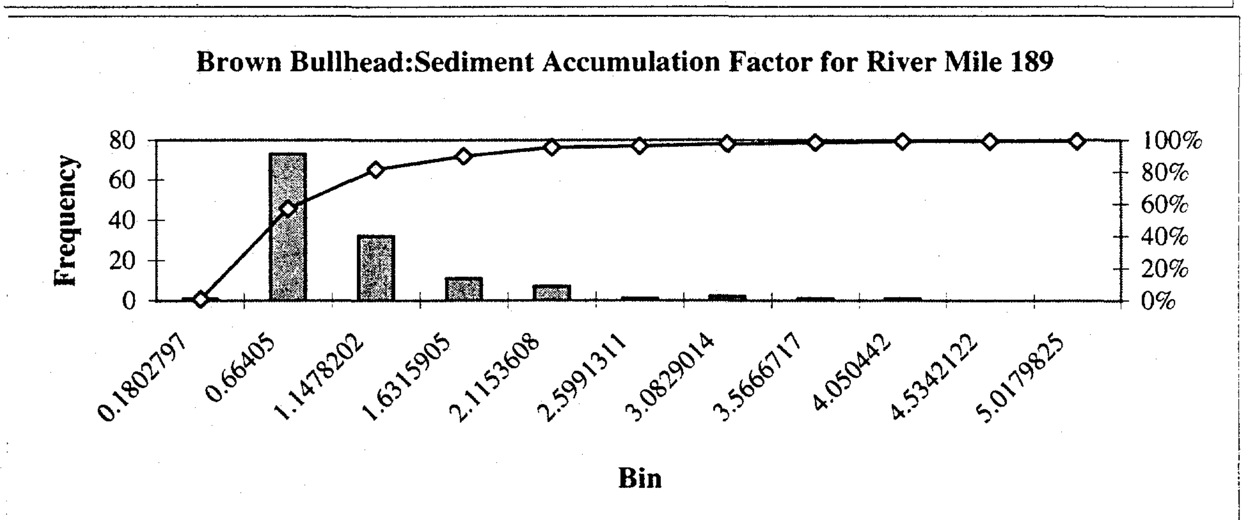


Figure 5-8: Whole Water and TOC-Normalized Sediment Concentrations Predicted by HUDTOX

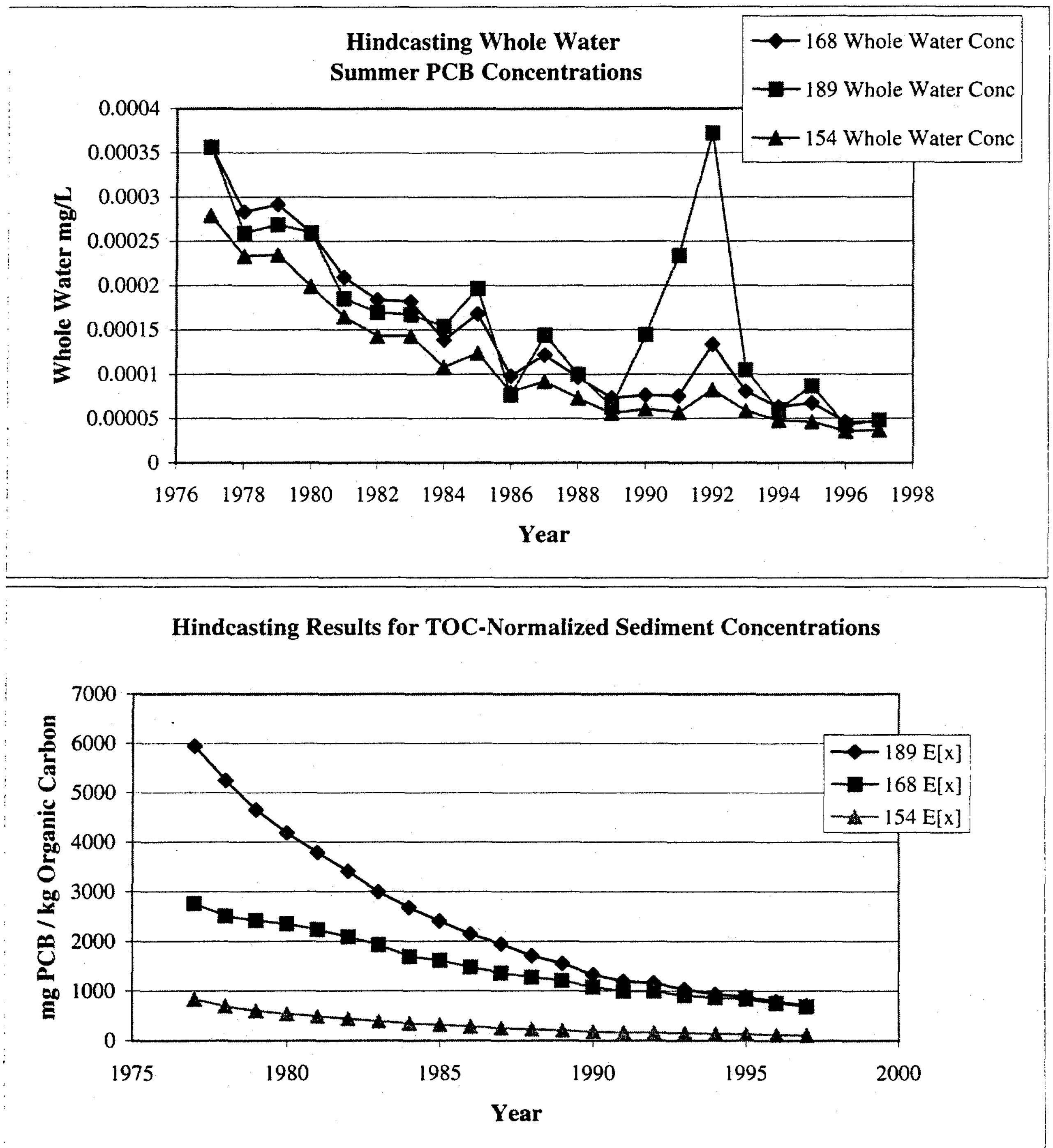


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FIGURE 5-9: Comparison to Data for Empirical Probabilistic Model for Largemouth Bass

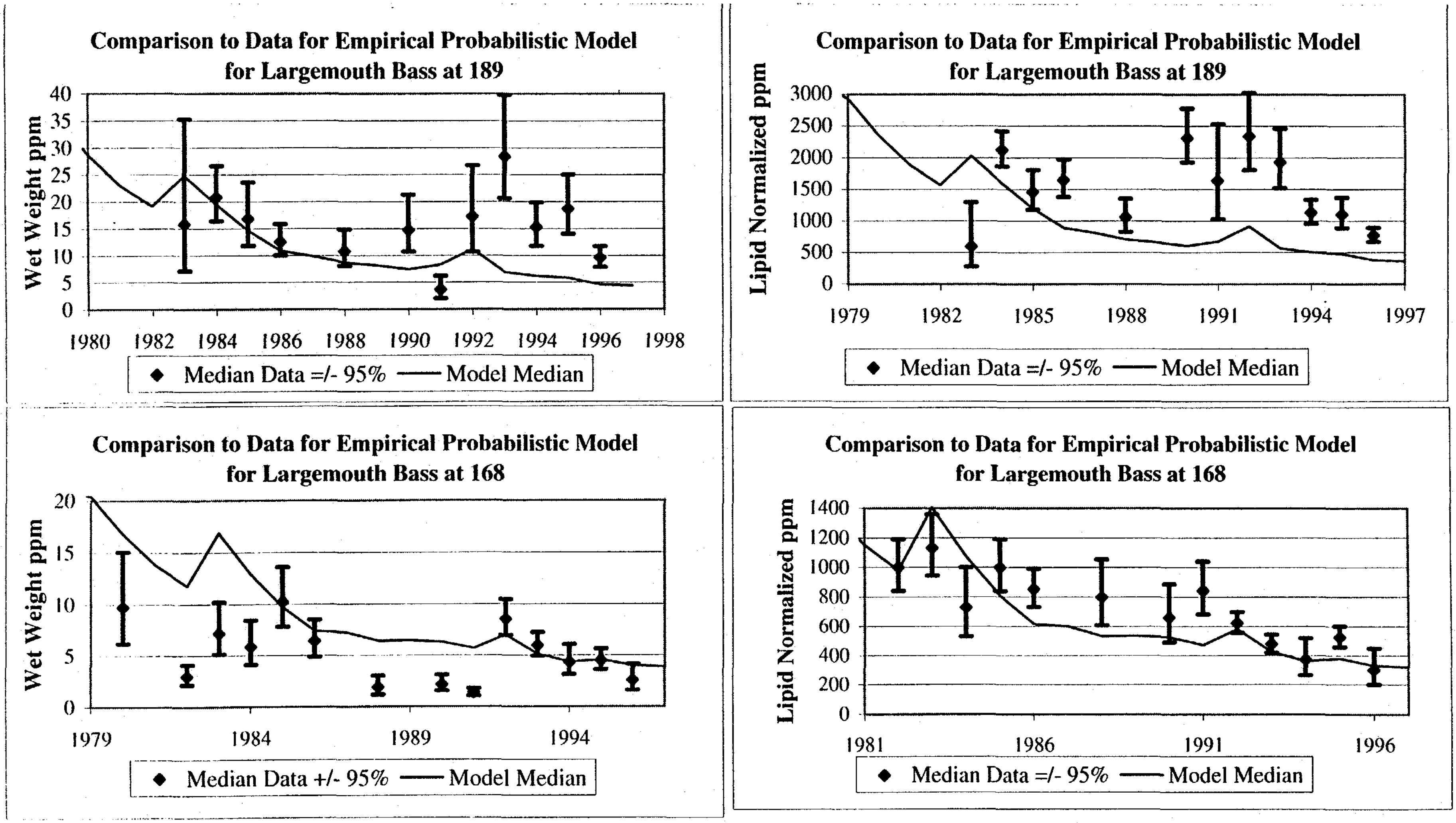
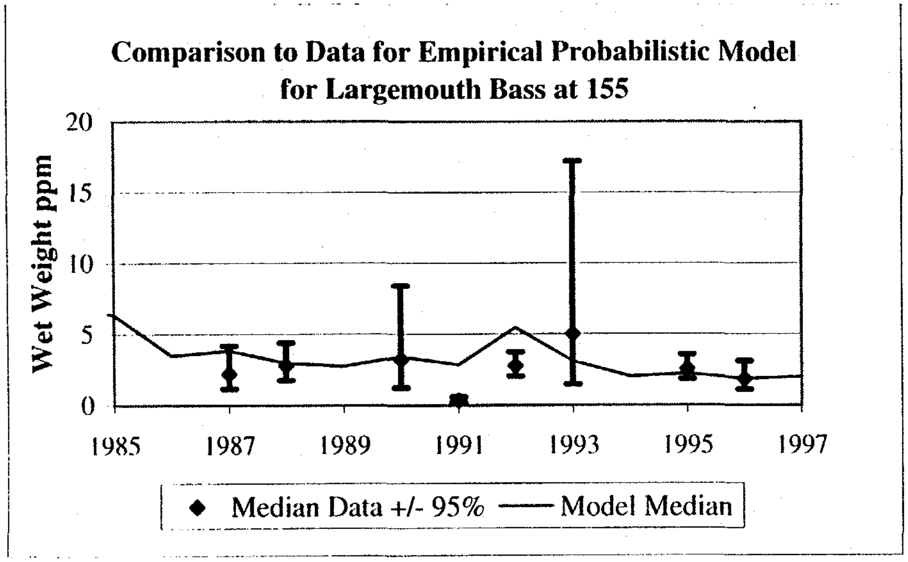


FIGURE 5-9: Comparison to Data for Empirical Probabilistic Model for Largemouth Bass, continued



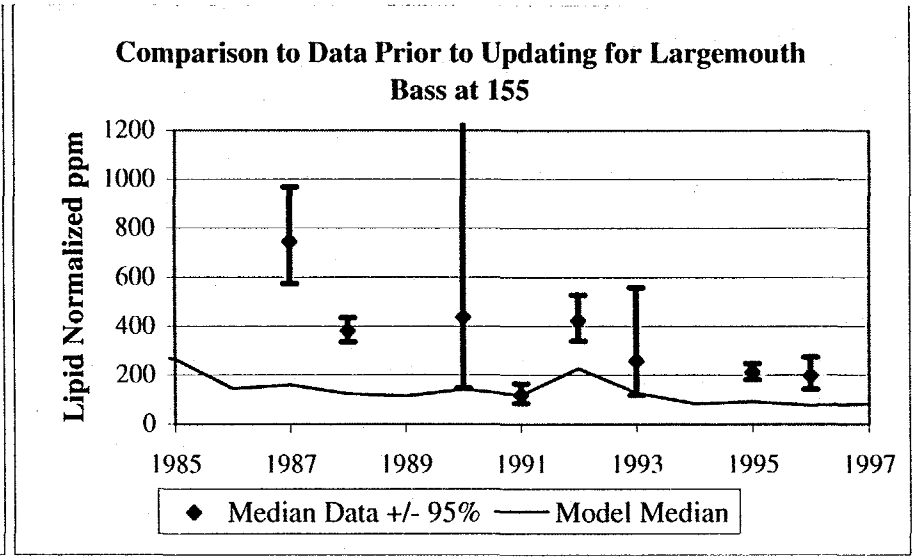


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Figure 5-10: Comparison to Data for Empirical Probabilistic Model for Brown Bullhead

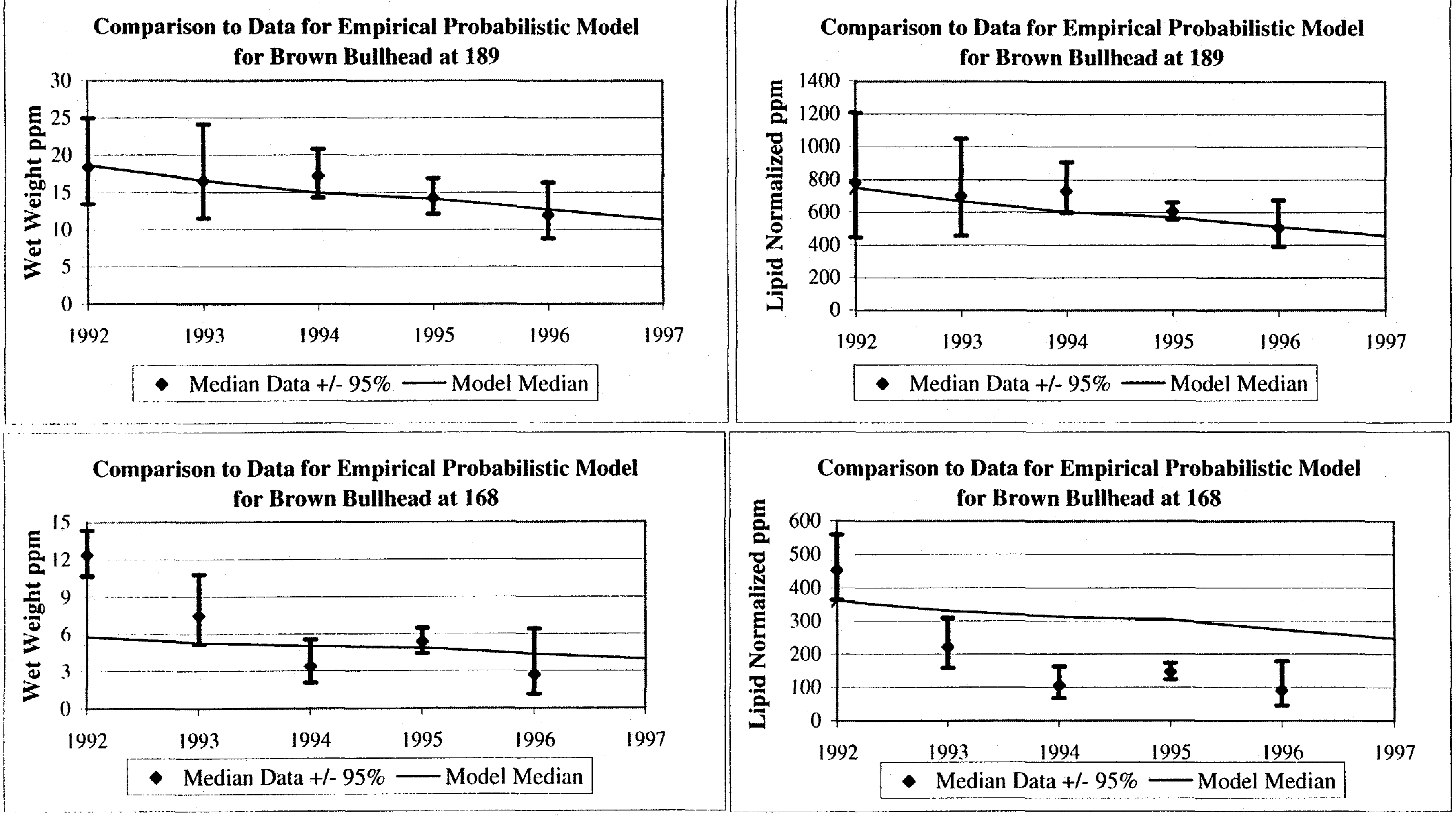


Figure 5-11: Comparison to Data for Empirical Probabilistic Model for Pumpkinseed

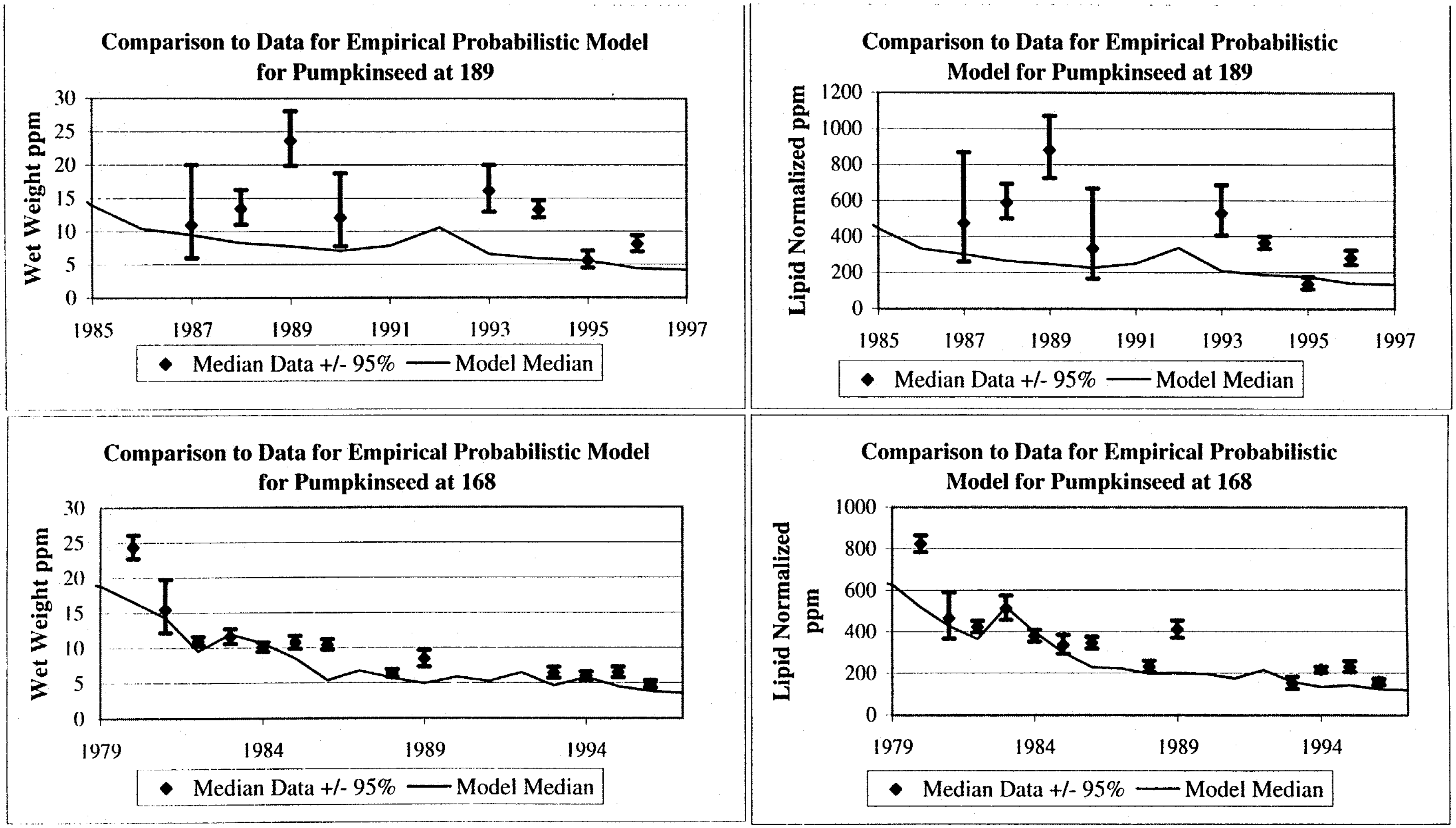
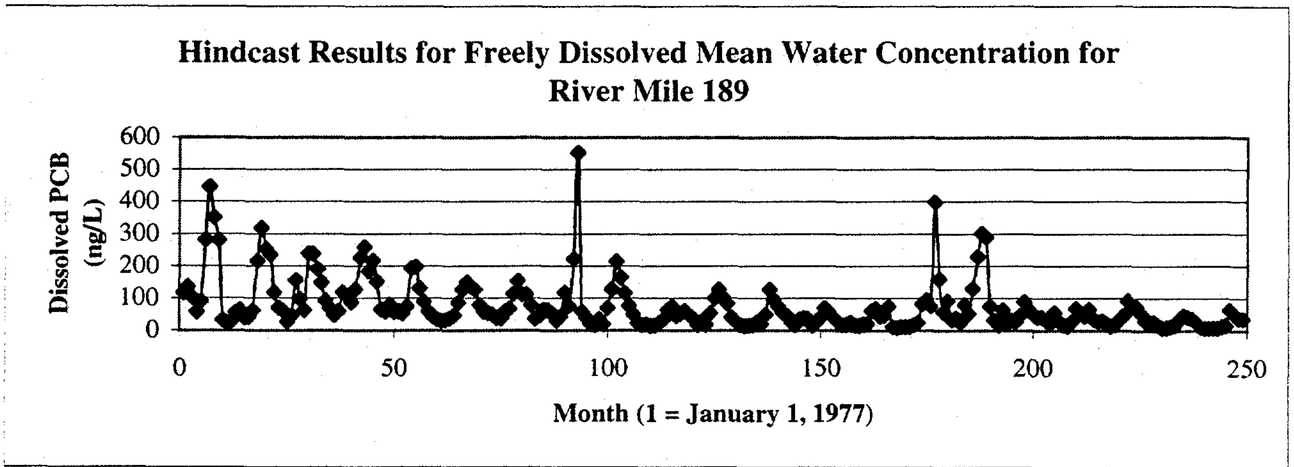
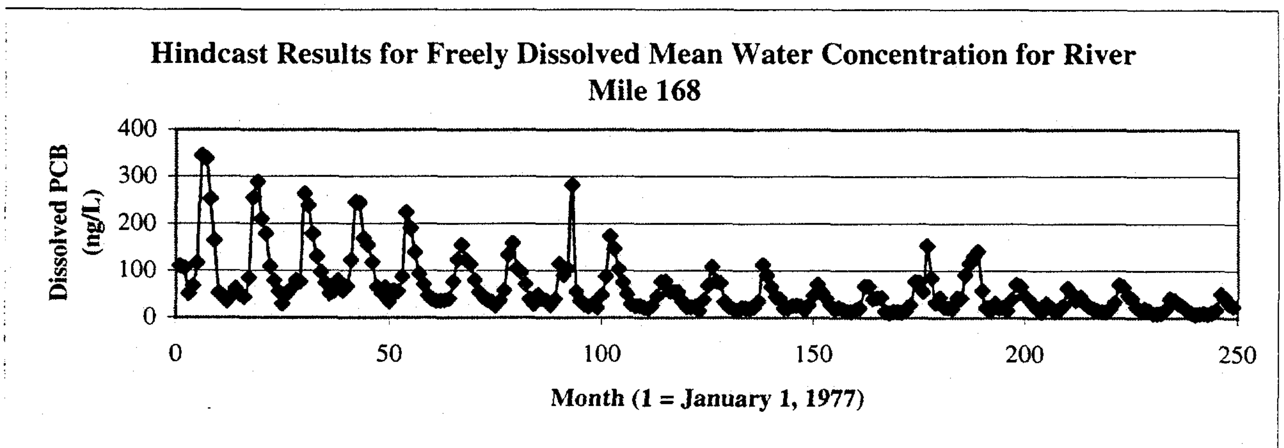


Figure 6-1: Freely Dissolved Water and Dry Weight Sediment Concentrations Predicted by HUDTOX for 1977 - 1997





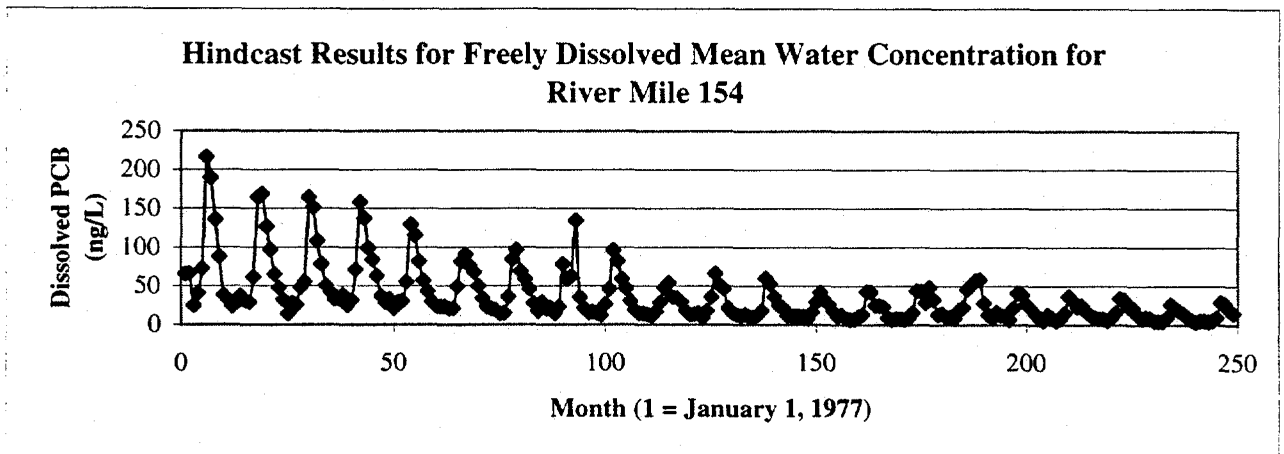


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Figure 6-1: Freely Dissolved Water and Dry Weight Sediment Concentrations Predicted by HUDTOX for 1977 - 1997, continued

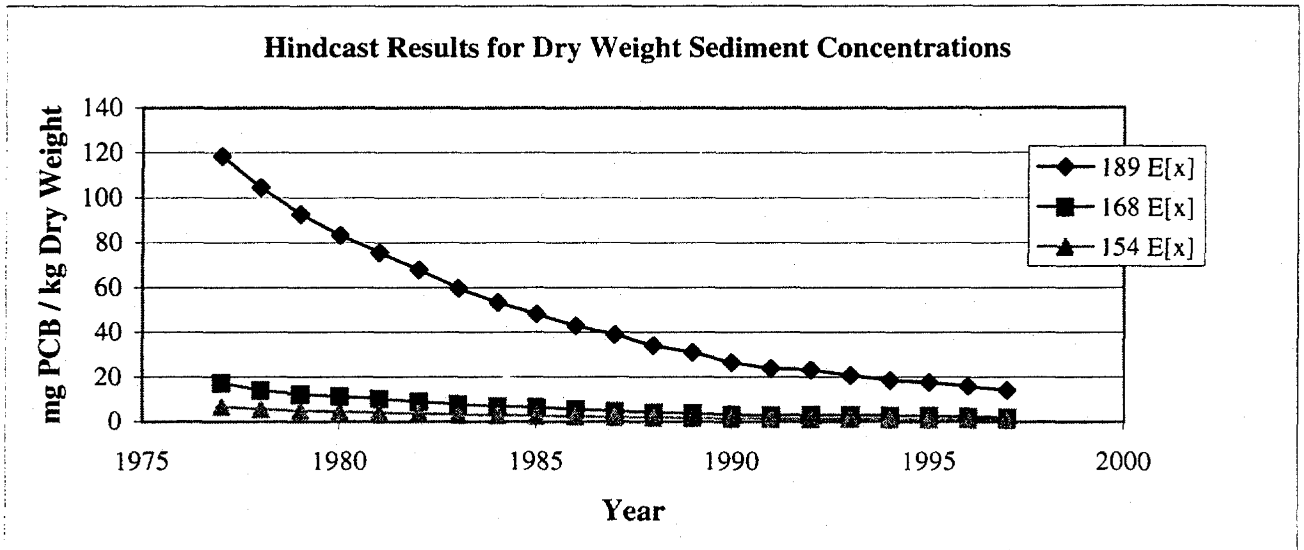

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Figure 6-2: Lipid Distributions Used in FISHRAND

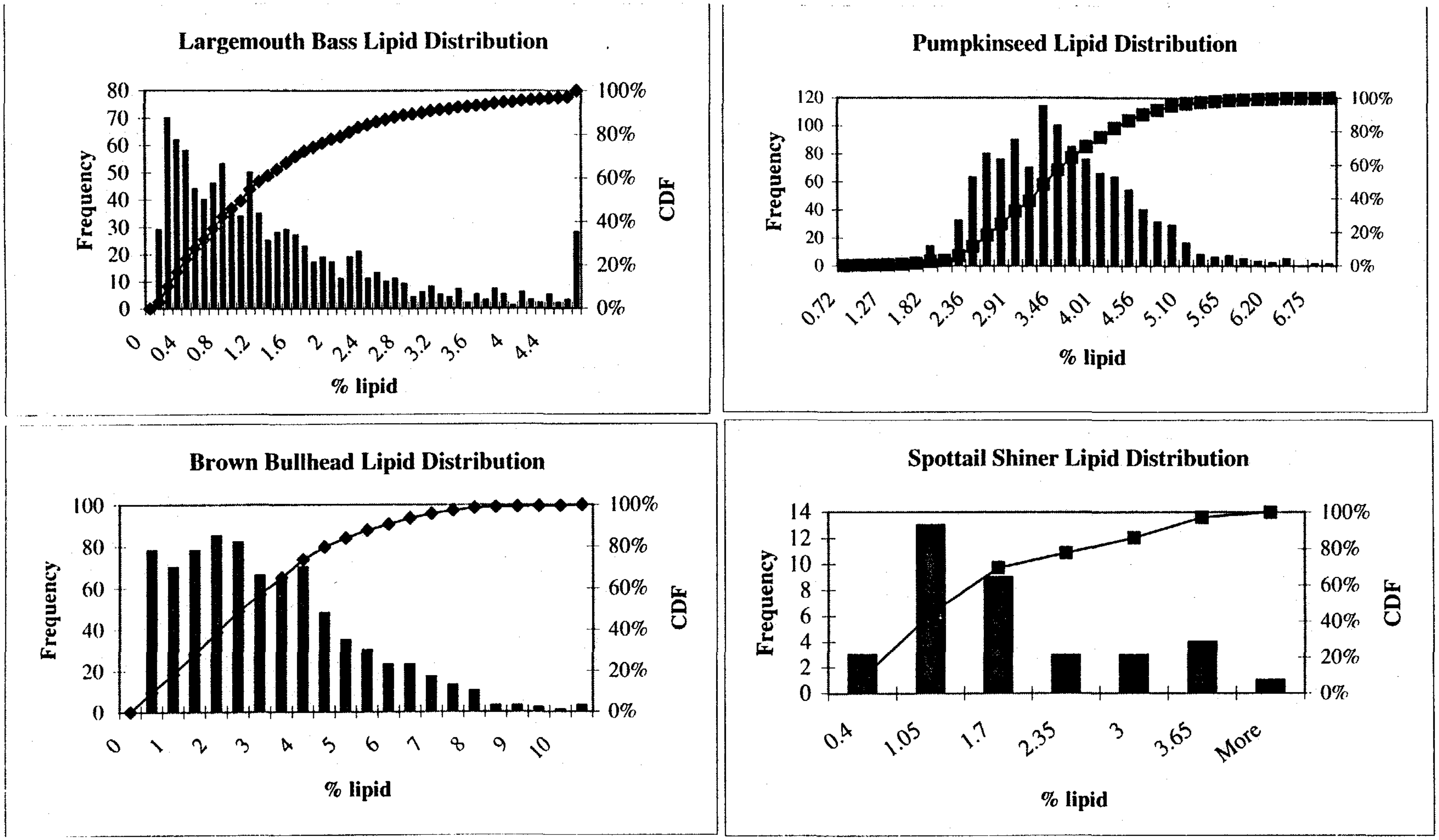

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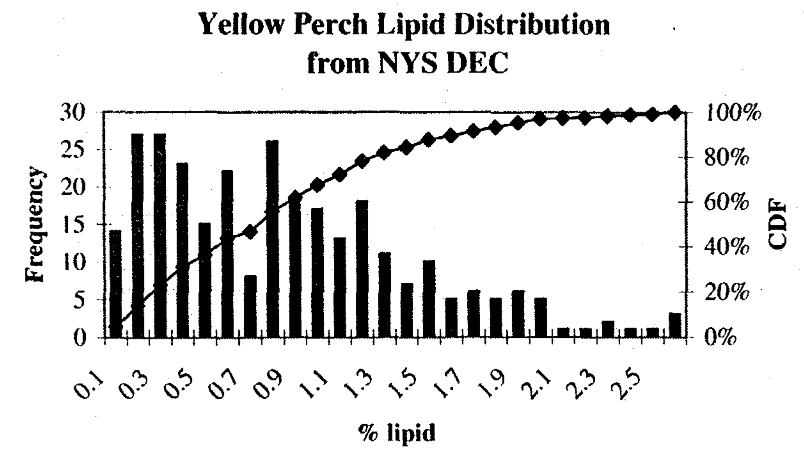
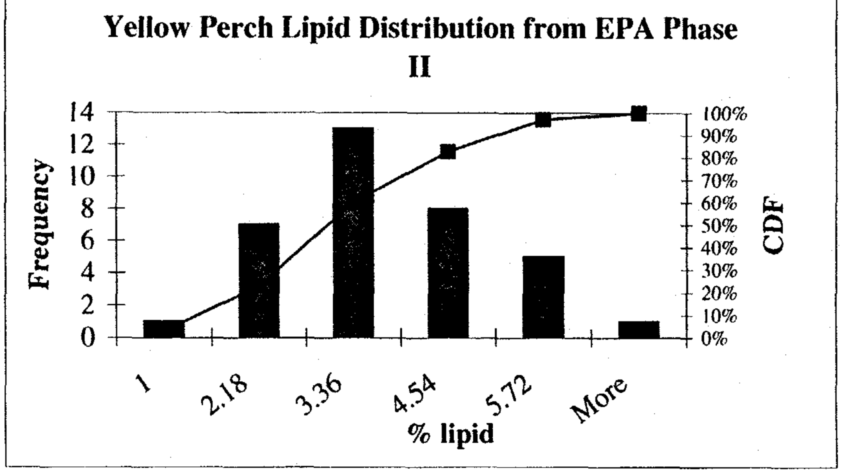
Figure 6-2: Lipid Distributions Used in FISHRAND (continued)





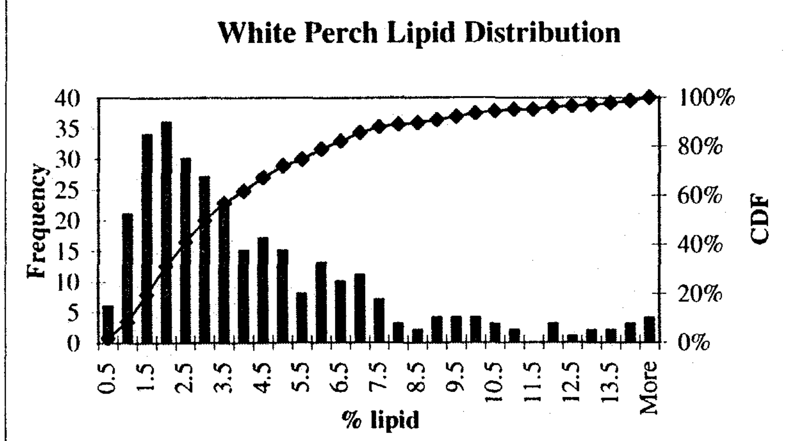


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Figure 6-3: Percent Lipid versus Weight for the Fish Species

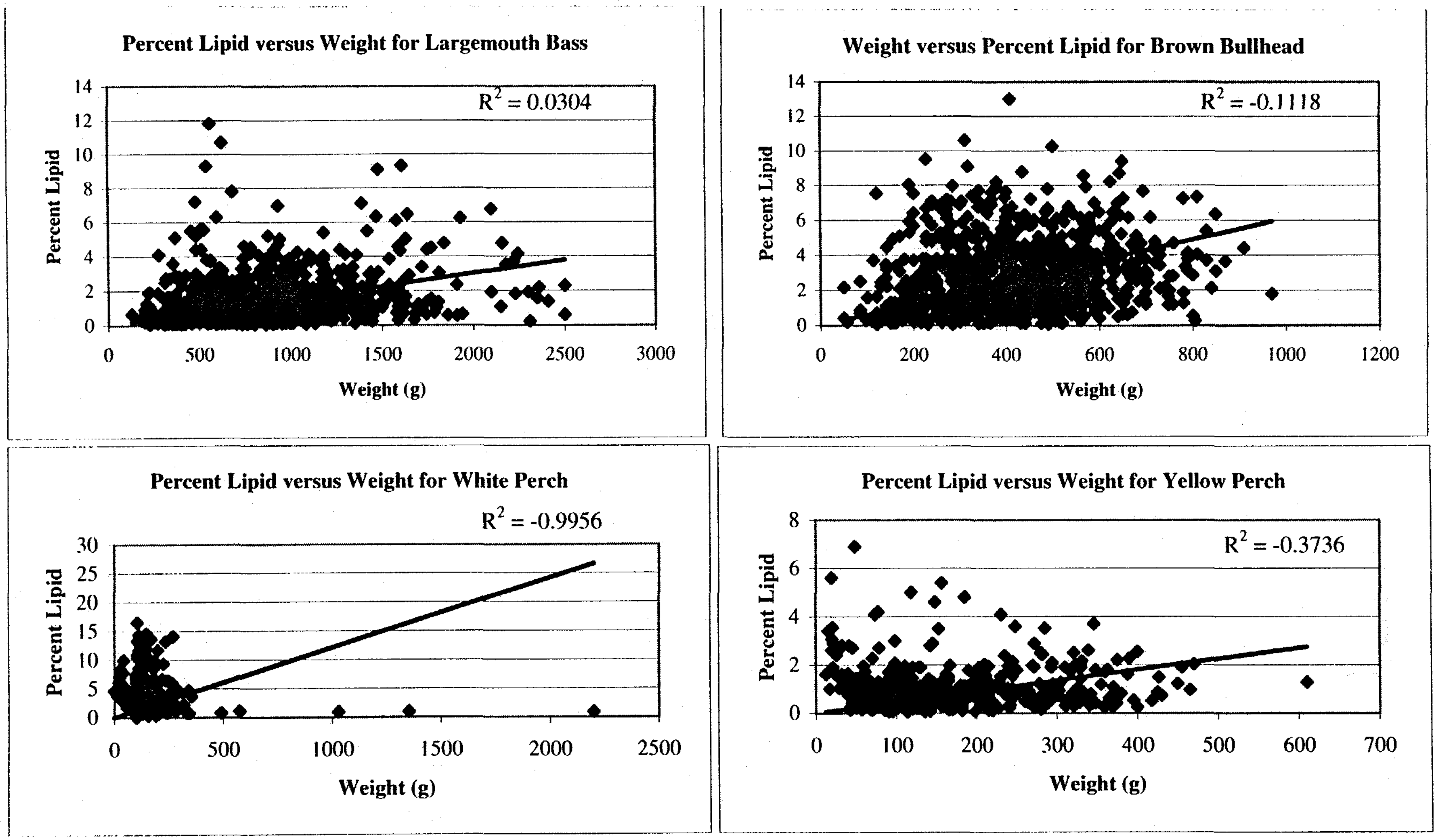

Figure 6-3: Percent Lipid versus Weight for the Fish Species (continued)

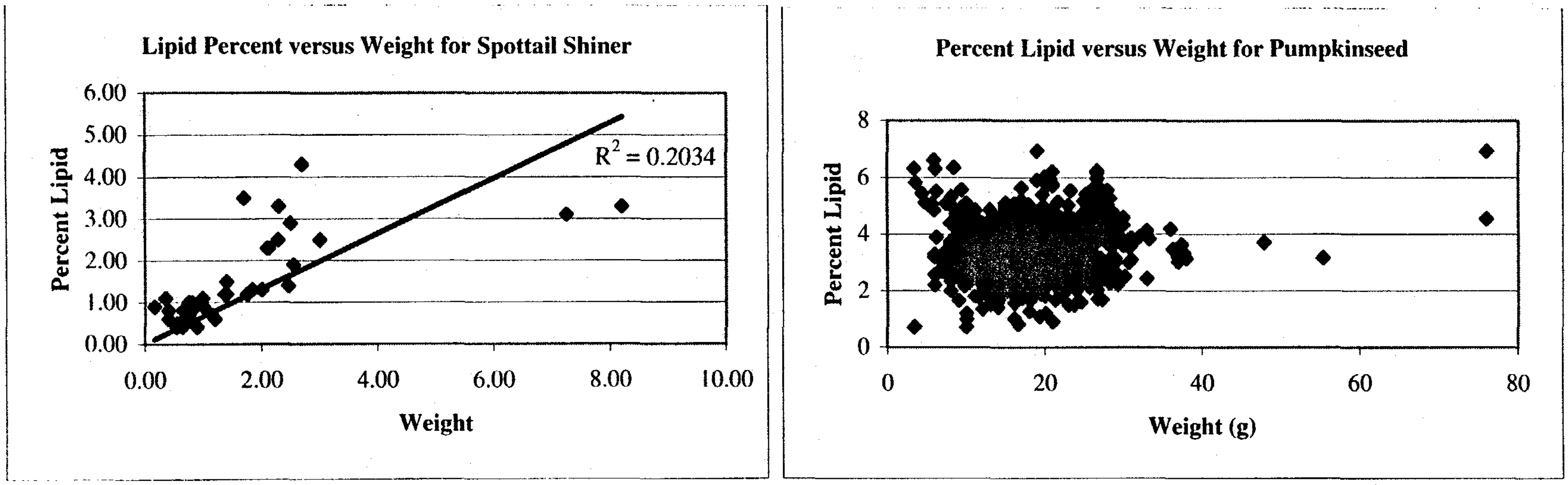

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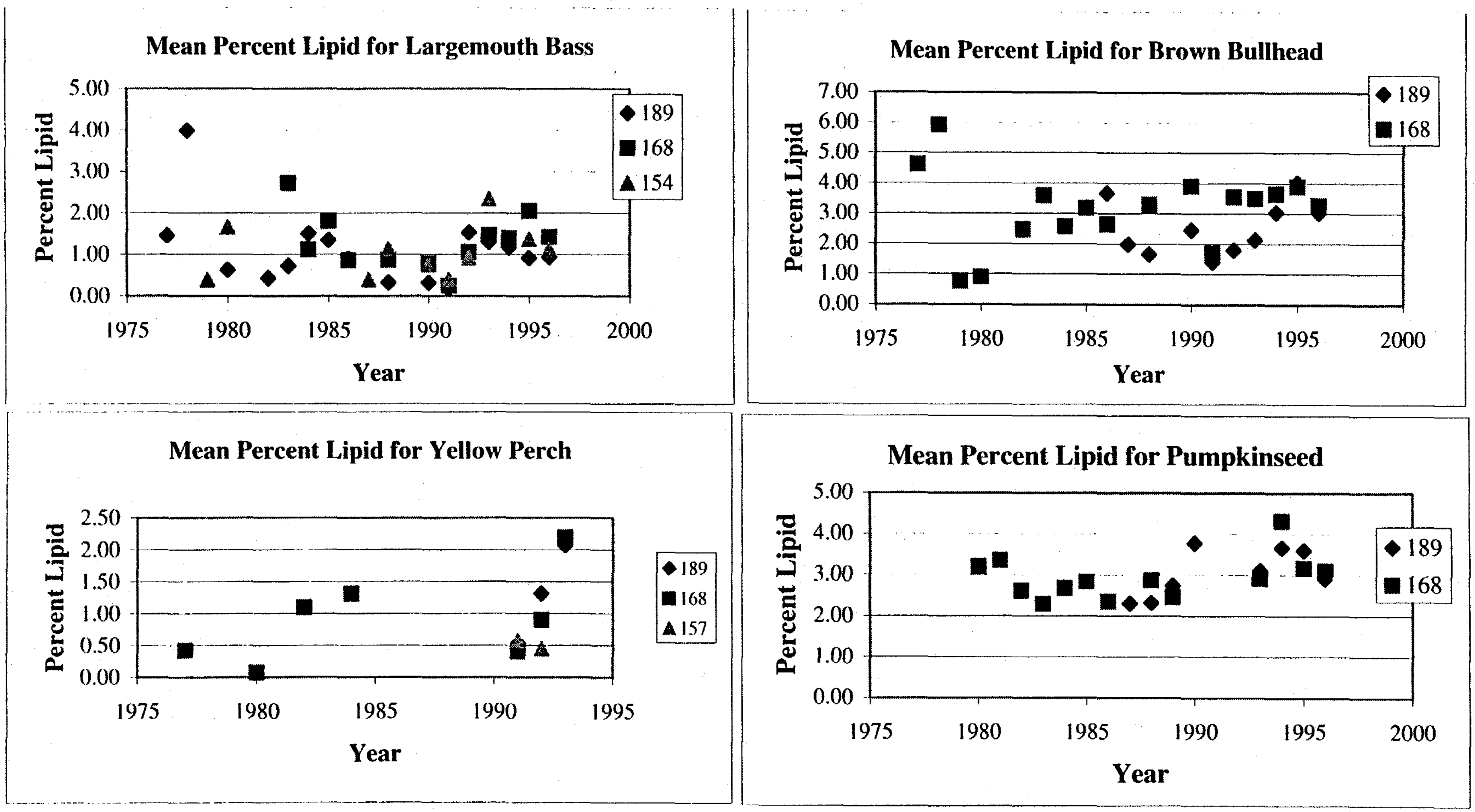
Figure 6-4: Mean Percent Lipid by Year for the Fish Species



Hudson River Database Release 4.1b

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Figure 6-5: Fish Weight Distributions Used in FISHRAND

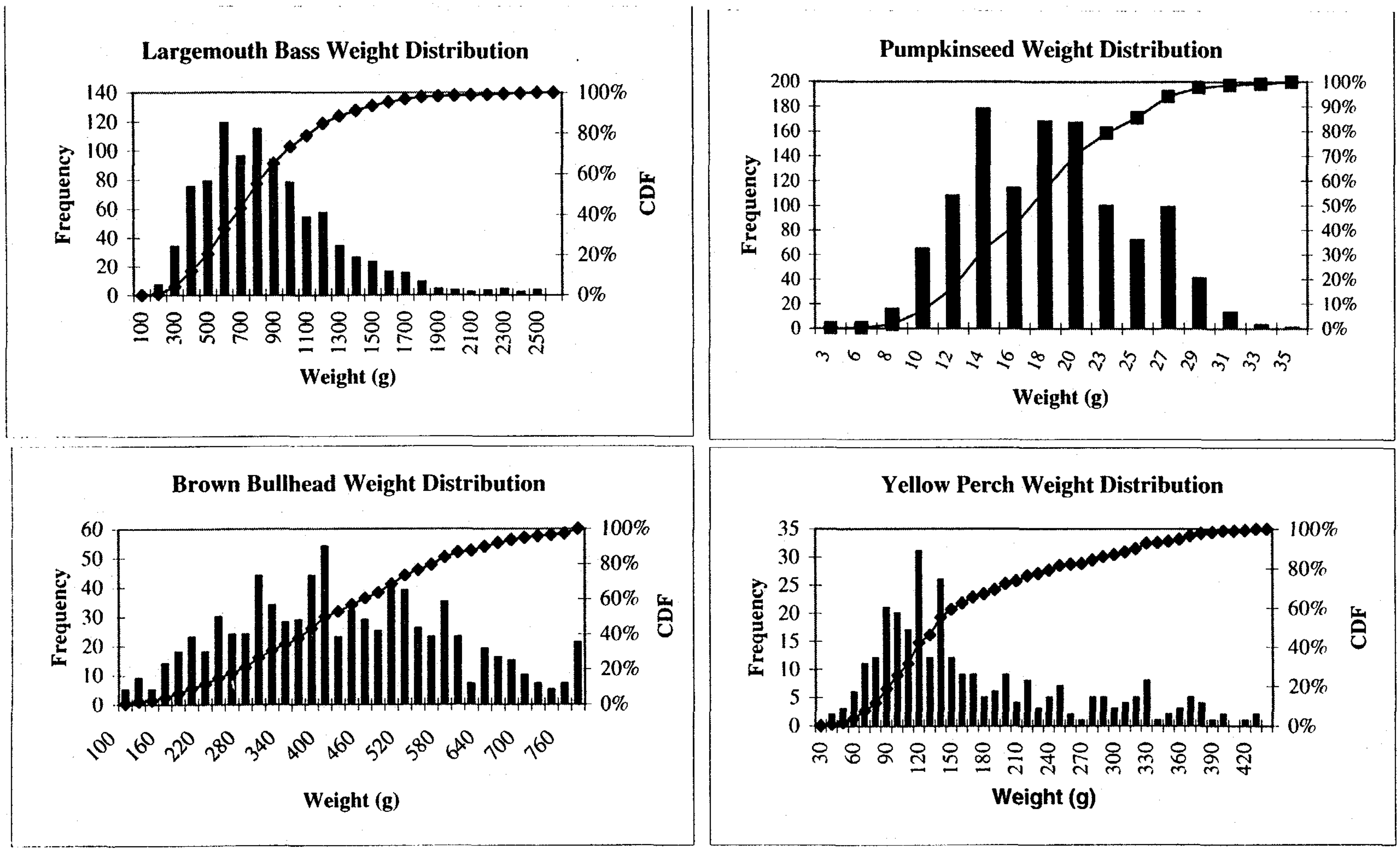

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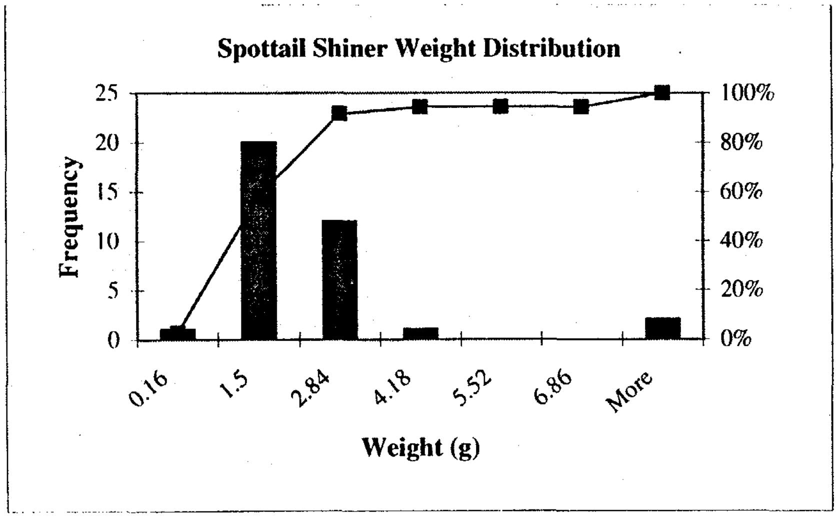
Figure 6-5: Fish Weight Distributions Used in FISHRAND (continued)



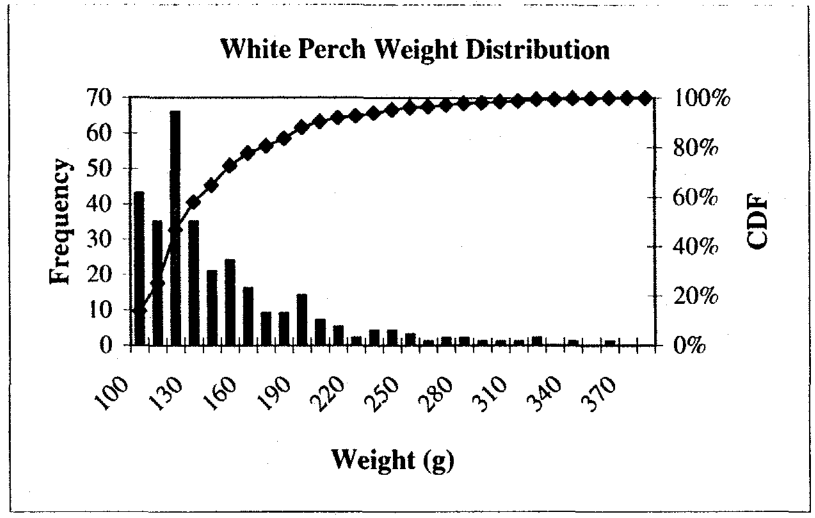


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Figure 6-6: Comparison of FISHRAND Model Results Before and After Calibration Procedure for Largemouth Bass

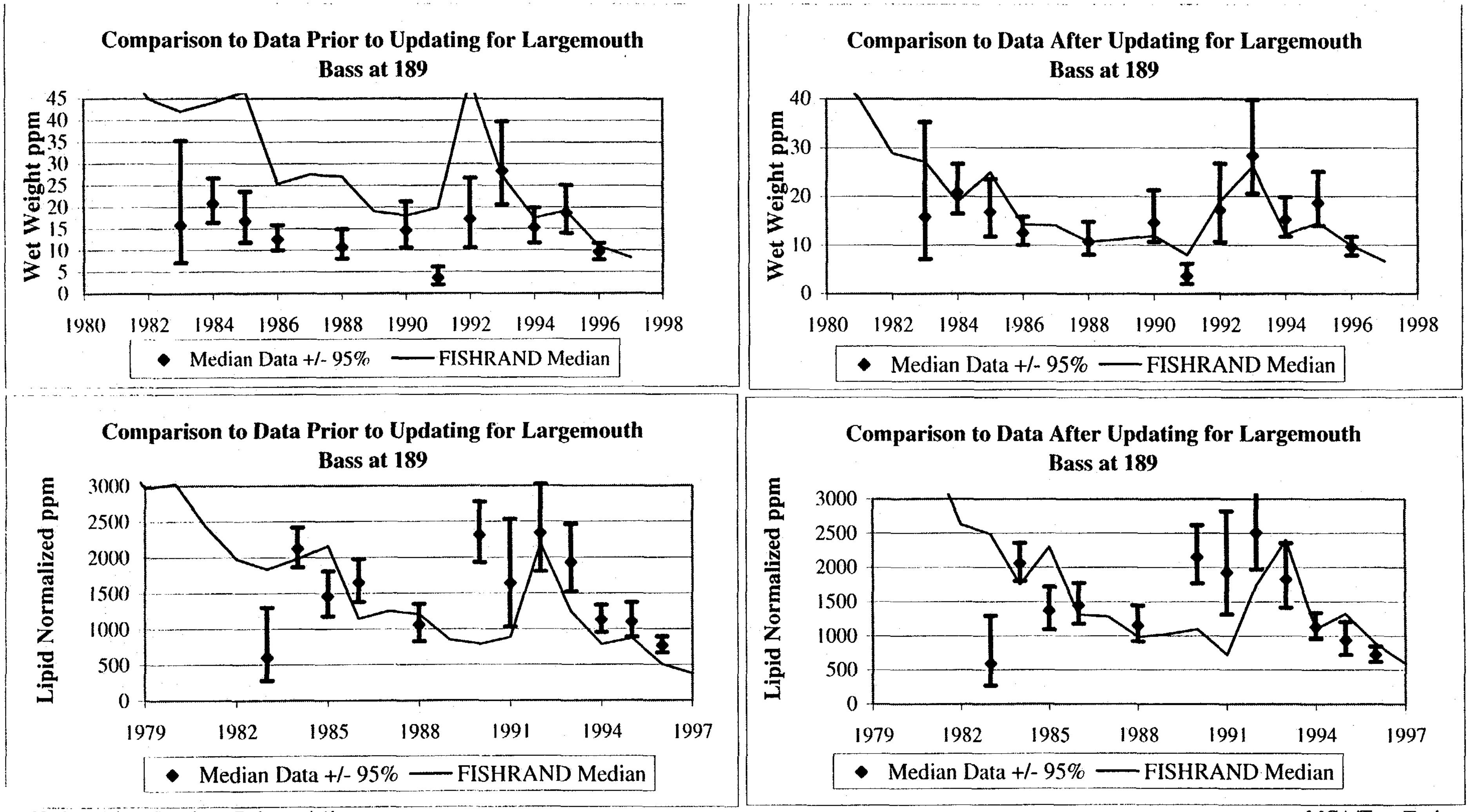

Figure 6-6: Comparison of FISHRAND Model Results Before and After Calibration Procedure for Largemouth Bass, continued

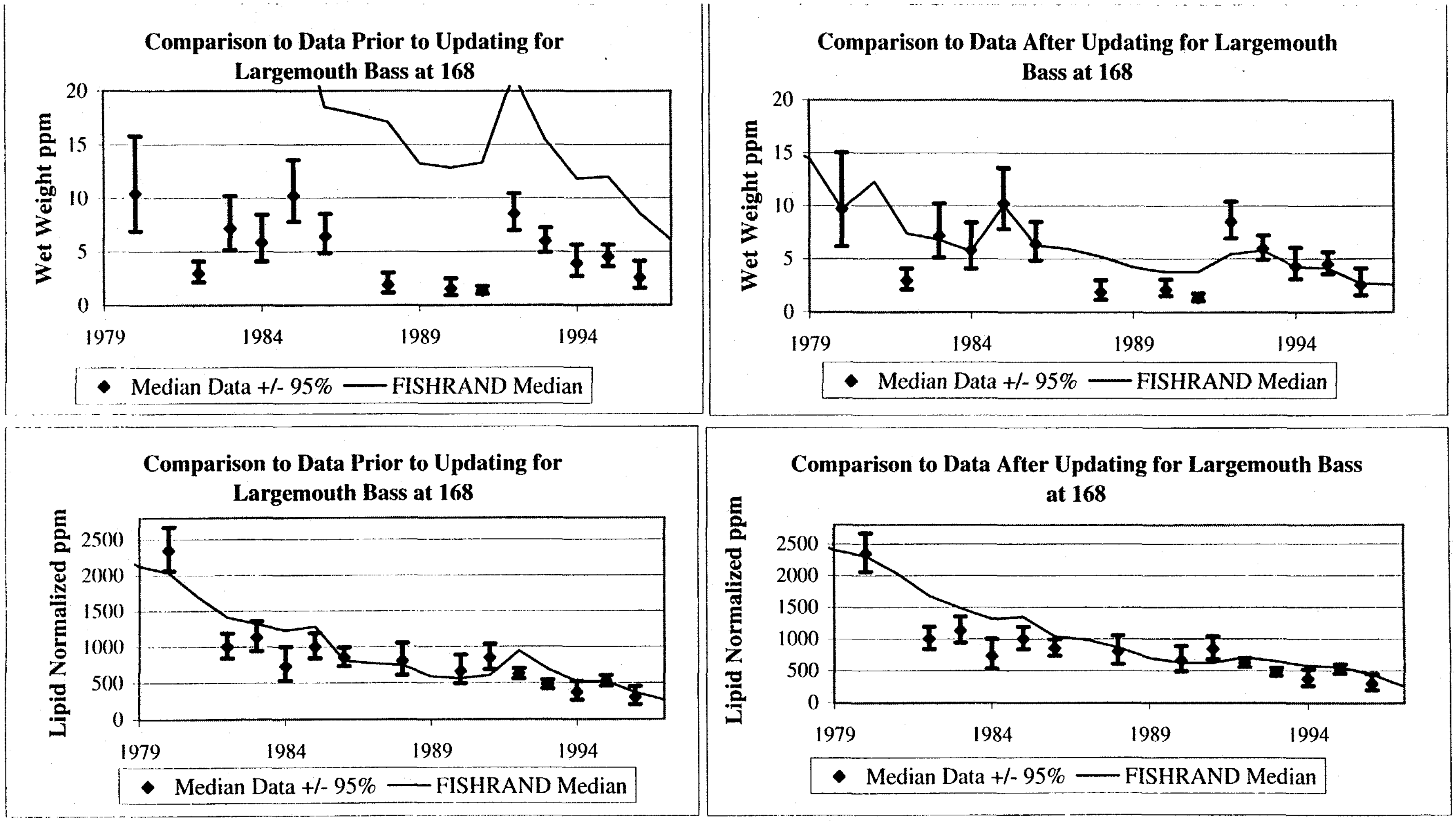

Figure 6-6: Comparison of FISHRAND Model Results Before and After Calibration Procedure for Largemouth Bass, continued

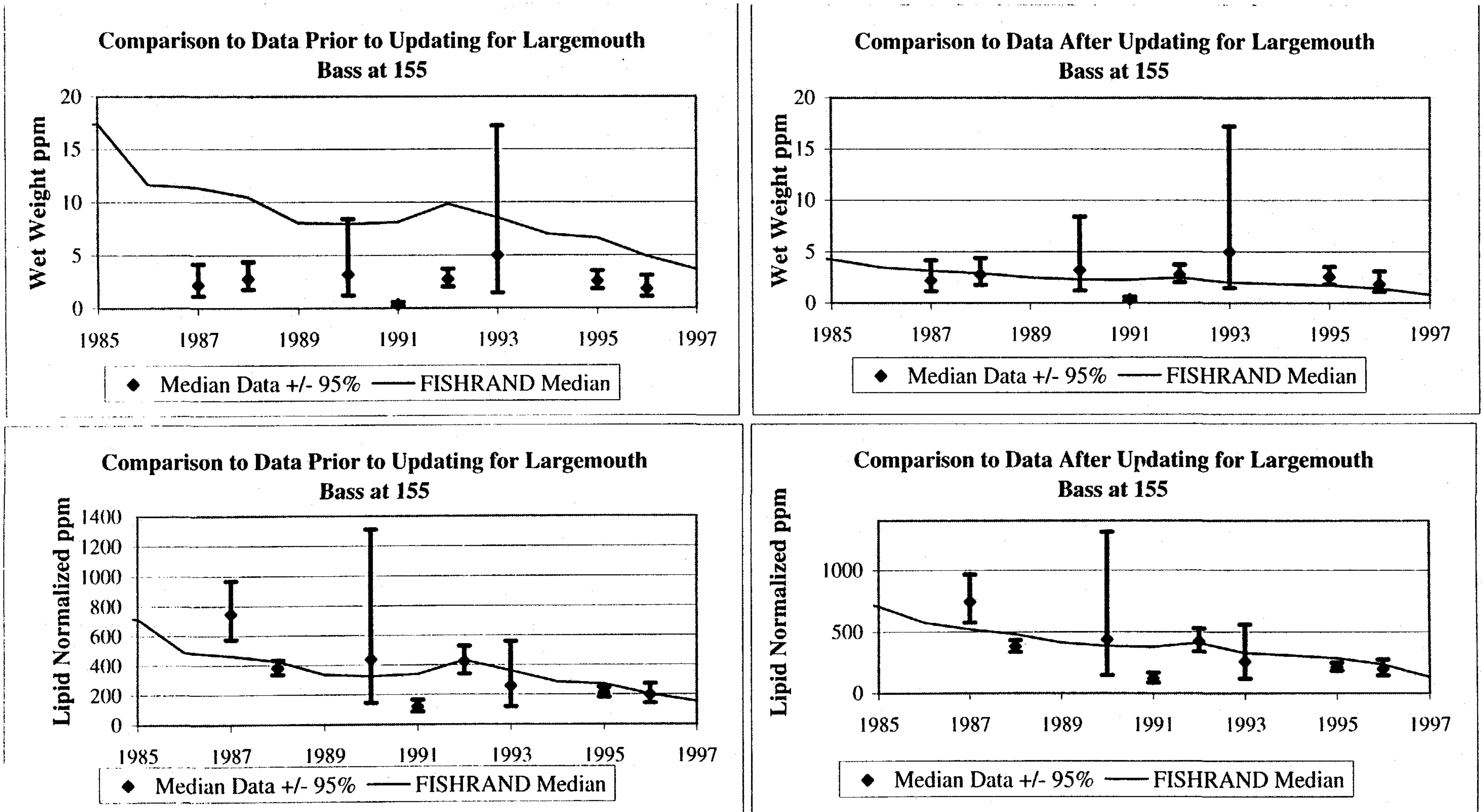

Figure 6-7: Comparison of FISHRAND Model Results Before and After Calibration Procedure, continued for Brown Bullhead

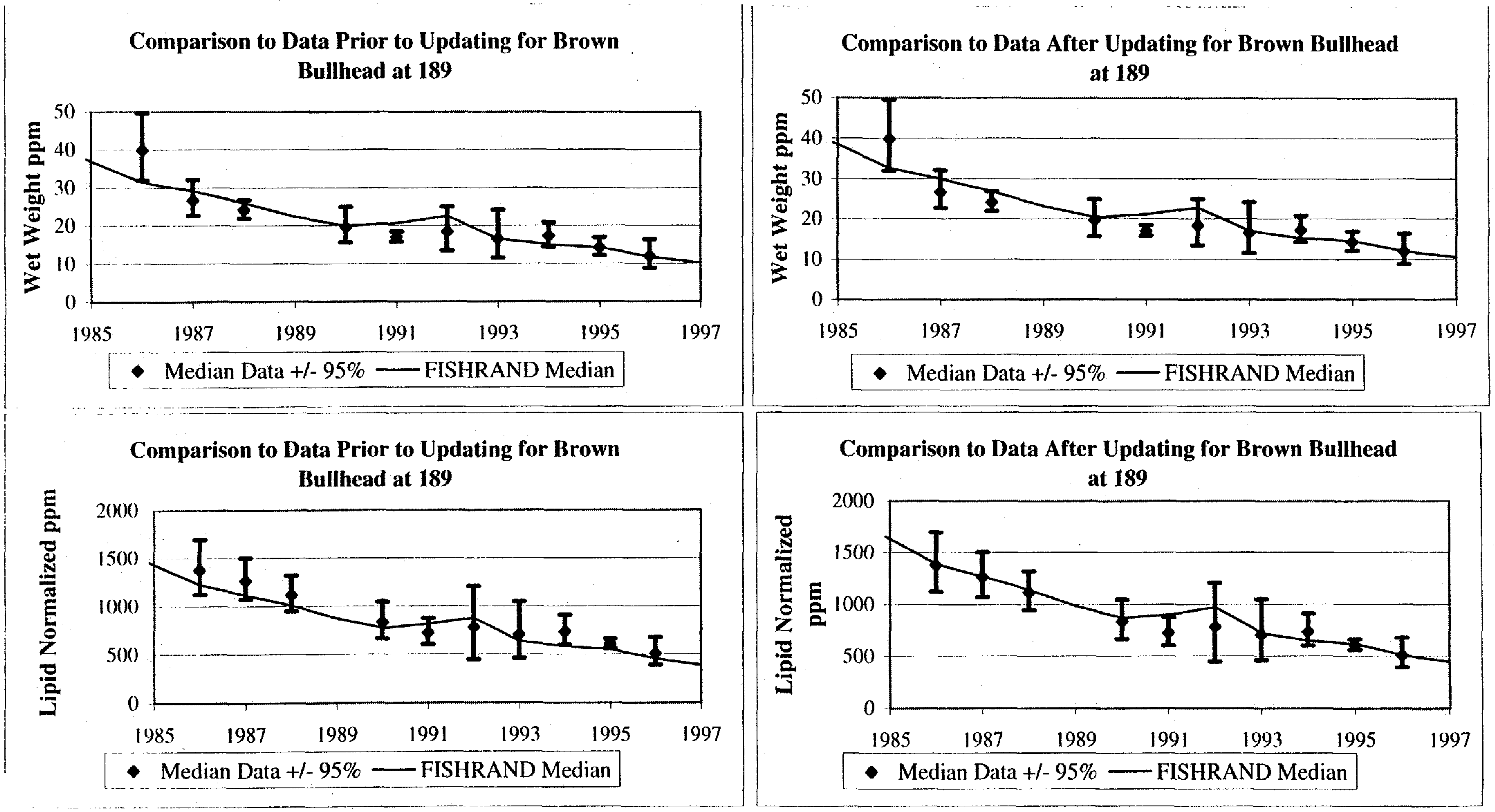

Figure 6-7: Comparison of FISHRAND Model Results Before and After Calibration Procedure for Brown Bullhead, continued

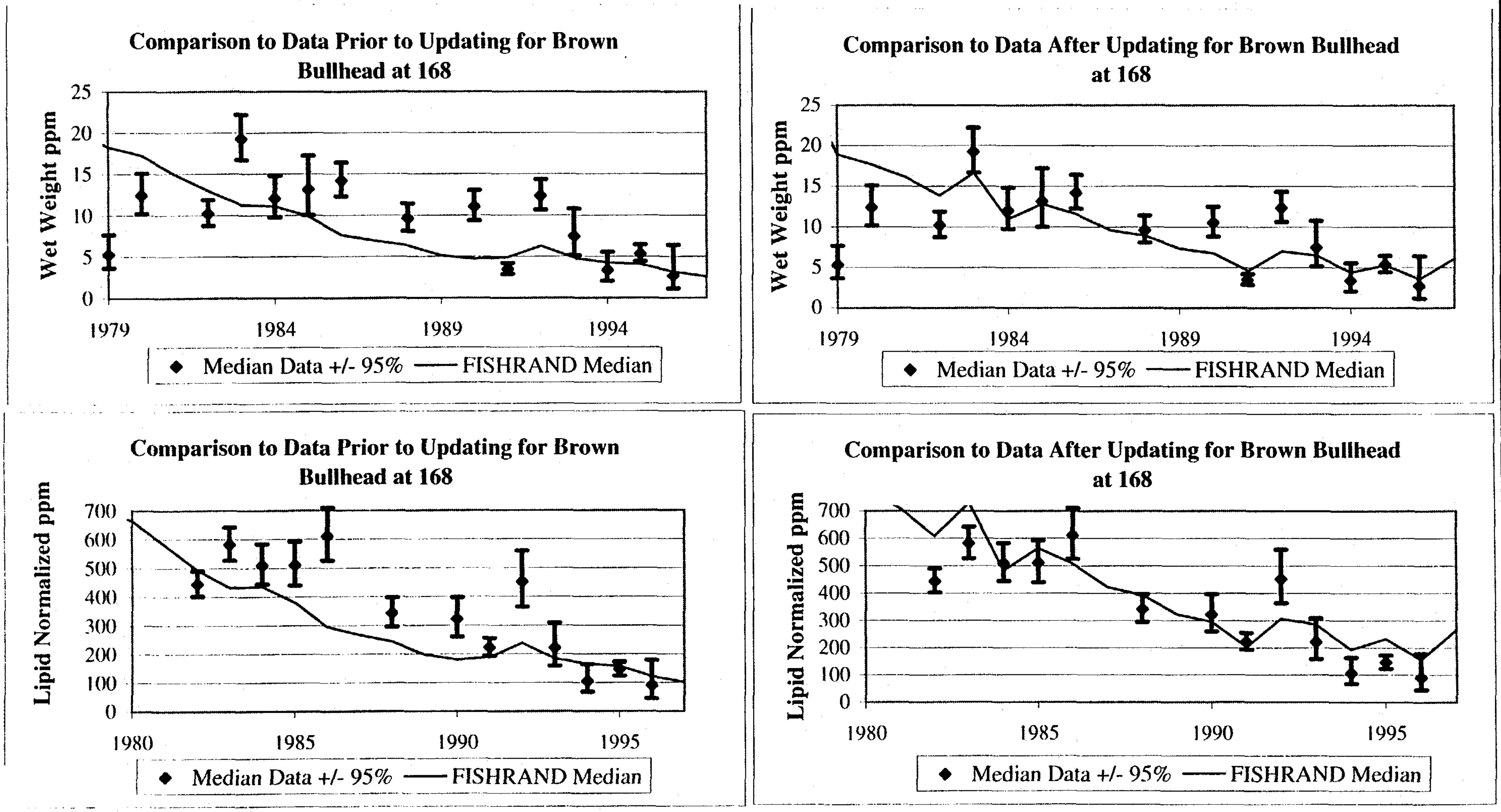

Figure 6-8: Comparison of FISHRAND Model Results Before and After Calibration Procedure for Yellow Perch and White Perch

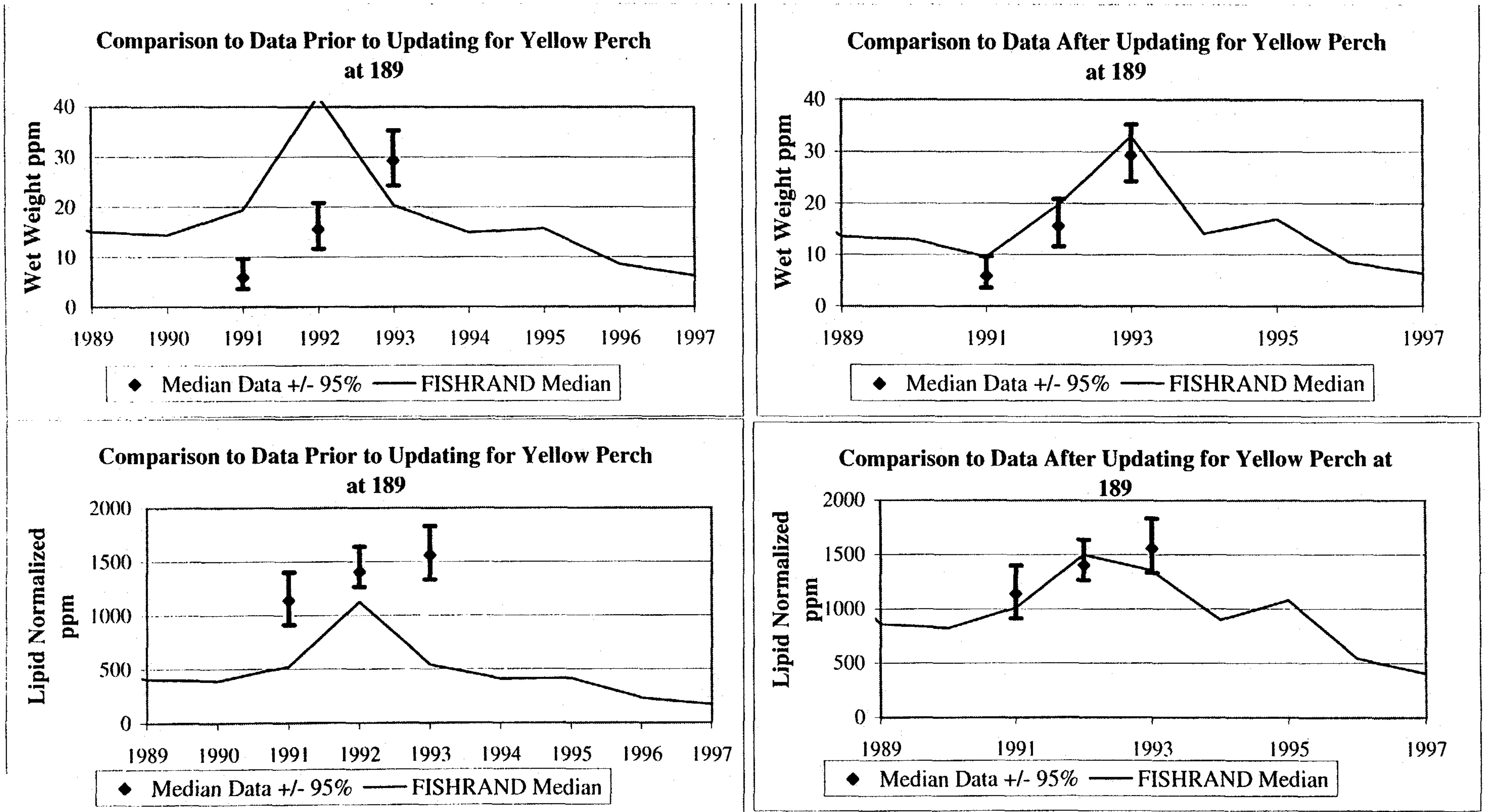

Figure 6-8: Comparison of FISHRAND Model Results Before and After Calibration Procedure, continued for Yellow Perch and White Perch, continued

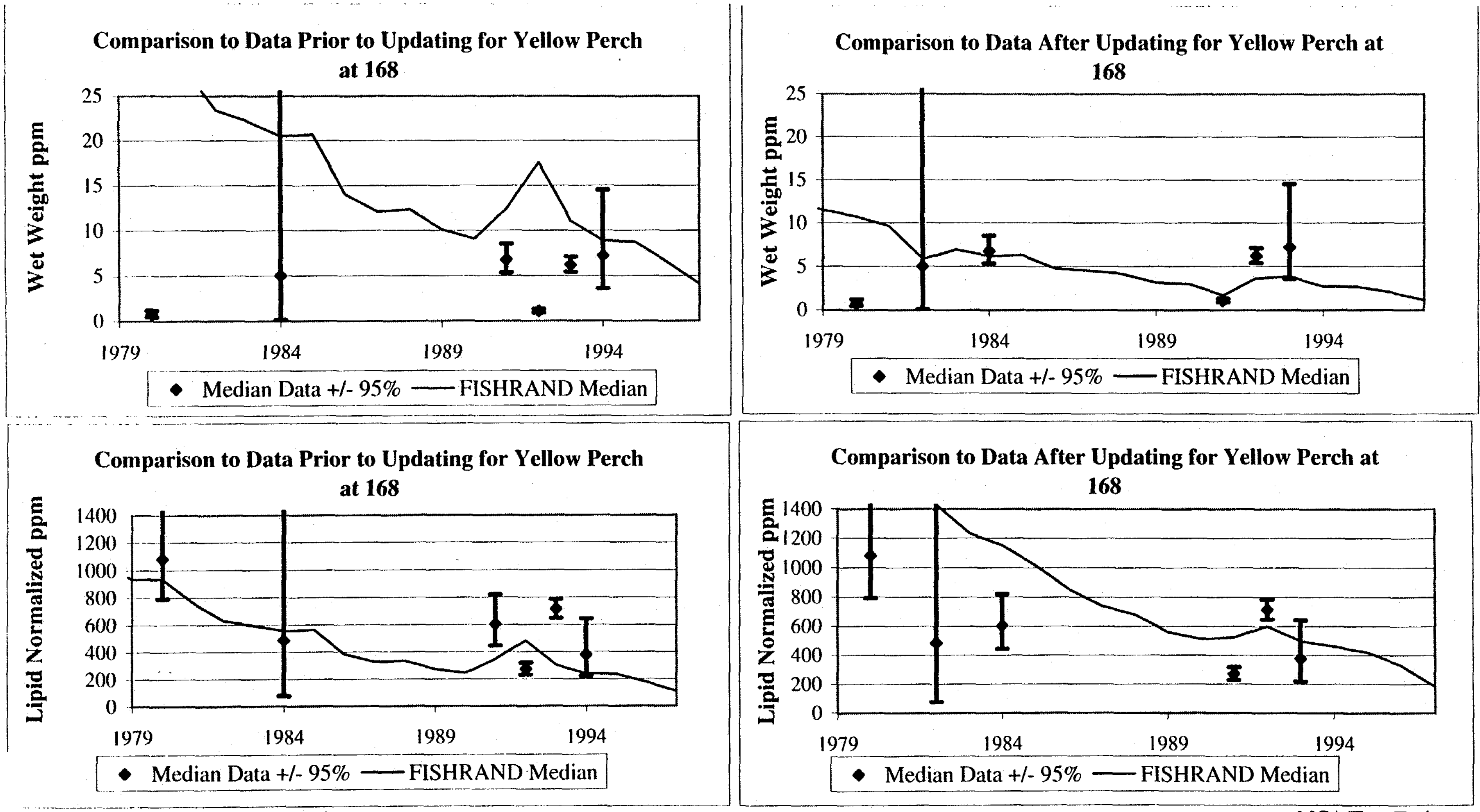

Figure 6-8: Comparison of FISHRAND Model Results Before and After Calibration Procedure for Yellow Perch and White Perch, continued

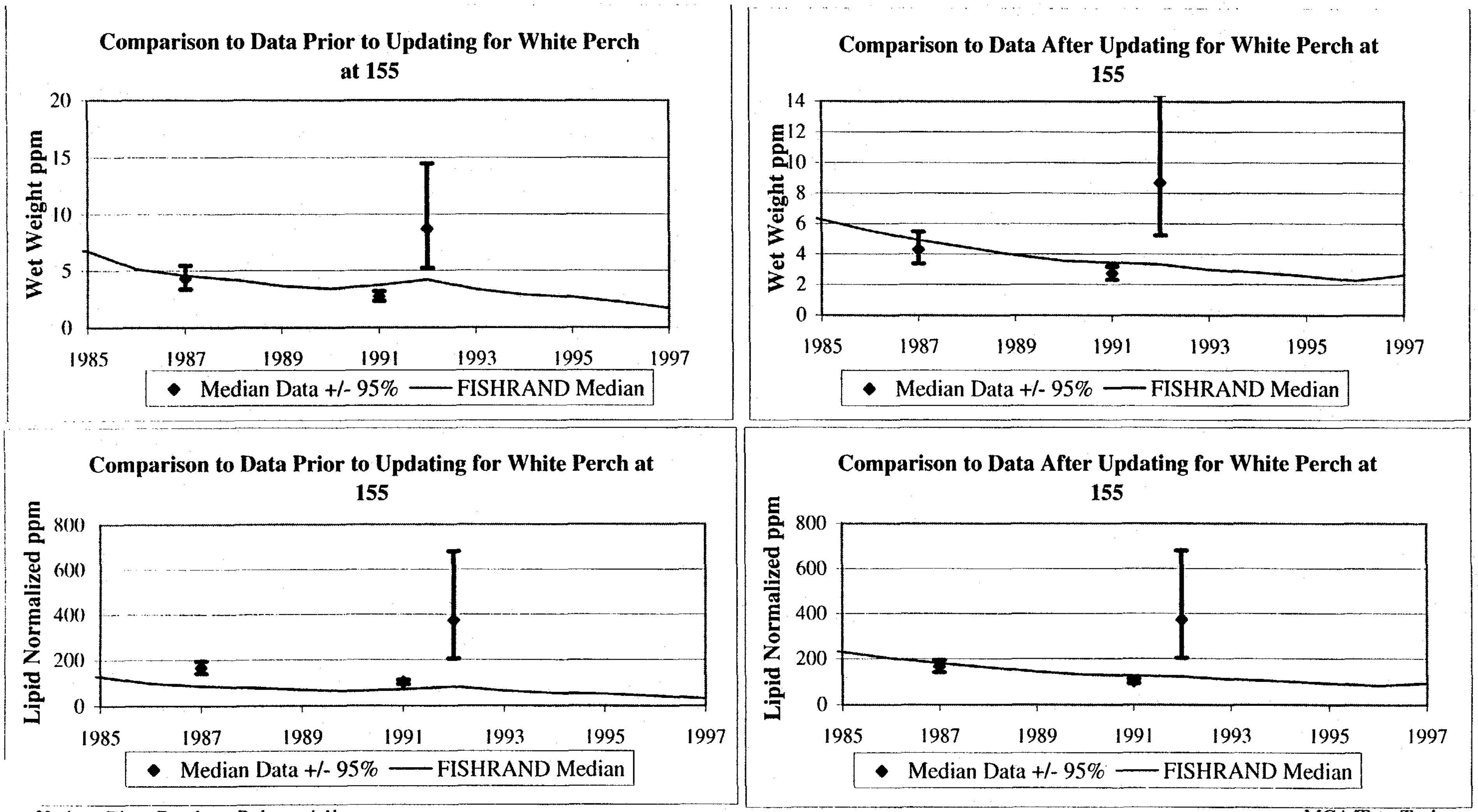

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Figure 6-9: Comparison of FISHRAND Model Results Before and After Calibration Procedure for Pumpkinseed

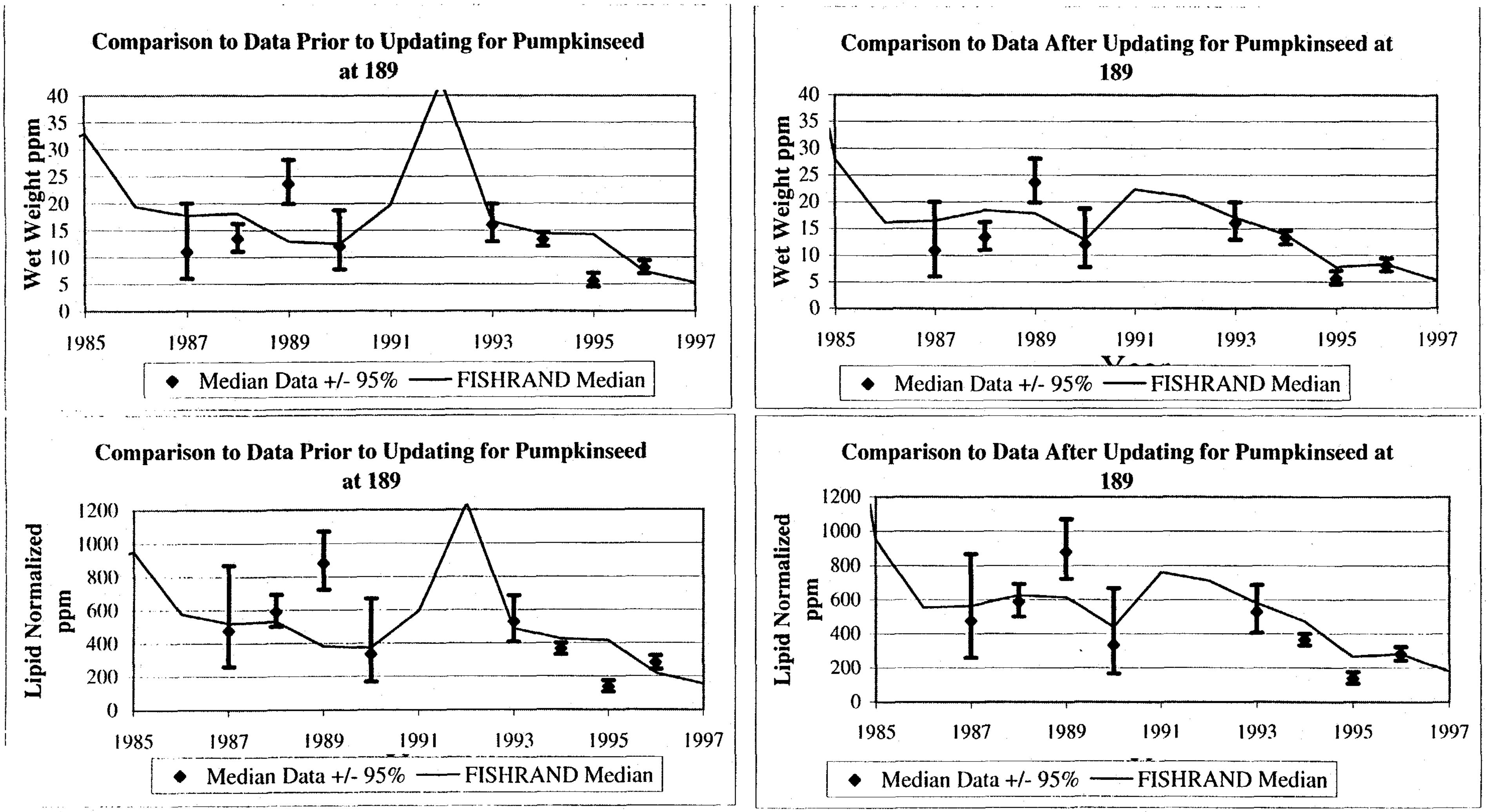

Figure 6-9: Comparison of FISHRAND Model Results Before and After Calibration Procedure for Pumpkinseed, continued

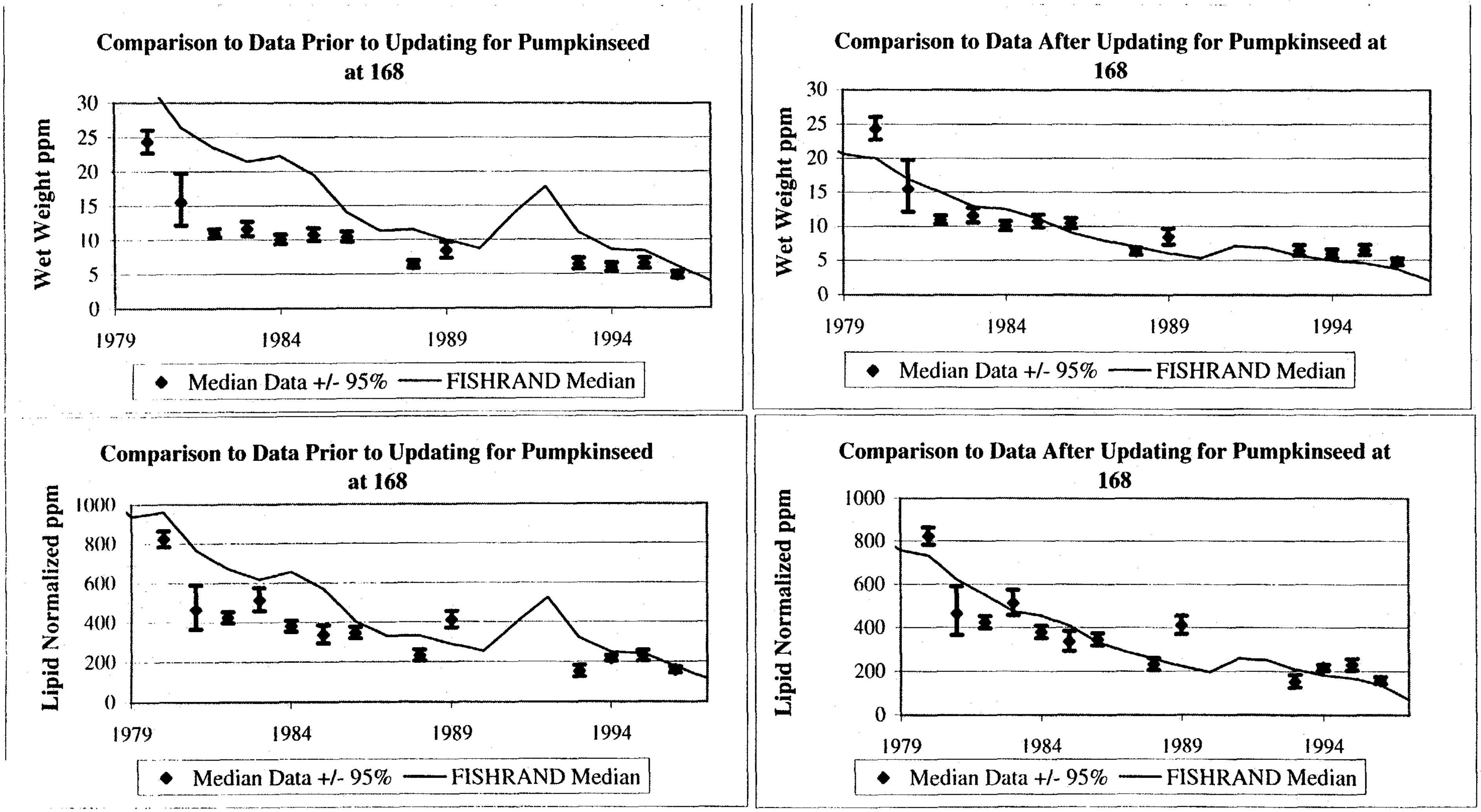

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Figure 6-10: Predicted versus Observed Quantiles for River Mile 189

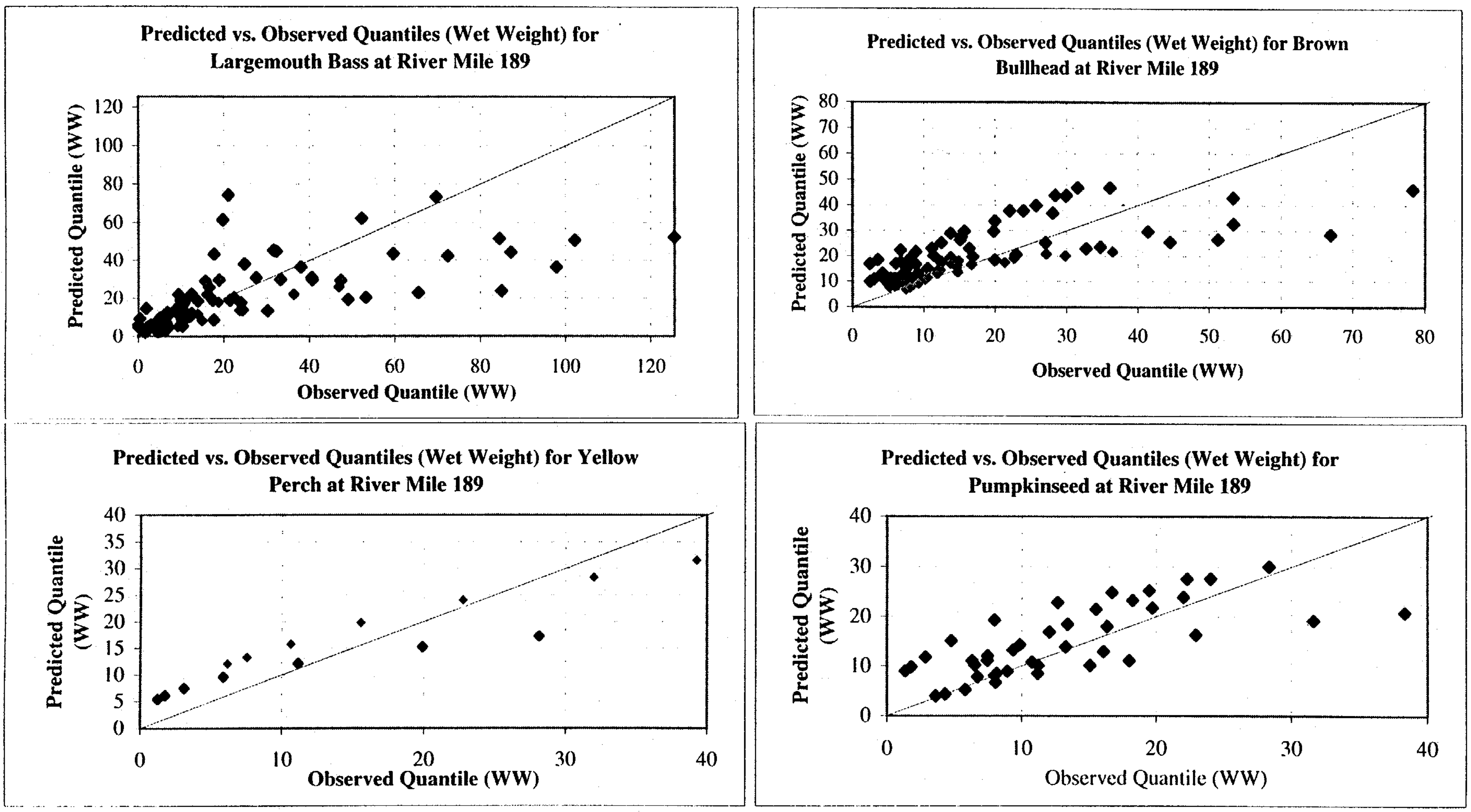
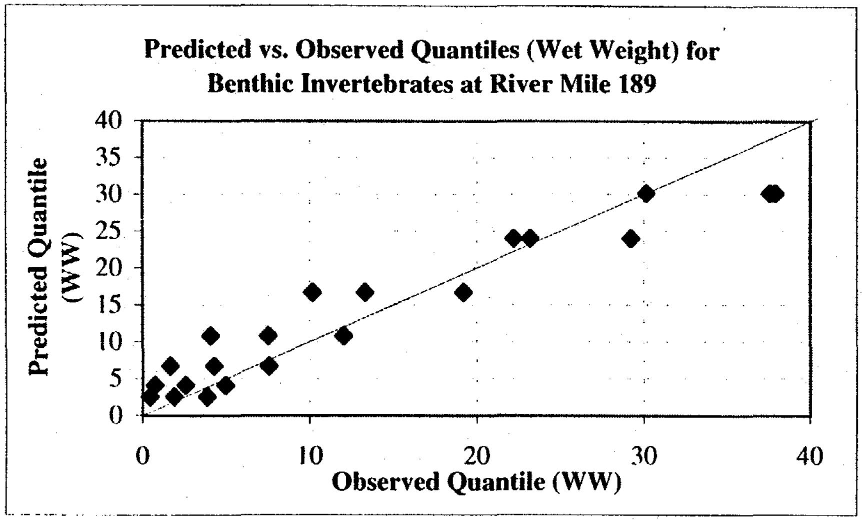


Figure 6-10: Predicted versus Observed Quantiles for River Mile 189



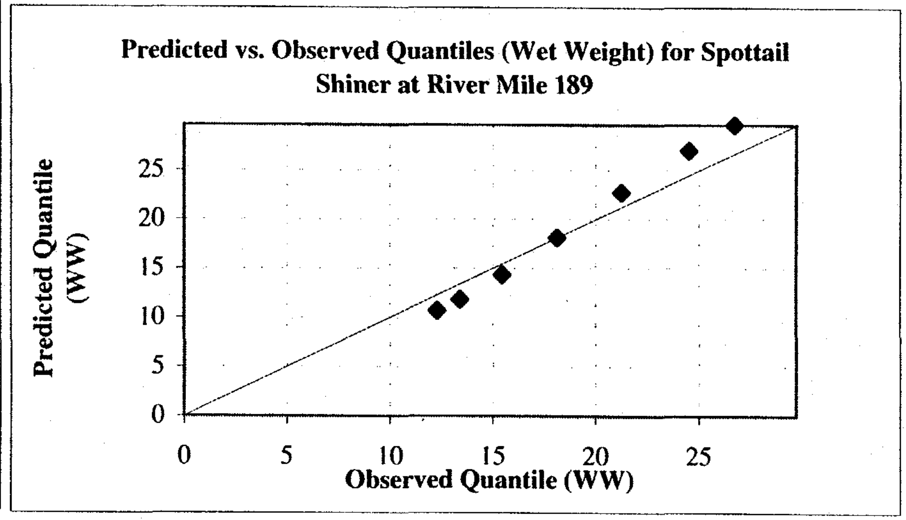


Figure 6-11: Predicted versus Observed Quantiles for River Mile 168

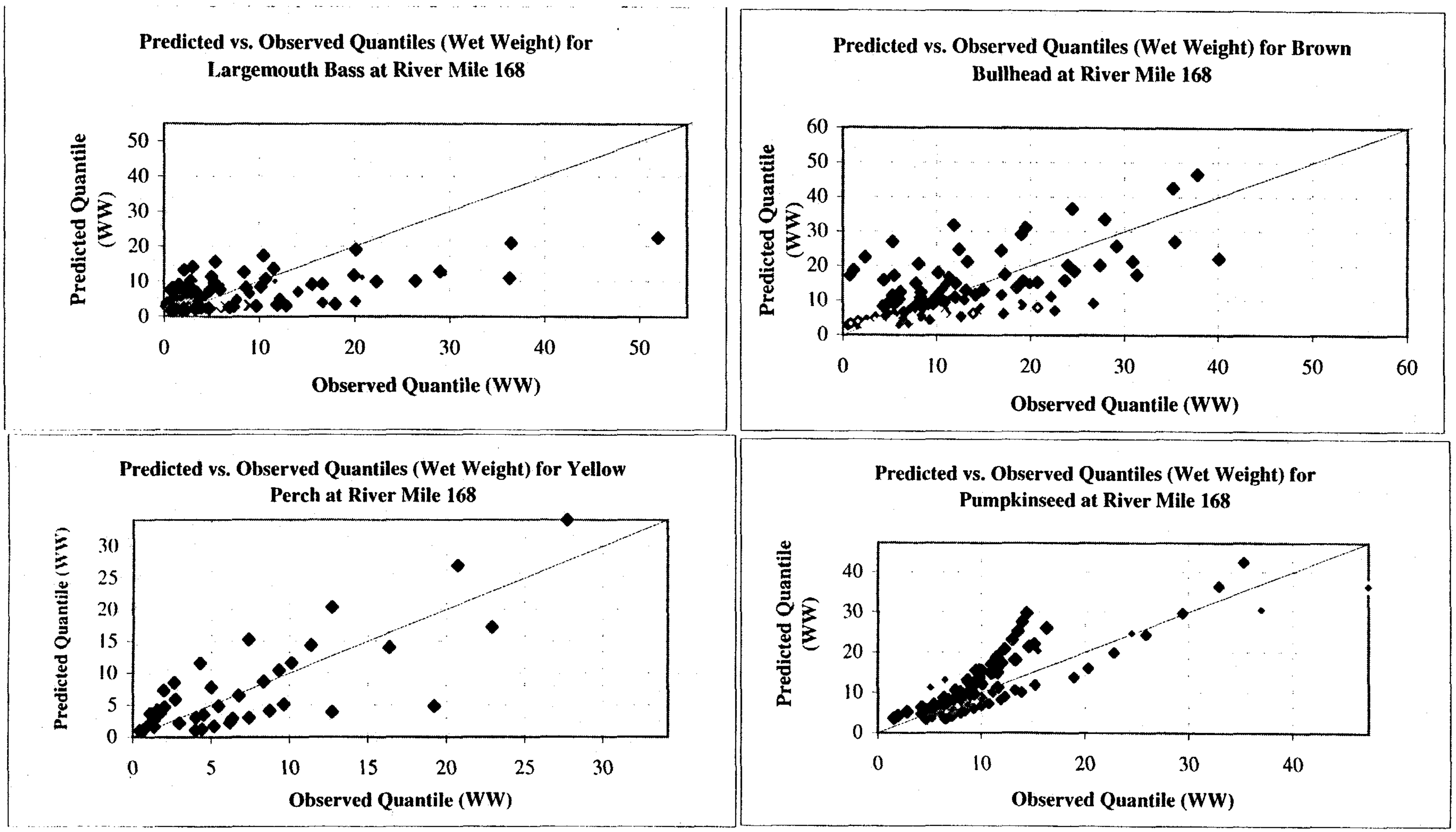
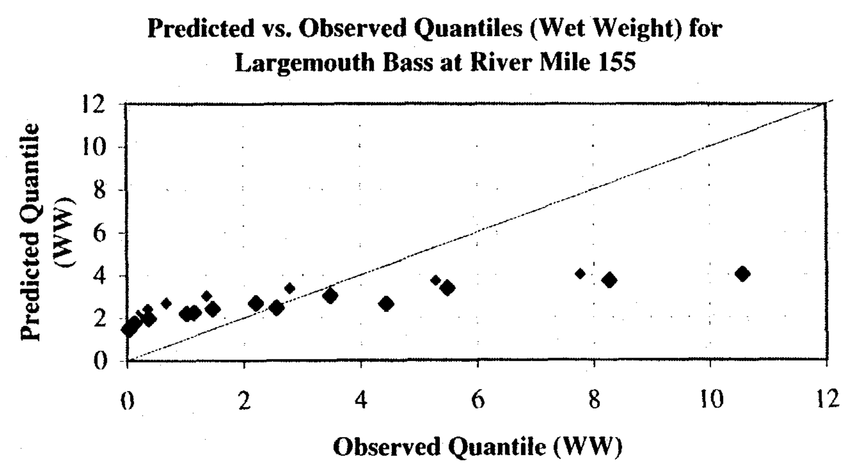


Figure 6-12: Predicted versus Observed Quantiles for River Mile 155



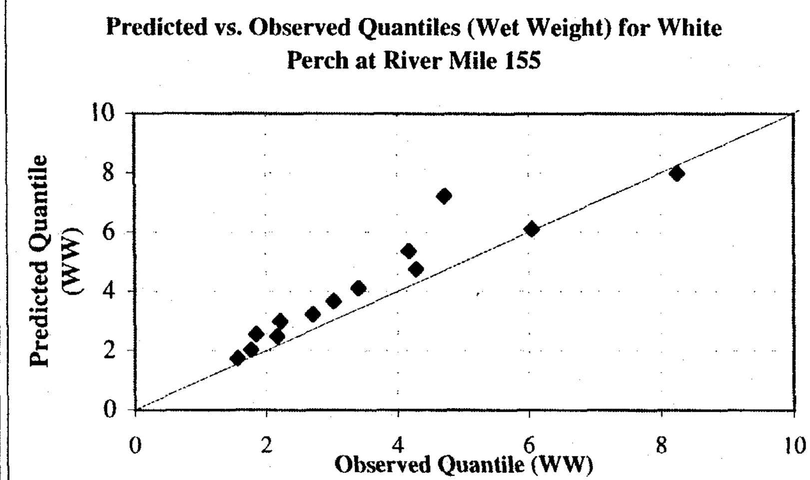


FIGURE 7-1: Freely Dissolved Water and Dry Weight Sediment Concentrations Predicted by HUDTOX for 1998 - 2067 Under Zero Upstream Boundary Condition

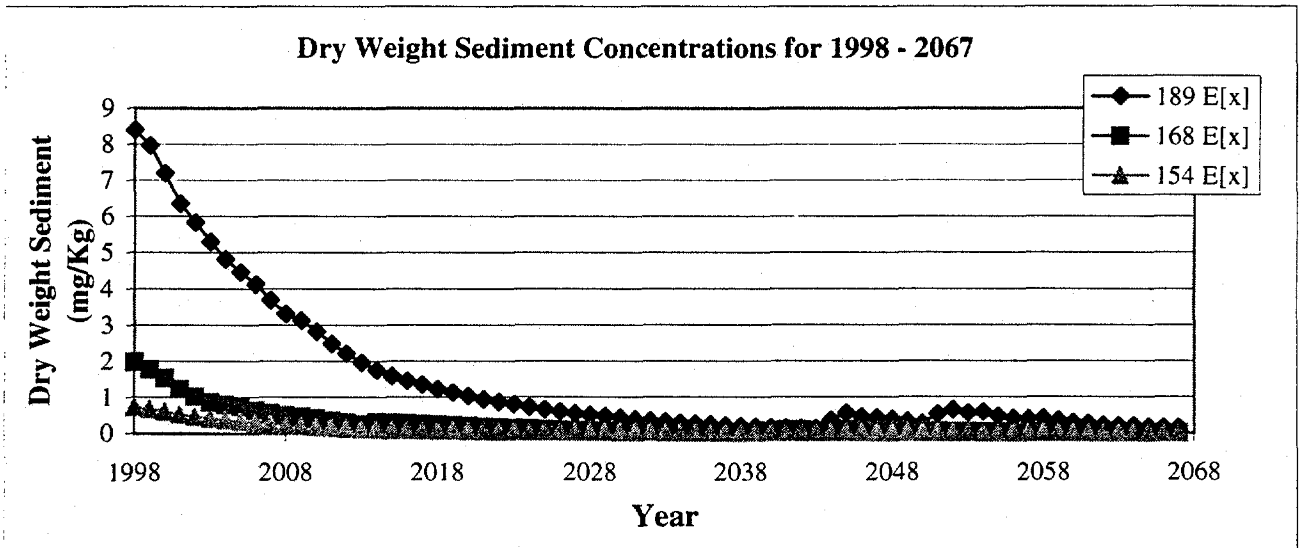


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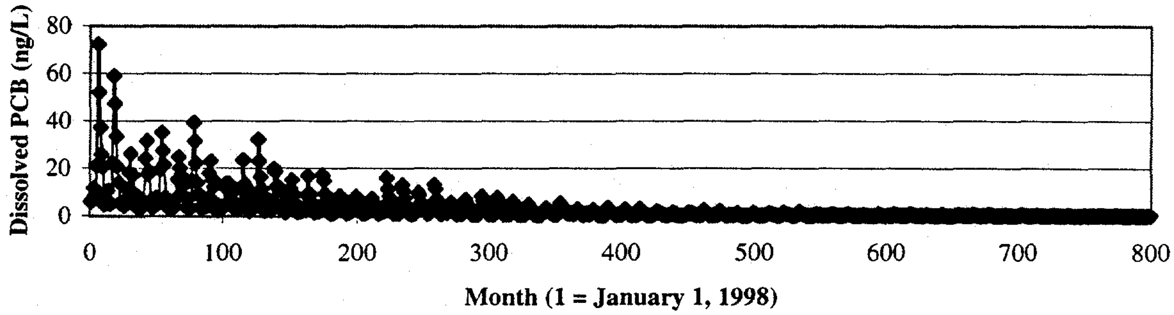
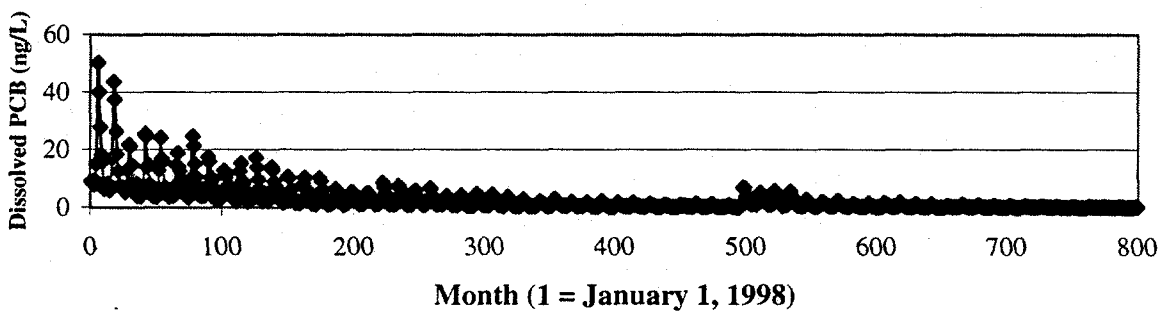
FIGURE 7-1: Freely Dissolved Water and Dry Weight Sediment Concentrations Predicted by HUDTOX for 1998 - 2067 Under Zero Upstream Boundary Condition

Forecast Results for Freely Dissolved Mean Water Concentration for River Mile 189



Forecast Results for Freely Dissolved Mean Water Concentration for River Mile 168



Forecast Results for Freely Dissolved Mean Water Concentration for River Mile 154

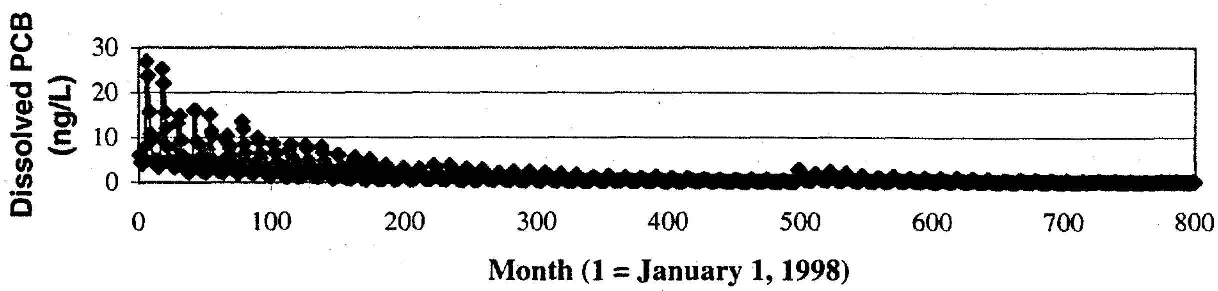


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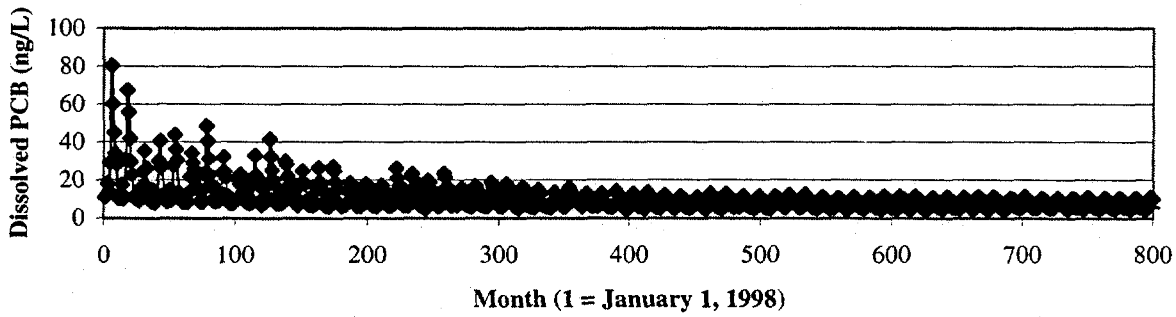
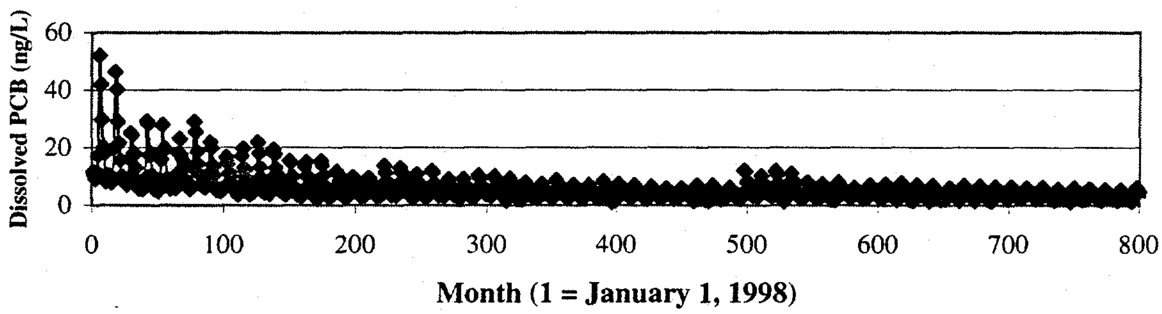
Figure 7-2: Freely Dissolved Water and Dry Weight Sediment Concentrations Predicted by HUDTOX for 1998 - 2067 Under 10 ng/L Upstream Boundary Condition

Forecast Results for Freely Dissolved Mean Water Concentration for River Mile 189



Forecast Results for Freely Dissolved Mean Water Concentration for River Mile 168



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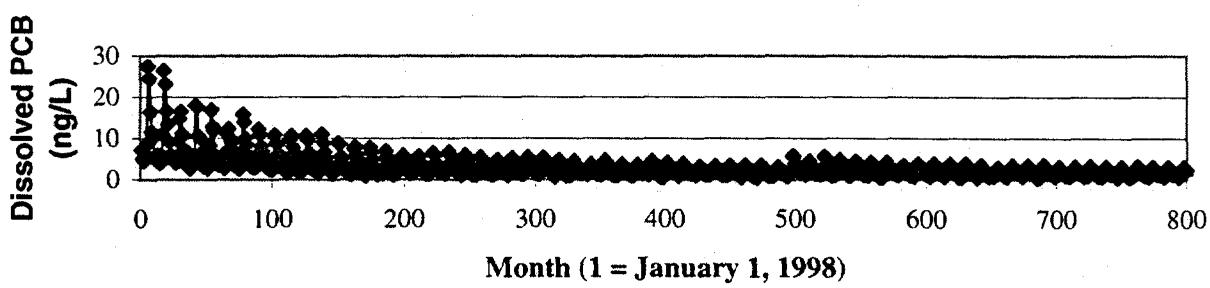

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Figure 7-2: Freely Dissolved Water and Dry Weight Sediment Concentrations Predicted by HUDTOX for 1998 - 2067 10 ng/L Constant Upstream Boundary Condition

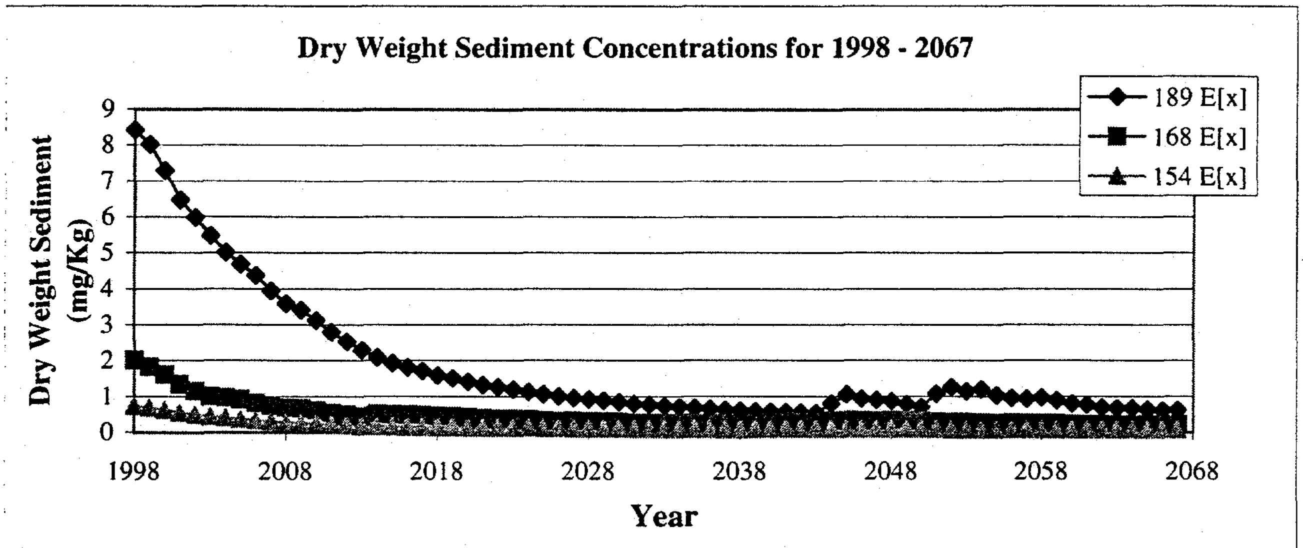

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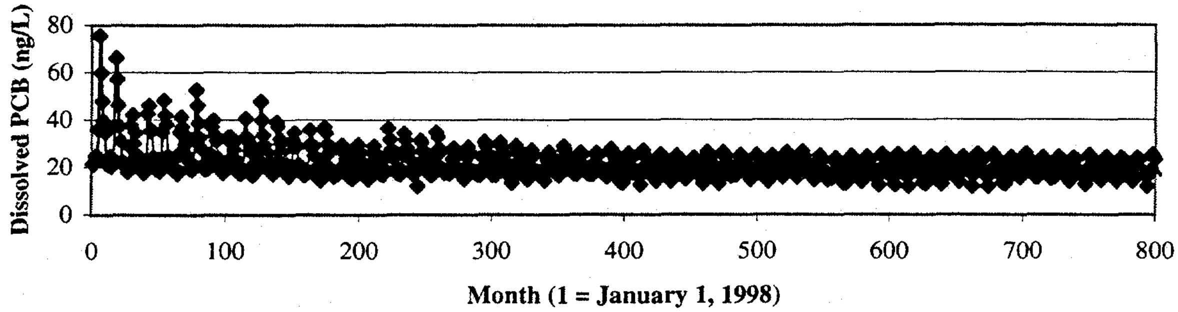
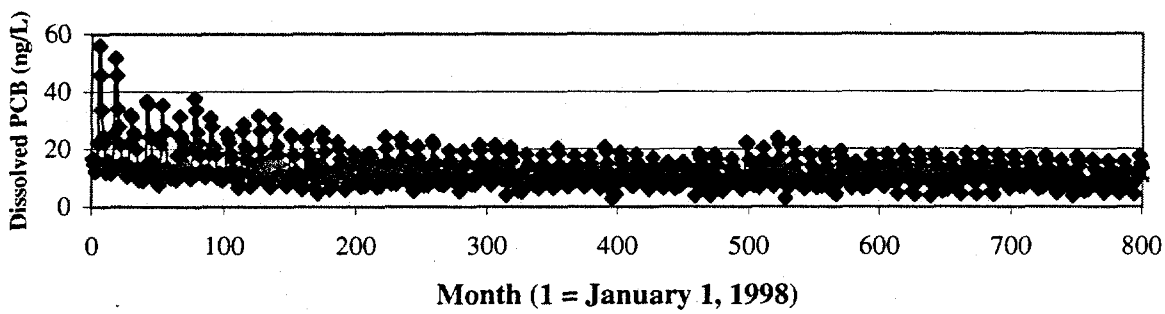
Figure 7-3: Freely Dissolved Water and Dry Weight Sediment Concentrations Predicted by HUDTOX for 1998 - 2067 Under 30 ng/L Upstream Boundary Condition

Forecast Results for Freely Dissolved Mean Water Concentration for River Mile 189



Forecast Results for Freely Dissolved Mean Water Concentration for River Mile 168



Forecast Results for Freely Dissolved Mean Water Concentration for River Mile 154

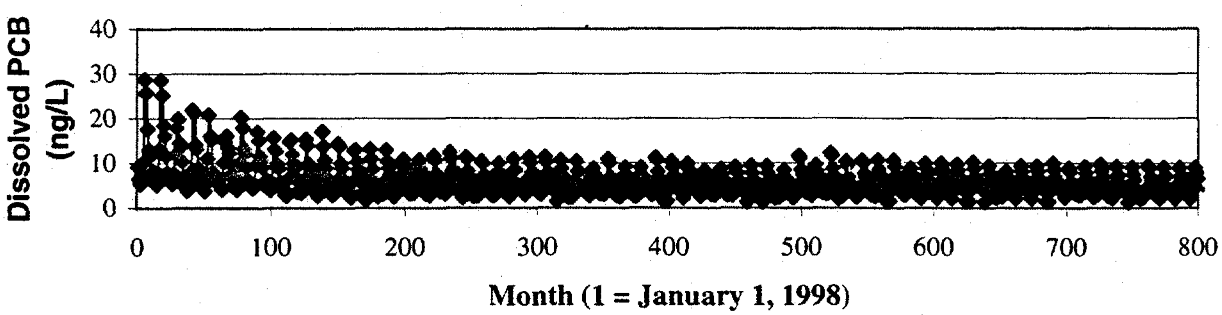


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Figure 7-3: Freely Dissolved Water and Dry Weight Sediment Concentrations Predicted by HUDTOX for 1998 - 2067 30 ng/L Constant Upstream Boundary Condition

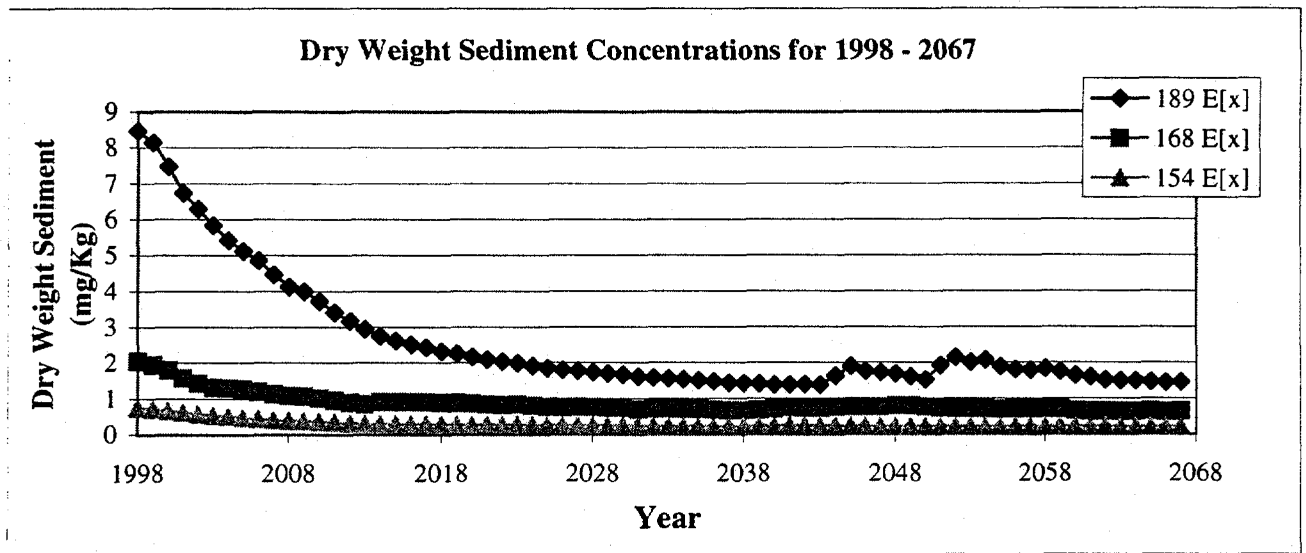

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Figure 7-4: FISHRAND Median (50th Percentile) Predictions for 1998 - 2067 for Largemouth Bass

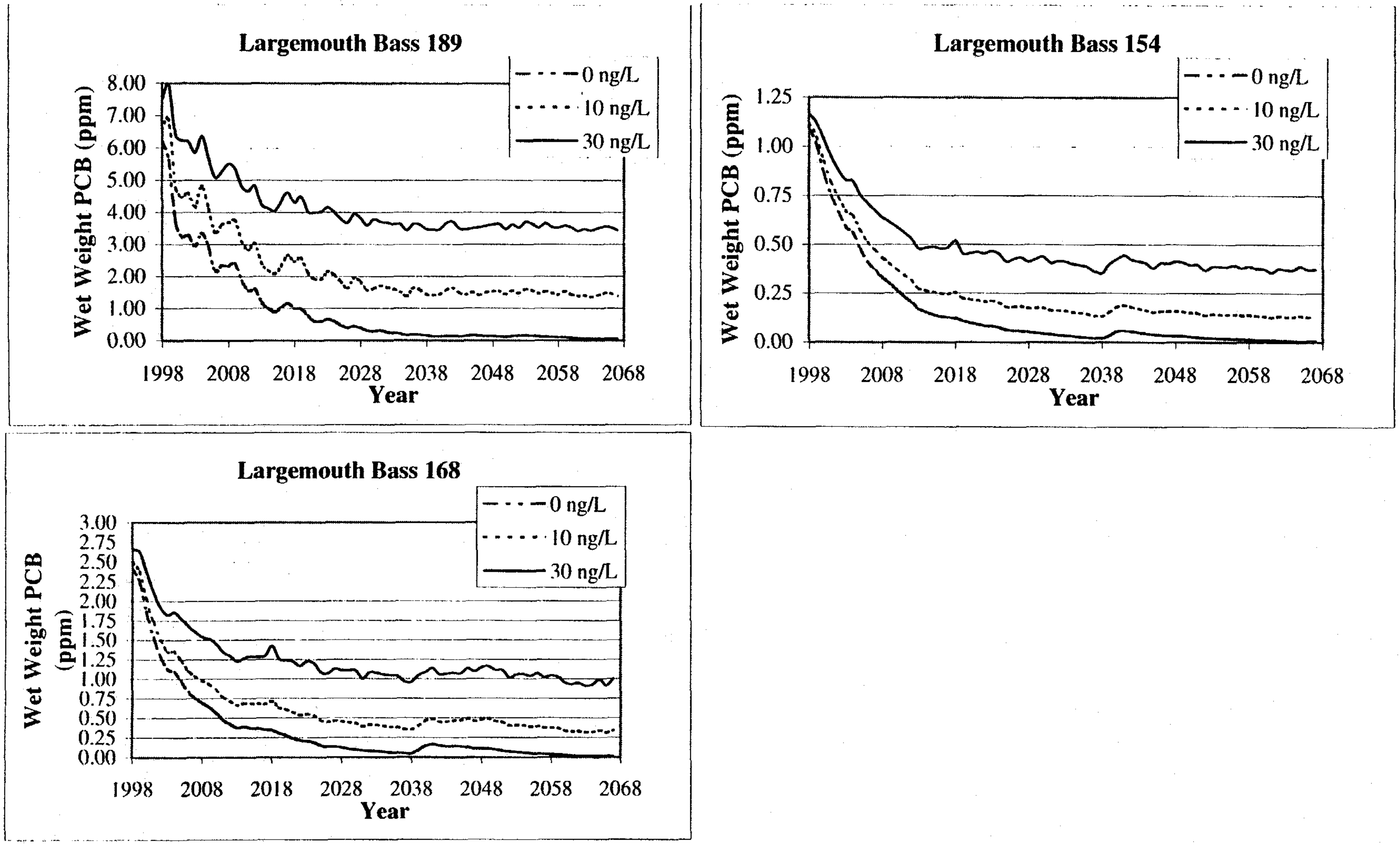

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Figure 7-5: FISHRAND Median (50th Percentile) Predictions for 1998 - 2067 for Brown Bullhead

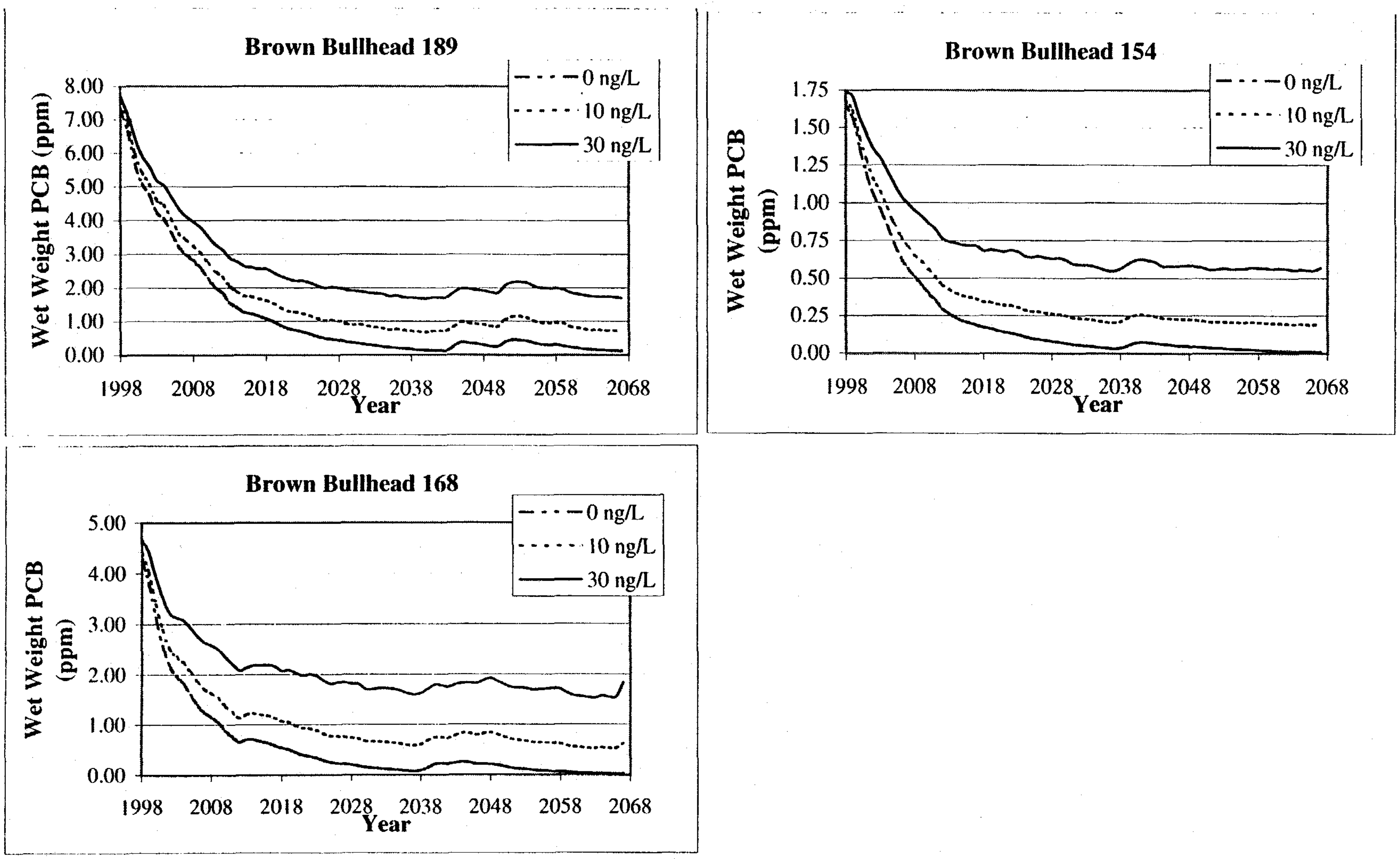

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Figure 7-6: FISHRAND Median (50th Percentile) Predictions for 1998 - 2067 for White and Yellow Perch

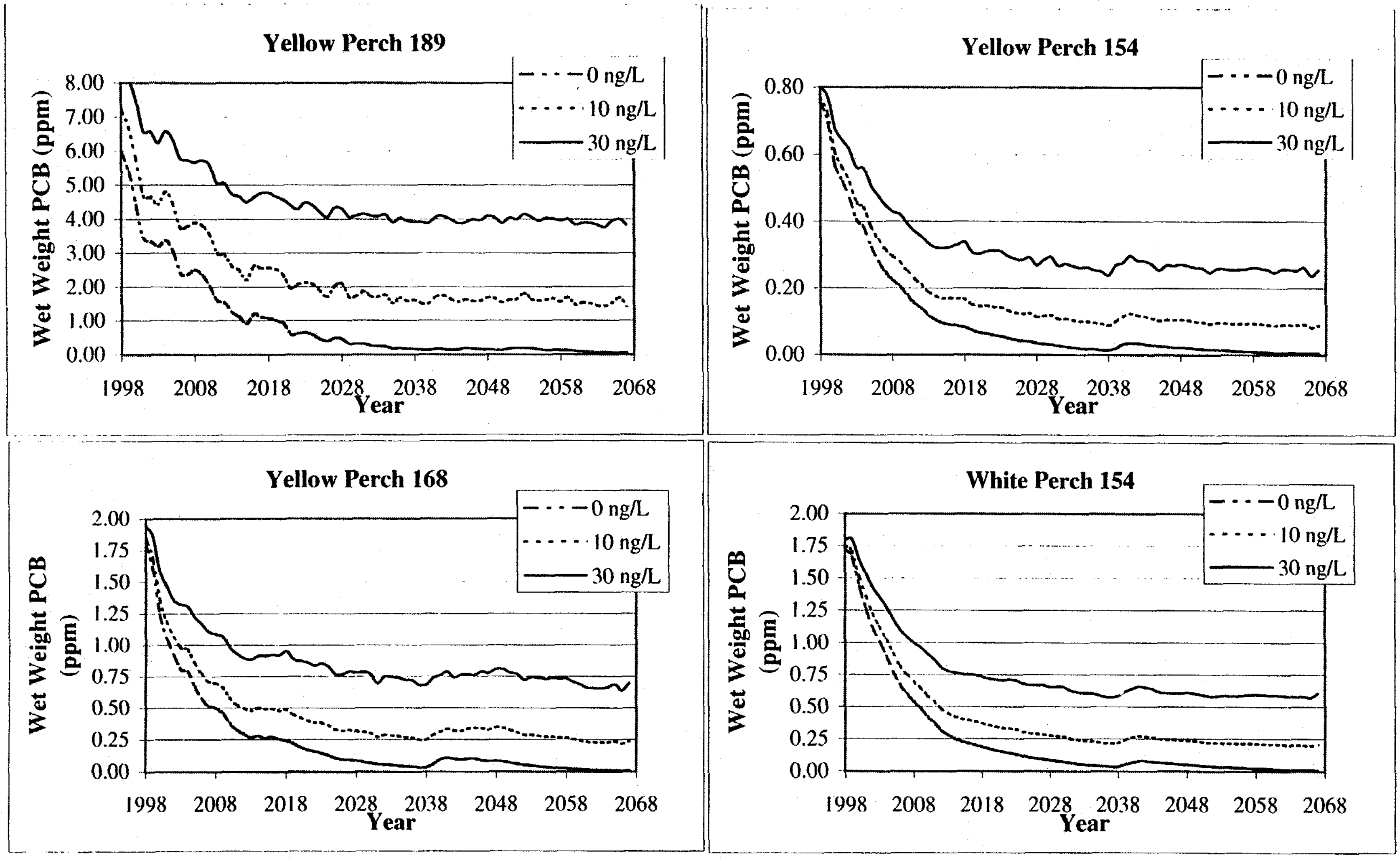

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Figure 7-7: FISHRAND Predictions for 25-50-95 Percentile Under Zero Upstream Boundary Condition for 1998 - 2067 For Largemouth Bass in ppm Wet Weight

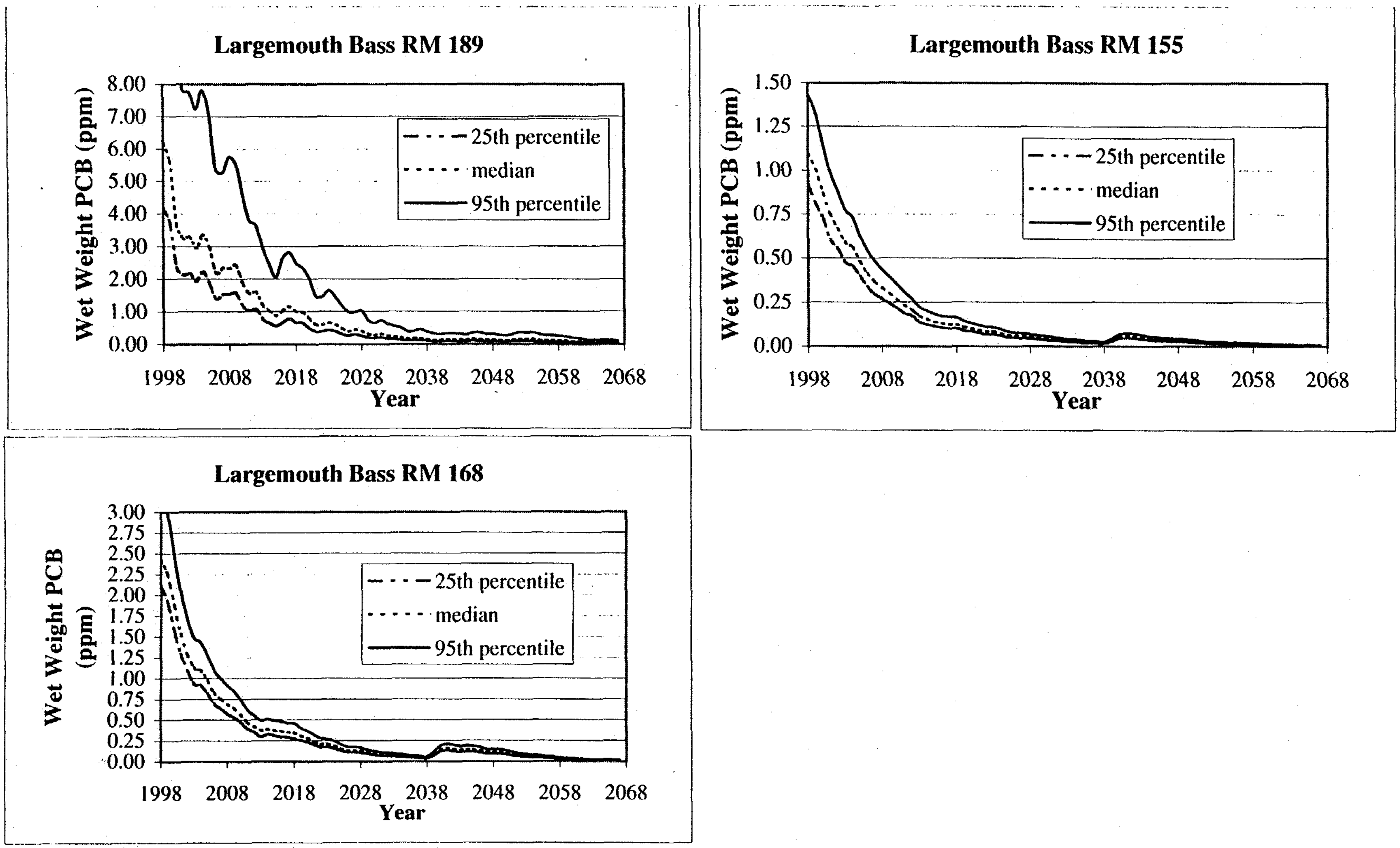

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Figure 7-8: FISHRAND Predictions for 25-50-95 Percentiles Under Zero Upstream Boundary Condition for 1998 - 2067 For Brown Bullhead in ppm Wet Weight

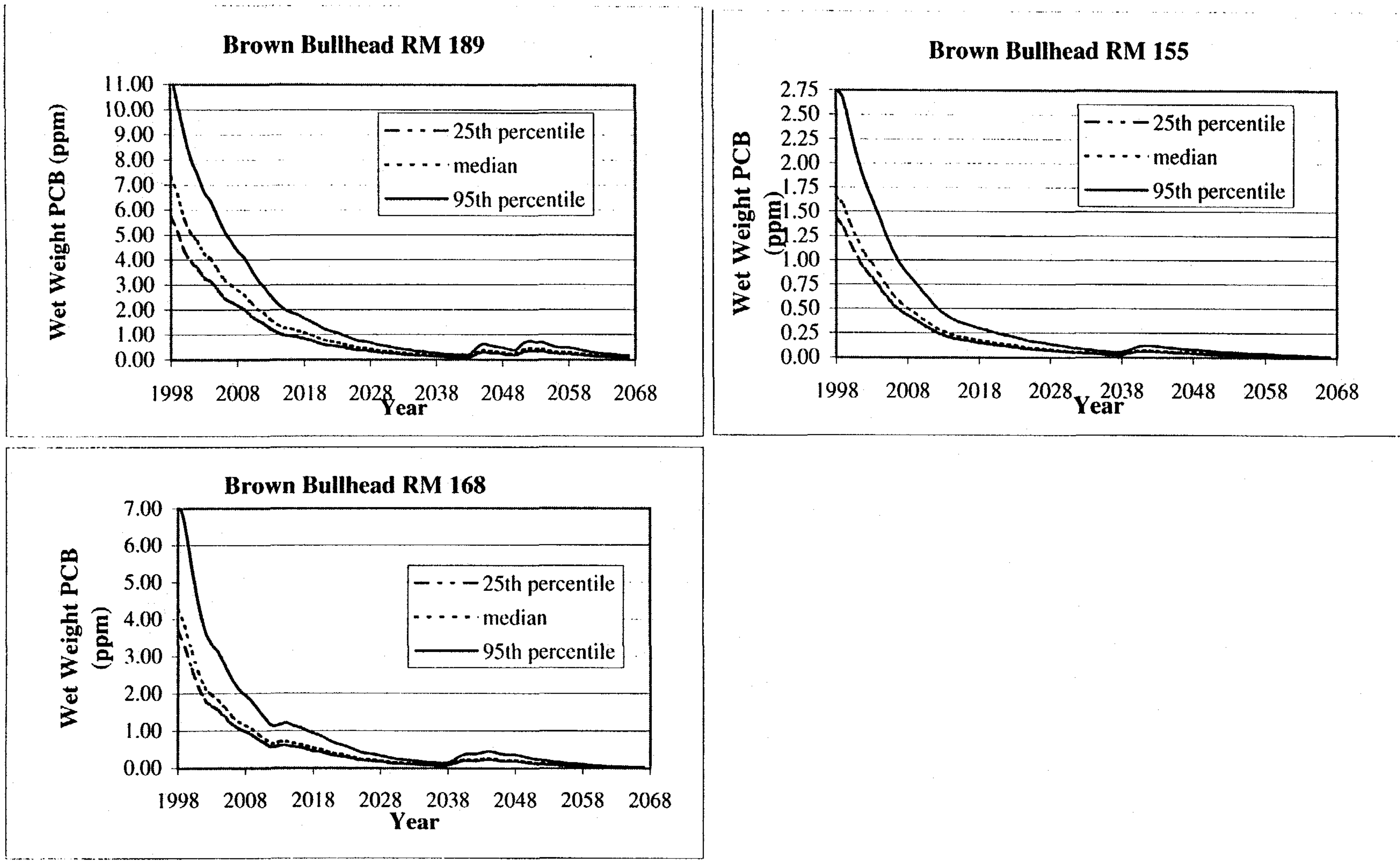

Figure 7-9: FISHRAND Predictions for 25-50-95 Percentiles Under Zero Upstream Boundary Condition for 1998 - 2067 For Yellow and White Perch in ppm Wet Weight

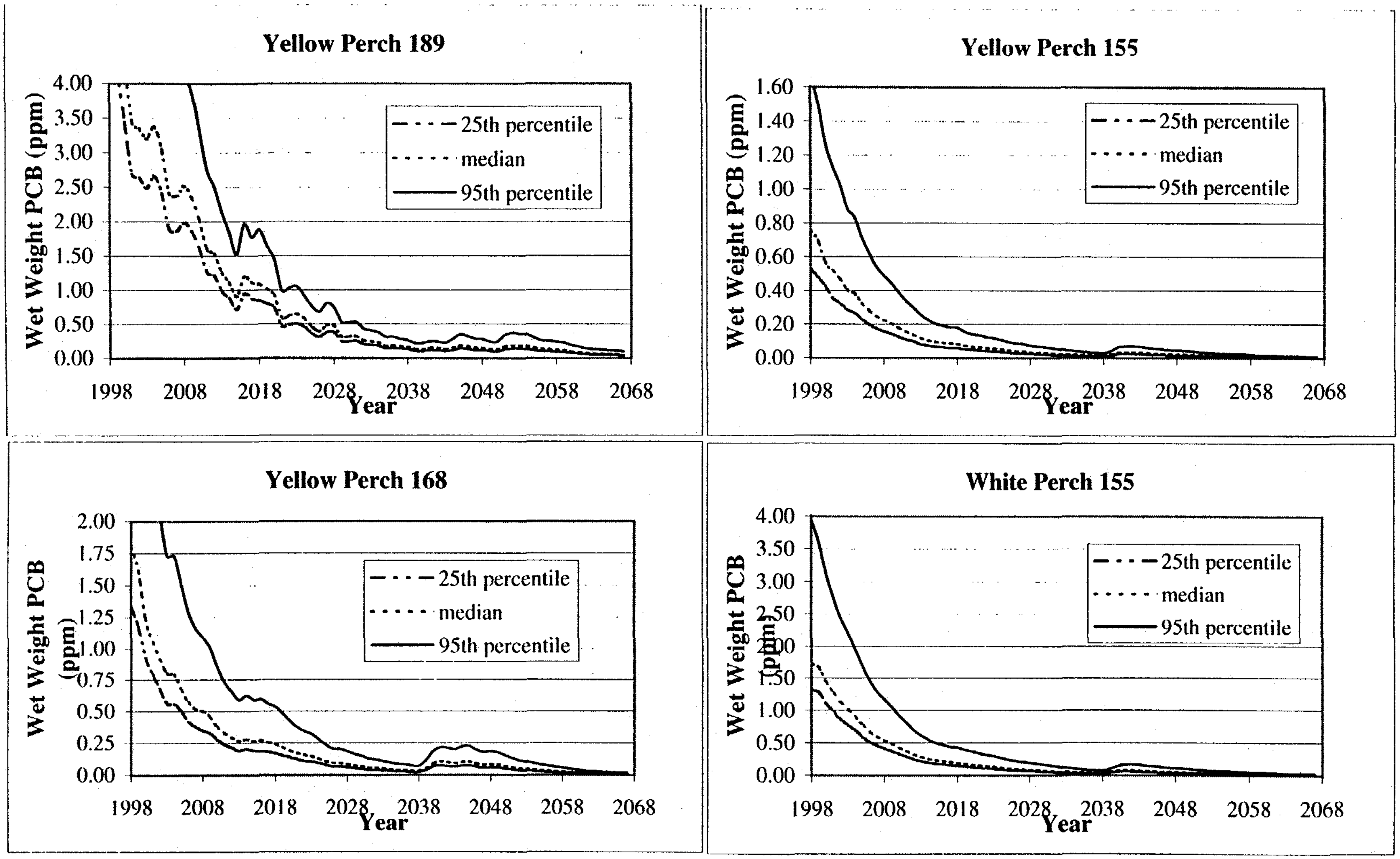

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Figure 7-10: FISHRAND Predictions for 25-50-95 Percentiles Under 10 ng/L Upstream Boundary Condition for 1998 - 2067 for Largemouth Bass in ppm Wet Weight

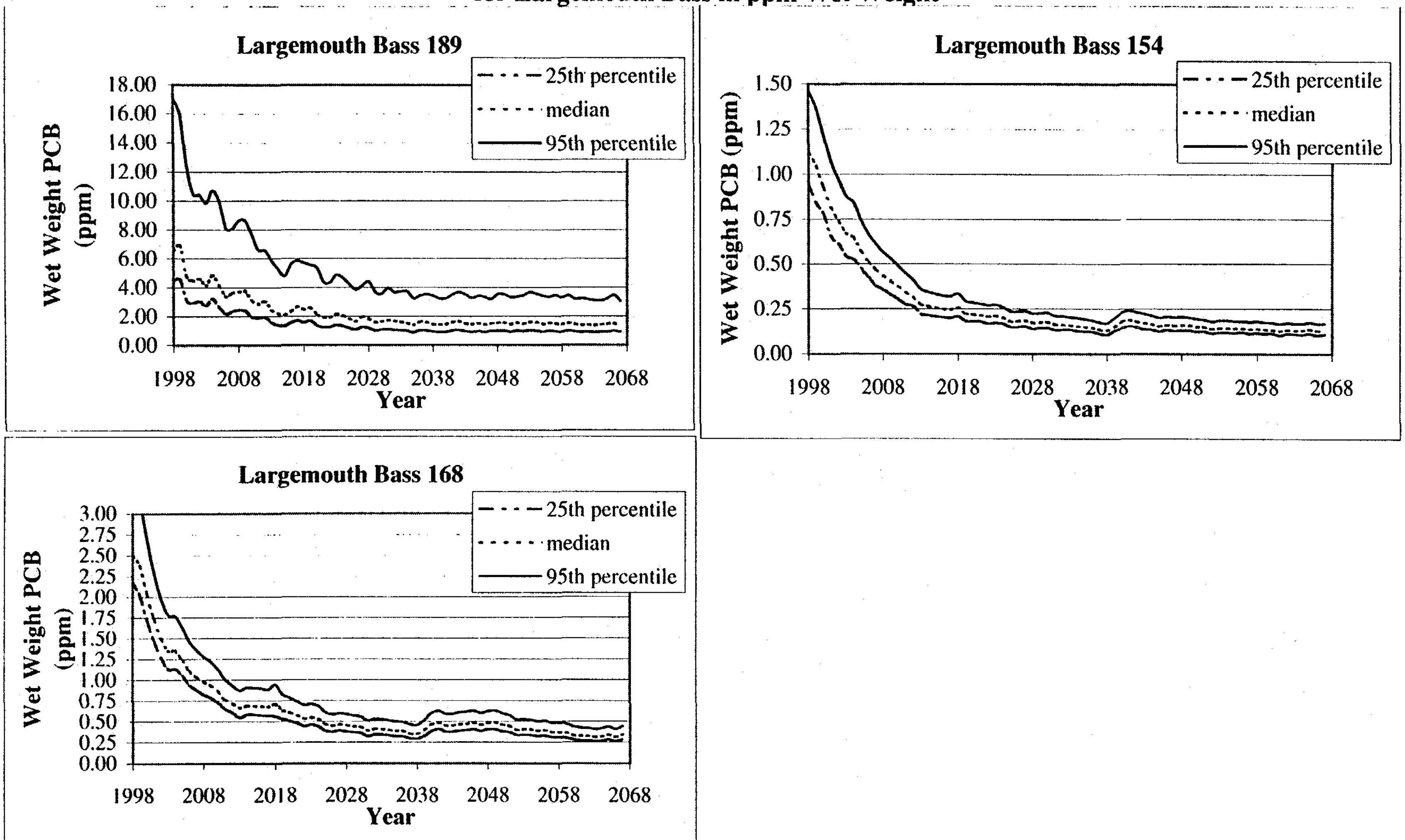

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Figure 7-11: FISHRAND Predictions for 25-50-95 Percentiles Under 10 ng/L Upstream Boundary Condition for 1998 - 2067 for Brown Bullhead in ppm Wet Weight

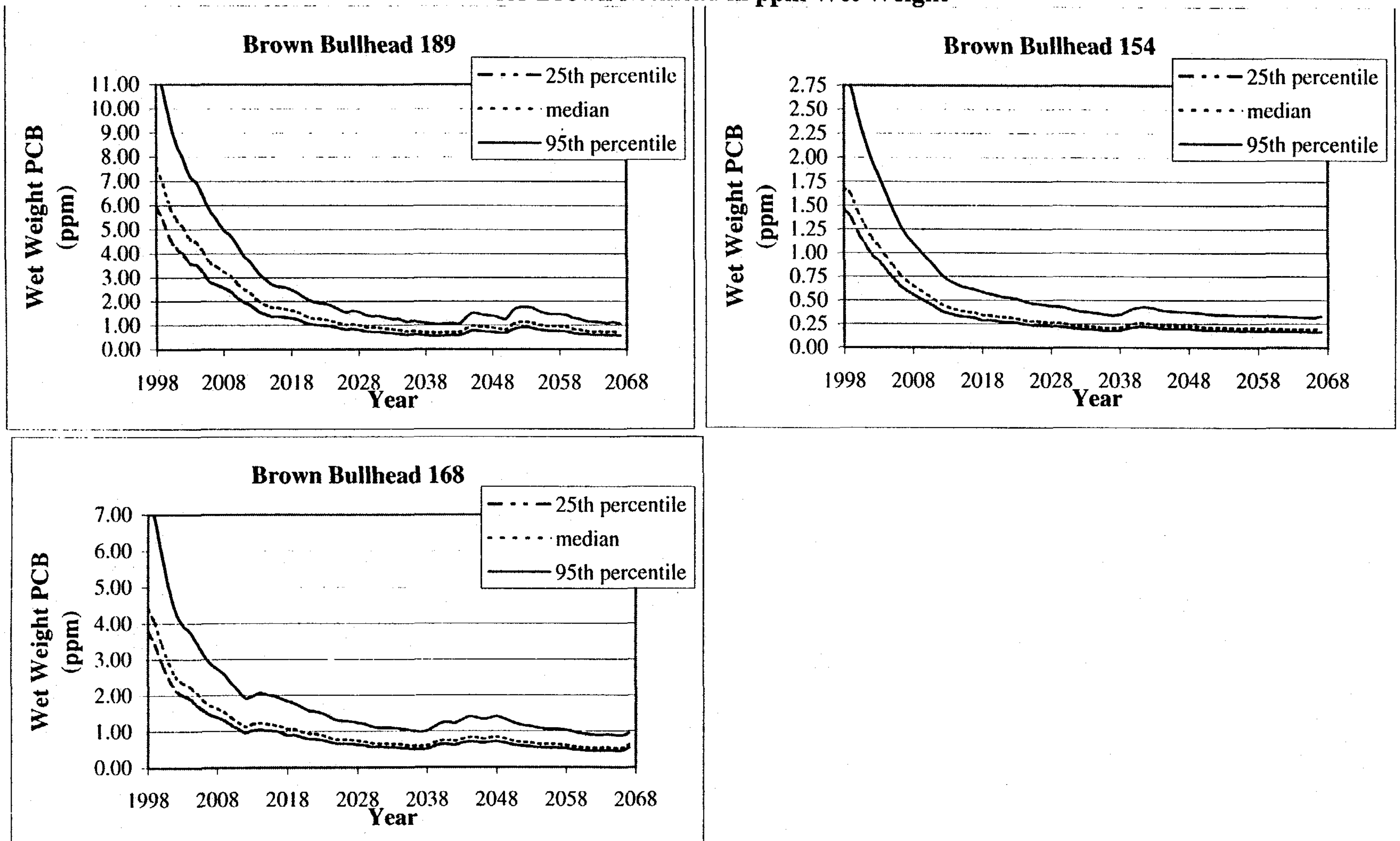

Figure 7-12: FISHRAND Predictions for 25-50-95 Percentiles Under 10 ng/L Upstream Boundary Condition for 1998 - 2067 for Yellow Perch and White Perch in ppm Wet Weight

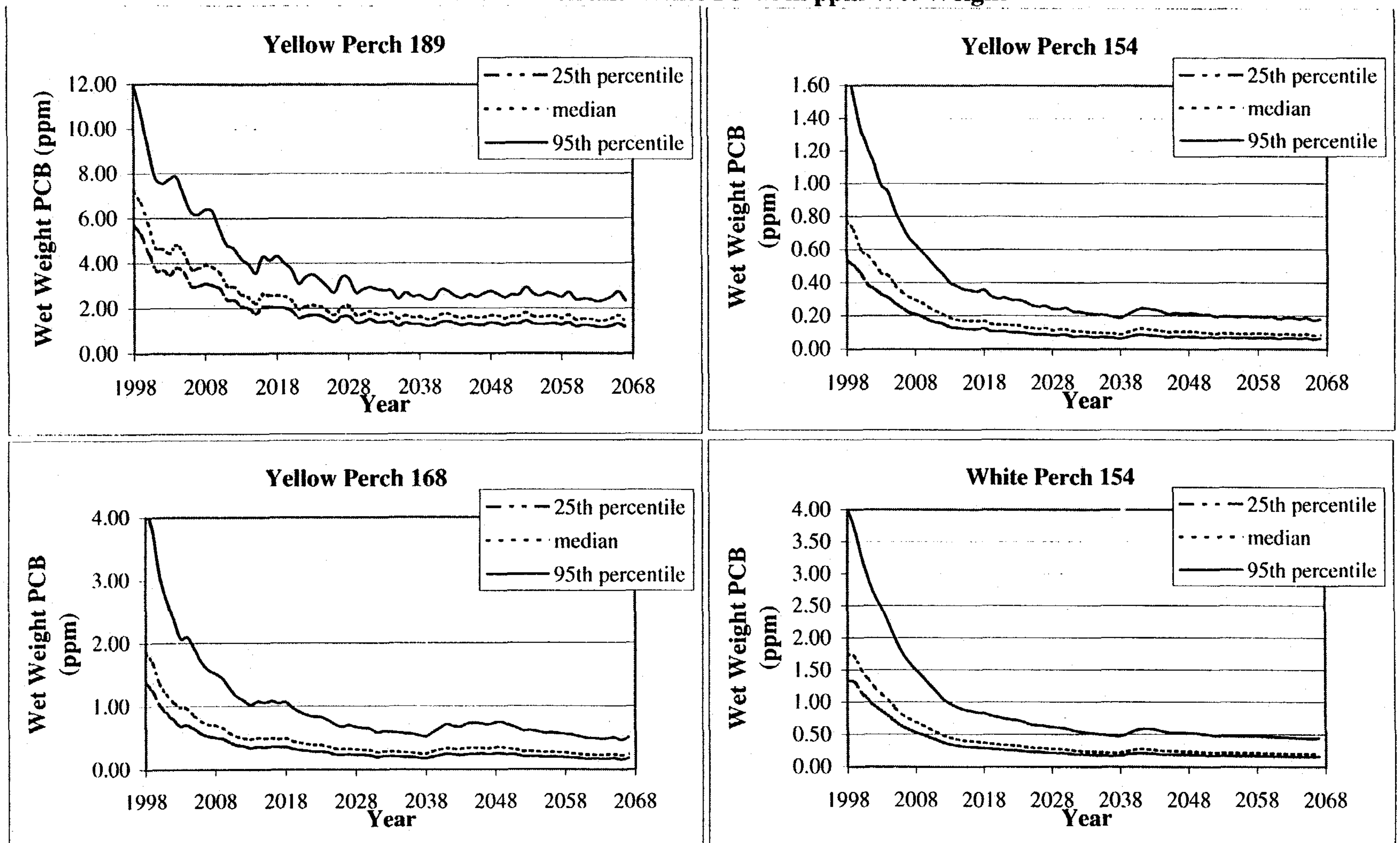

Figure 7-13: FISHRAND Predictions for 25-50-95 Percentiles Under 30 ng/L Upstream Boundary Condition for 1998 - 2067 for Largemouth Bass in ppm Wet Weight

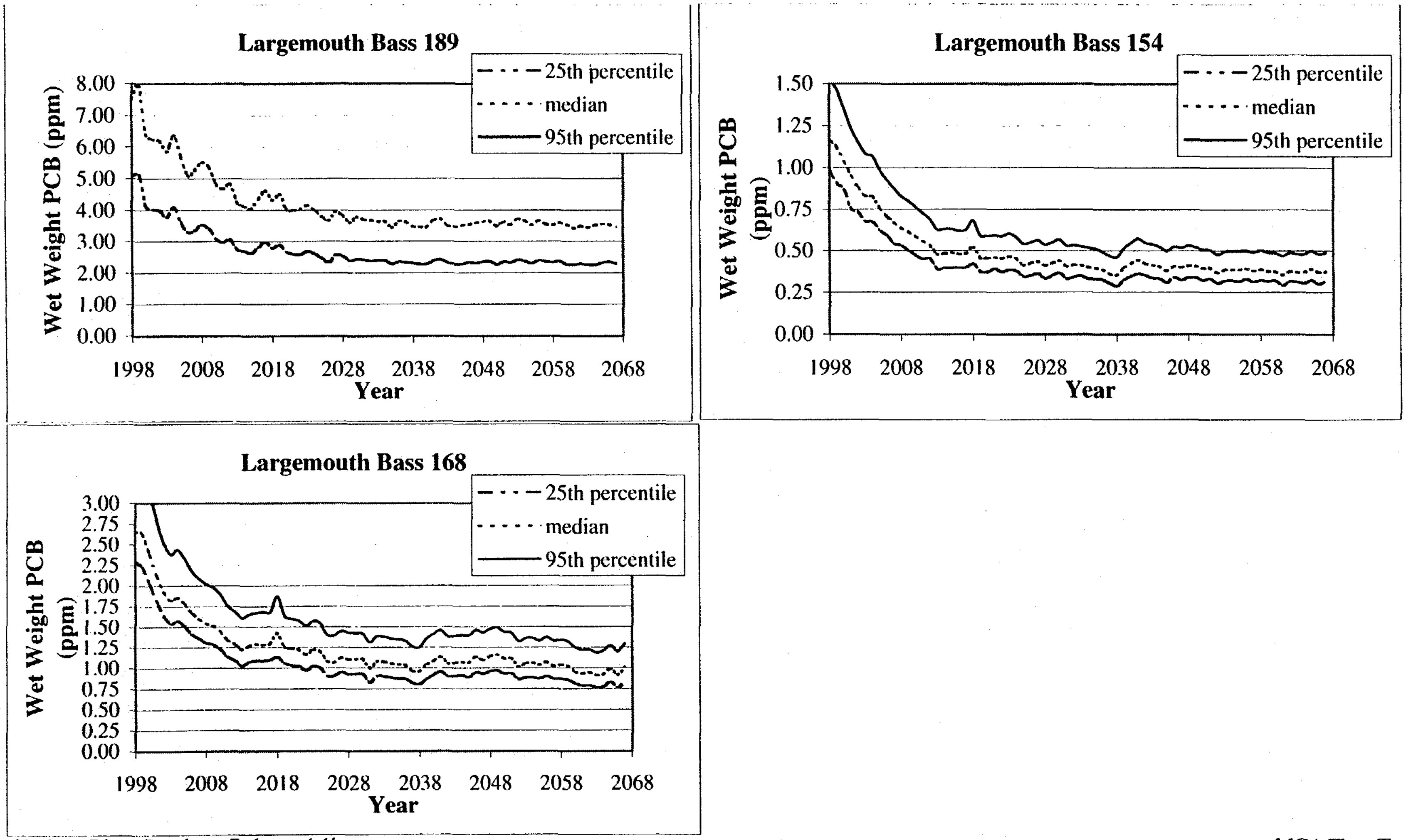

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Figure 7-14: FISHRAND Predictions for 25-50-95 Percentiles Under 30 ng/L Upstream Boundary Condition for 1998 - 2067 for Brown Bullhead in ppm Wet Weight

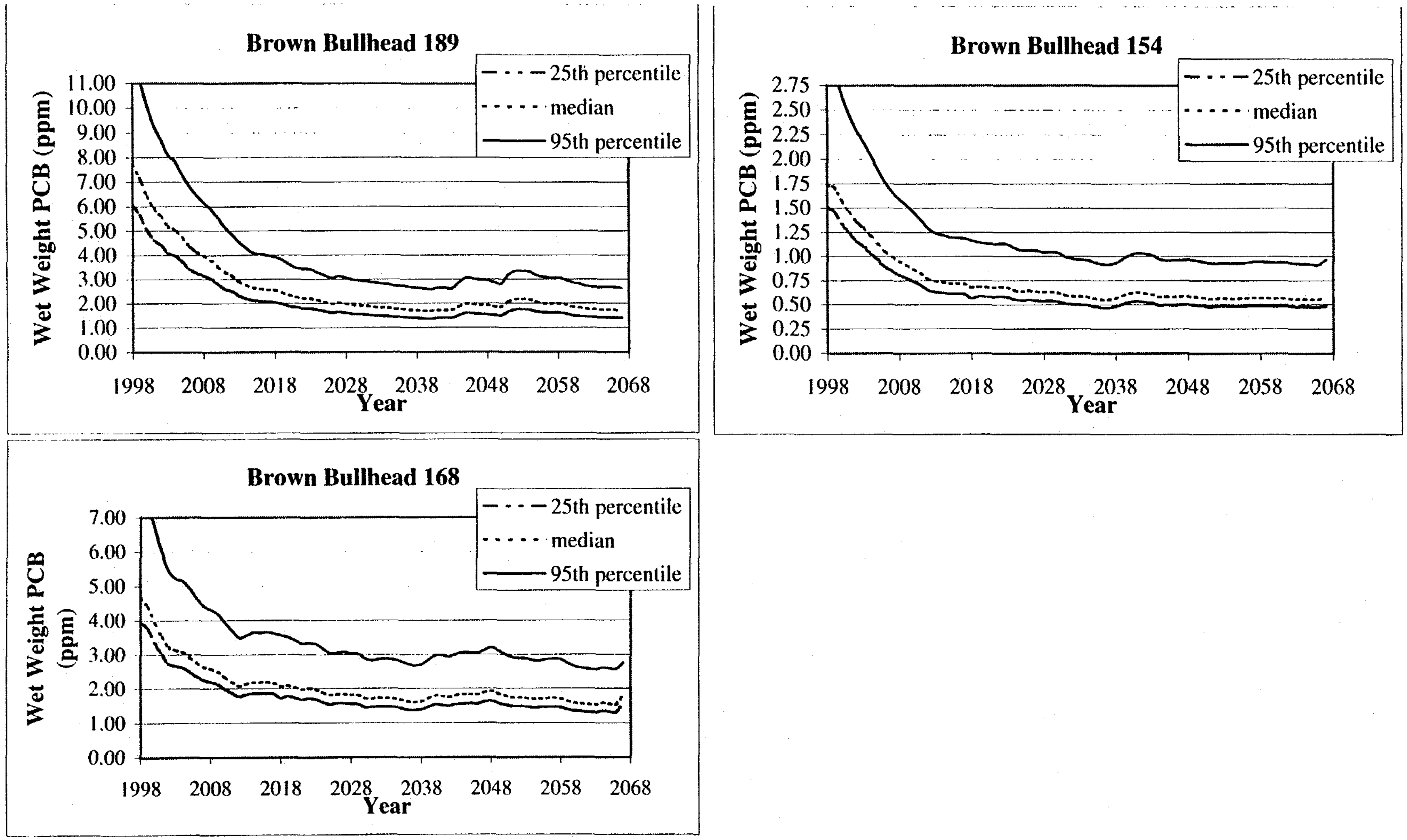

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Figure 7-15: FISHRAND Predictions for 25-50-95 Percentiles Under 30 ng/L Upstream Boundary Condition for 1998 - 2067 for Yellow Perch and White Perch in ppm Wet Weight

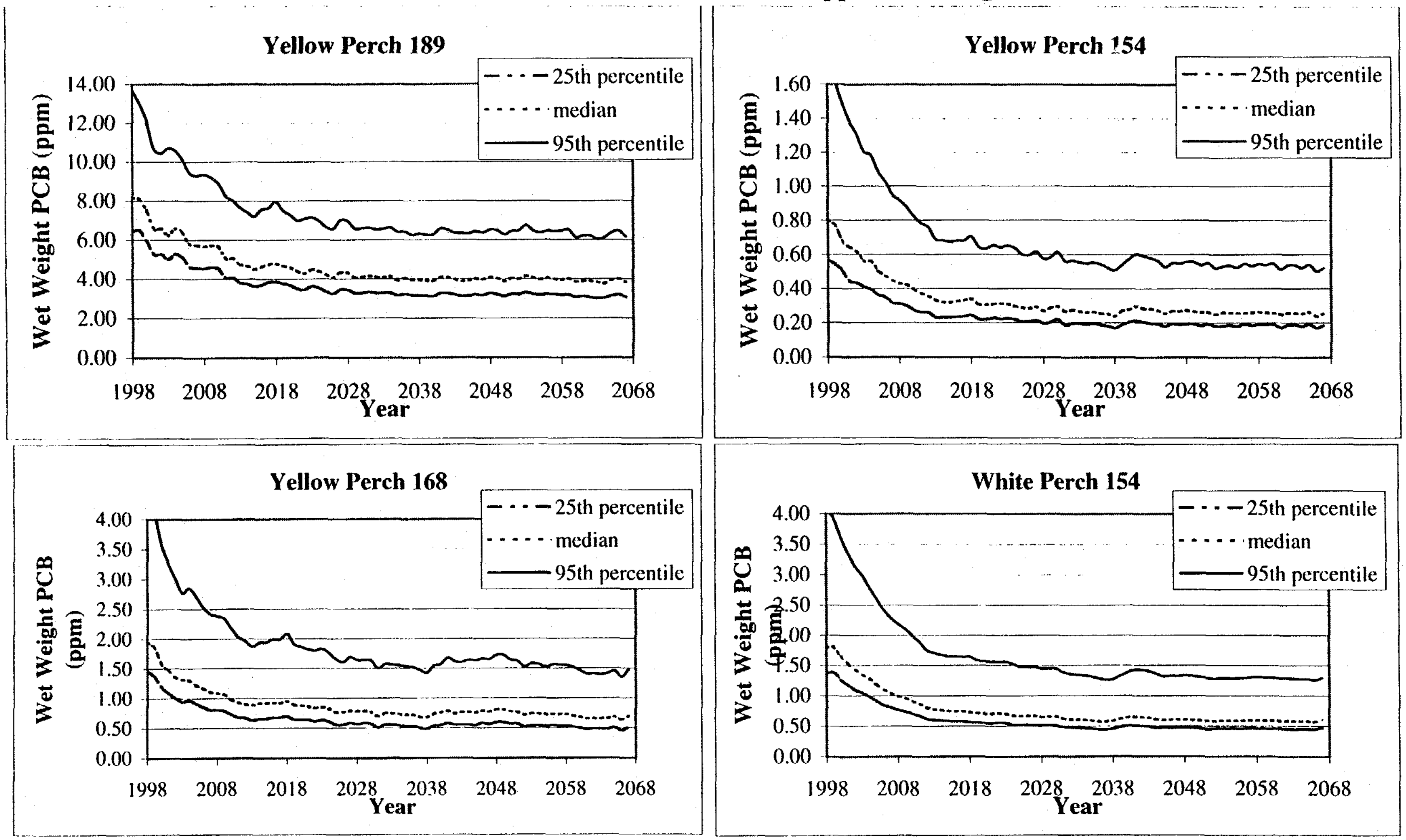

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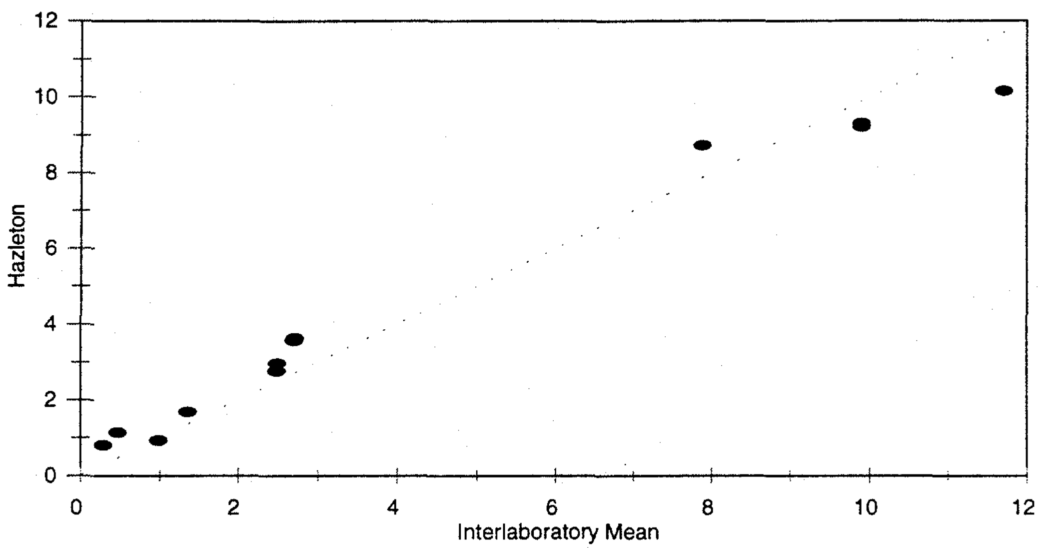
FIGURE 8-1: Comparison of Hazleton and Interlaboratory Mean Determinations of Percent Lipid from 1989, 1992, and 1995 Interlaboratory Comparisons



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Appendix A

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APPENDIX A

1. FISH PROFILES

1.1 Introduction

This section presents the life histories of the fish species selected for closer study in the Hudson River. Profiles of the species focus on the foraging behavior, range and movement, and reproduction of the fish species as they relate to PCB exposures in the Hudson River.

Species of interest include largemouth bass, white perch, yellow perch, brown bullhead, pumpkinseed, spottail shiner, striped bass, and shortnose sturgeon. These species represent fish that experience a wide variety of exposures, including pelagic and demersal feeders, stationary and migratory species, and various trophic levels.

Information on the feeding ecology of Hudson River fish species is taken from the literature and from several studies on the river. Important sources of information include: 1) the Hudson River aquatic ecology studies performed by LMs Engineers in Haverstraw Bay (LMS, 1975a), above Newburgh (LMS, 1975b), and in the vicinity of Kingston (LMS, 1975c); 2) observations on white perch feeding made as part of the TAMS/Gradient Phase II sampling effort; 3) analyses of gut contents along with invertebrate investigations by Exponent (1998a, 1998b); and 4) analysis of several fish species collected by New York State Department of Environmental Conservation in 1997 and 1998 and analyzed by Menzie-Cura & Associates.. Additional insight into feeding ecology for fish collected from the river were obtained from Gladden et al. (1988) and Feldman (1992).

Information relied on for evaluating the ecology of the prey base included the literature, observations in the river reported by Exponent (1998a, 1998b), observations made by Charles Menzie on the ecology of zoolplankton, epibenthos, and infauna in the lower river invertebrates during 1971 – 1975 while employed by LMS, and observations reported in Gladden et al. (1988), Simpson and Bode (1980), and Feldman (1992).

1.1.1 Habitats in the Upper Hudson River

Several 1983 reports (MPI, 1984; Makarewicz, 1983; Makarewicz, 1987) provided primary information concerning habitat types and relative abundance in the Upper Hudson River. These reports provided the results of a fish survey conducted for New York State from the Federal Dam past Thompson Island. The reports identified nine habitat types in the lock pools, beginning with the Federal Dam, in the Hudson River:

Stream mouth habitats are adjacent to the outlets of small to large streams but within the Hudson River itself. They have slow to strong currents, depending on seasonal flow. Bottom types range from silt in slower zones to sand and gravel in faster zones. Aquatic macrophytes are generally absent. The shoreline has a mixture of tree cover, including willows, aspens, and maples, with numerous areas of overhang. Depths range from 0.3 to 5 meters.

Main channel habitats are in the designated ship channel of the river. They have moderate to strong currents depending on the specific lock pool. Aquatic macrophytes are generally absent. The shoreline has a mixture of trees (willows, aspens, maples) with areas of overhang. Depths range from 5 to 6 meters.

Shallows are areas adjacent to the main channel, without visible wetland vegetation. Currents are mostly slow with some moderate to strong areas. Bottom types range from organic sediment in slower zones to sand, gravel, and cobbles in the faster zones. Emergent and submergent vegetation line most areas of the shoreline. The same mixture of trees with areas of overhang plus significant growth of aquatic macrophytes provide excellent habitat areas for fish species. Depths range from 0.3 to 2.1 meters.

Rapids contain a fast current with numerous zones of white water. The bottom is covered with cobbles and gravel as a result of scouring action. Outcrops of bedrock are located adjacent to steep embankment areas. Emergent and submerged vegetation areas are absent. Depths range from 1.2 to 3.1 meters.

Embayments are coves along the shoreline. Cove water is mostly stagnant with areas of slight current. The bottom contains mostly organic sediment with numerous patches of bottom debris such as logs and submerged trees. Large areas of emergent and submerged vegetation dominate. Substantial growth of water lilies, water chestnuts, and cattails choke selected areas, particularly in late summer. Shoreline has a mixture of hardwoods, some partially submerged. Observed schools of larval fish and adult spawning individuals demonstrate the importance of the area as a sensitive fish habitat. Depths range from 0.2 to 2.4 meters.

Wetlands are shallow areas with emergent, floating, or submerged vegetation. Current is slow with selected areas of stagnant water. The bottom consists of organic sediment and bottom debris. Shoreline is partially flooded with numerous submerged willows and maples. Cattails dominate emergent vegetation by forming extensive marsh areas. Like the embayment areas, the wetlands represent a sensitive fish habitat. Water is shallow with a depth range of 0.3 to 1 meter.

Alternate channels are natural side channels are separated from the main channel by an island. The current is variable ranging from imperceptible to fast. The bottom contains organic material with a mixture of sand and gravel. The slower current areas are dominated by organic sediment. Cattails dominate the emergent and submerged vegetation. Shorelines contain willows and maples with areas of overhang. Depths range from 0.3 to 4.3 meters.

Artificial cuts are landcut portions of the river. Currents vary from slight to moderate. The bottom is mostly organic sediment with bedrock outcrops along some portions of the shoreline. A sparse growth of emergent vegetation exists. The shoreline has numerous areas of riprap, sand, and cobbles. A mixture of hardwoods provides overhang in some areas. Depths range from 0.2 meters in shore areas to 4.9 meters in midchannel.

Wet dumpsites are areas designated on the NOAA charges or NYSDOT 10-year management plan as wet dumping grounds. These areas are variable with respect to physical features and flora. Currents tend to be moderate in summer and strong in spring. Bottom types range from organic material and gravel to silt in slower moving zones. Macrophytes are absent from most areas. Water is shallow, with depths ranging from 0.3 to 3 meters.

In general, the shallow and wetland areas provide ideal fish habitats with slower currents and an abundance of floral cover.

1.1.2 Habitats in the Hudson River Estuary

In 1986, NYSDEC conducted a survey of fish and their habitats in the lower Hudson River Estuary below Federal Dam. The study area consisted of three reaches encompassing 51 miles:

Upper reach: Troy to Coxsackie; River Miles 153-125
Middle reach: Coxsackie to Germantown; River Miles 124-107
Lower reach: Below Germantown; River Miles 106-102

This study showed the upper reach is narrow with very few tidal flats while the middle reach is wide and shallow, containing major tributaries, islands, and numerous tidal flats. The lower reach is characterized by moderate depth and many tidal flats. A greater proportion of lentic backwaters and tributaries are present in the lower two reaches. Substrates through the study area consist of fine and silty sand, with a few areas of bedrock, gravel, and boulder channel markers. Aquatic vegetation is common in this segment of the estuary, and is mostly restricted to and abundant in the backwaters, marshes and tributary mouths (Carlson, 1986). Carlson identified seven distinct habitats:

Vegetated backwaters are shallow side channels or bays with silty bottoms and abundant vegetation such as milfoil (*Myriophyllum* spp.) or wild celery (*Vallisneria americ*ana). Typical areas include Inbocht Bay, Stockport Marsh, Schodack Creek and east of Green Island.

Major tributaries include the tidal portion of streams with rocky or muddy substrates and sparse vegetation. Typical areas include Roeliff Jansen Kill, Stockport Creek, and Island Creek.

Rock piles are the bases of navigation markers constructed of large boulders positioned near the channel or sometimes in more shallow shoal areas. The boulders provide shelter in areas exposed to strong currents. Most rock piles are located downriver of River Mile 149.

Shore areas are generalized shallow areas with gradual slopes, muddy or rocky substrates, and sparse cover. This category is less specific than others and often has characteristics common to backwaters and tributaries.

Channel border or shoal areas include areas where the bottom is shallower than the 32-foot navigation channel but generally deeper than 10 feet. Rooted vegetation is usually lacking.

Channel areas are within the navigation channel with substrates of sand, sand and pebbles, and sand and silt.

Tailwater habitats are areas within 0.4 miles of Federal Dam with substrates composed mostly of gravel and bedrock. Tidal fluctuations and flows extend to the base of the dam at all times except during high runoff periods.

1.2 Largemouth Bass

The largemouth bass, *Micropterus salmoides*, is a relatively large, robust fish that has a tolerance for high temperatures and slight turbidity (Scott and Crossman, 1973). It occupies waters with abundant aquatic vegetation. Largemouth bass show a low tolerance for low oxygen conditions. The largemouth bass represents a top predator in the aquatic food web, consuming primarily fish but also benthic invertebrates.

1.2.1 Foraging

Young largemouth bass feed on algae, zooplankton, insect larvae, and microcrustaceans (Boreman, 1981). Largemouth bass can grow to 136 grams on a diet consisting of insects and plankton. Larger prey are needed to continue growth after reaching a total length of 20 mm. Young largemouth bass compete for food with a variety of other warmwater and bottom-feeding fishes.

Johnson (1983) found that the diets of juvenile fish foraging in the St. Lawrence River varied somewhat by location and length of the fish. Fish, insects including corixids, and other invertebrates made up the diets in varying proportions.

Largemouth bass longer that 50 mm total length usually forage exclusively on fish. Prey species include gizzard shad, carp, bluntnose minnow, silvery minnow, golden shiner, yellow perch, pumpkinseed, bluegill, largemouth bass, and silversides. turbidity (Scott and Crossman, 1973). Cannibalism is more prevalent among largemouth bass than among many species. Ten percent of the food of largemouth bass 203 mm and longer is made up of their own fry turbidity (Scott and Crossman, 1973).

Largemouth bass take their food at the surface during morning and evening, in the water column during the day, and from the bottom at night. They feed by sight, often in schools, near shore, and almost always close to vegetation. Feeding is restricted at water temperatures below 10°C and decreases in winter and during spawning. Largemouth bass do not feed during spawning.

Information on feeding habits of largemouth bass in the upper Hudson River was obtained for 73 juvenile and adult fish collected in Spring 1997 by the New York DEC and analyzed by Menzie-Cura & Associates. Sample locations included Griffin Island, Stillwater, Troy, and Catskill Creek. Thirty-one of the bass (42%) had fish remains in their digestive system and represented the most common food item for adult bass. Crayfish were eaten occasionally at most river locations. However, six of twenty bass collected at Catskill Creek had eaten crayfish. Benthic invertebrates were observed in the diet of juvenile bass. It is difficult to reconstruct the amount of food eaten on a percentage basis because of many factors including inter- and intra-species variability in biomass and differential digestion rates for different species eaten by fish. On the basis of the available data it is estimated that fish comprise between 75 and 90% of the diet. The spring 1997 data indicate that the balance of the diet is made up of benthic invertebrates.

Exponent (1998a, 1998b) conducted gut analyses of 32 adult largemouth bass from Griffin Island, Thompson Island Pool, and Stillwater in Fall 1997 and 21 bass collected from Griffin Island and at Coveville in Spring 1998. Results were similar to those observed by Menzie-Cura. Thirty-one of the bass (58%) had fish in their digestive systems and crayfish were occasionally eaten. Smaller invertebrates (insects and crustaceans) were commonly present. Frogs were also occasionally eaten.

We analyzed the Exponent (1998a, 1998b) data to evaluate the composition of invertebrates eaten by bass. Our analyses were qualitative and focused on the composition of predominant species in the gut contents of the fish. We looked for associations between invertebrates in the gut contents and those that Exponent, Inc. collected in sediments and on plants; we also considered the possibility based on our knowledge of the river that some invertebrates are zooplankton members (not explicitly evaluated by Exponent.) Our analyses revealed that largemouth bass feed on a variety of invertebrates that inhabit sediments, live on plants, or are part of the zooplankton. Predominant invertebrate species observed in the gut contents of bass include amphipods (both *Hyallella* and *Gammarus),* isopods (*Caecidotea*), cladocerans (*Bosmina, Chydorus, Eurycercus, and Simocephalus),* cyclopoid copepods, ostracods (e.g., *Podocopa*), and some chironomid larvae (Table A-1 and Table A-2). The crustacea observed include a number of species that inhabit the water column (e.g., *Bosmina*), occupy the littoral area and also open water (e.g., *Chydorus sphaericus*) , and live in close association with surface sediments (e.g., *Gammaus* and *Caecidotea*). The amphipod *Gammarus spp.* also occur in the plankton of the river and are likely influence by both water and surficial sediment exposures. The isopod is probably a surface deposit feeder and is also likely influenced by surface water as well as surficial sediment exposure.

It is difficult to reconstruct the amount of food eaten on a percentage basis because of many factors including inter- and intra-species variability in biomass and differential digestion rates for different species eaten by fish. Further, food consumption varies seasonally due to changes in the availability of different prey items. Therefore, any estimate based on a few sampling dates and locations must be viewed as a rough indication of feeding preference. On the basis of the available data obtained by Menzie-Cura and Exponent we estimate that fish comprise between 75 and 90% of the average adult largemouth bass diet. The balance of the diet is made up primarily of invertebrates including crayfish. Our estimates consider the relative size of the prey organisms as well as the frequency of prey animals in the diet. Terrestrial animals are also occasionally eaten. A qualitative assessment of the Exponent (1998a, 1998b) data suggests that 54% and 68% of the invertebrates are associated with sediments and 34 to 46% are associated with water. Invertebrates associated with sediments such as amphipods and isopods are also likely influenced by water exposures. The extent to which water or sediment affect the body burdens of surface deposit feeders and meroplanktonic animals such as *Gammarus* is not known.

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1.2.2 Range, Movement and Habitat within the Hudson River

Largemouth bass have distinct home ranges and are generally found between 8 and 9 kilometers of their preferred range (Kramer and Smith, 1960). Kramer and Smith found that 96 percent of the fish remained within 91 meters of their nesting range. Fish and Savitz (1983) found that bass in Cedar Lake, Illinois, have home ranges from 1,800 to 20,700 square meters. The average home range was 9,245 square meters and the average primary occupation area, defined as that area within the home range in which the fish spends the majority of its time, including foraging, was 6,800 square meters.

Largemouth bass are almost universally associated with soft bottoms, stumps, and extensive growths of a variety of emergent and submerged vegetation, particularly water lilies, cattails, and various species of pond weed. It is unusual to find largemouth bass in rocky areas. Largemouth bass are rarely caught at depths over 20 feet, although they often move closer to the bottom of the river during the winter.

Mobility of largemouth bass also varies seasonally. Daily movements increase with temperature from March through June, but decrease sharply during the hottest months (Mesing and Wicker, 1986). Activity during warmer seasons occurs primarily near dawn and dusk, while cool-water activity is most extensive in the afternoon.

A 1984 Malcolm-Pirnie report prepared for New York State describes the results of a fish survey taken that same year. The results are reported as number of fish by habitat type as well as number of fish by lock pool for the upper Hudson River and associated canals. The numbers shown are not significant in terms of absolute numbers, but rather provide a qualitative indication as to the relative distribution of fish within each habitat area and within each lock pool. Largemouth bass were found in each of the lock pools (see Table A-3).

Largemouth bass were found throughout the Upper Hudson River in significant numbers. Major concentrations of fish were within areas where submerged and emergent vegetation, overhang, and bottom debris provided adequate cover (MPI, 1984). Largemouth bass were not found in the main, natural channel of the river nor in the rapids (see Table A-3).

In the Lower Hudson River Estuary, Carlson (1986) found that largemouth bass preferentially winter in five major areas:

- Coxsackie Bay (roughly River Mile 130)
- The mouth of the Catskill Creek (River Mile 115)
- The mouth of the Espopus Creek (River Mile 103)
- The mouth of the Rondout Creek (River Mile 92)
- The mouth of the Wappinger Creek (River Mile 67)

Largemouth bass prefer to establish habitats near dense vegetation not just during winter, primarily near milfoil (*Myriophyllum verticillatum*) (Carlson, 1992). A study of largemouth bass in two freshwater lakes in central Florida found a positive correlation between the use of specific habitats in proportion to the availability of those habitats to the fish (Mesing and Wicker, 1986).

Vegetative habitat covers included *Panicum* spp., cattails (*Typha* spp.), and water lilies (*Nuphar* spp.).

In a 1982 survey of the Lower Hudson River Estuary (Carlson, 1986), largemouth bass were found to prefer vegetated backwater and tributary locations, with a few fish caught in rock piles and tailwater. This suggests a preference for nearshore areas rather than the main channel.

1.2.3 Reproduction

Largemouth bass mature at age five and spawn from late spring to mid-summer, in some cases as late as August. Male largemouth bass construct nests in sand and/or gravel substrates in areas of nonflowing clear water containing aquatic vegetation (Nack and Cook, 1986). This aquatic vegetation generally consists of water chestnut (*Trapa natans*), milfoil (*Myriophyllum verticillatum*), and water celery (*Valisneria americana*).

Females produce 2,000 to 7,000 eggs per pound of body weight (Smith, 1985) and leave the nest after spawning.

1.3 White Perch

White perch, *Morone americana*, are resident throughout the Hudson River Estuary below Federal Dam. They are semi-anadromous and migrate to the lower lock pools of the Upper Hudson River to spawn. They are one of the most abundantly collected species in the region and are the dominant predatory fish in the Lower Hudson River (Bath and O'Connor, 1981; Wells et al., 1992).

1.3.1 Foraging

Adult white perch are benthic predators, with older white perch becoming increasingly piscivorous (Setzler-Hamilton, 1991). Insect larvae and fishes comprise the principal food of white perch, and dipteran larvae, especially chironomids, represent the most important insect prey. White perch have two peak feeding periods: midnight and noon. Midnight is the most important foraging time.

In a study of Hudson River larvae, Hjorth (1988) found that white perch larvae fed almost exclusively upon microzooplankton. Adults and copepods of *Eurytemora affinis* were the preferred food, but when they were not present, white perch larvae consumed rotifers, cladocerans, and other seasonal zooplankters.

From August through October, young-of-the-year white perch in the Hudson River feed predominantly on amphipods supplemented by copepods and mysids (NOAA, 1984). In a study of white perch taken from the Hudson River between Haverstraw and Bear Mountain (Bath and O'Connor, 1985), gammarid amphipods occurred most frequently in the stomachs of immature and mature white perch. Mature fish ate a higher proportion of isopods and annelid worms than did immature fish during the spring and summer. During May and June, mature fish contained between 2 and 8.6 percent by occurrence, while gammarid amphipods were the predominant food item in July, 64 percent, and November, 75 percent. Insect larvae occurred in fewer than 2 percent of mature fish during May and June, and were not found again during the remainder of the sampling year. White perch in this oligohaline sector of the river fed primarily at or near the sediment-water interface. Their preferred prey items consisted of epibenthic crustaceans and insects.

In 1973 and 1974, Lawler, Matusky & Skelly Engineers conducted an extensive biomass and stomach content analysis in the lower Hudson River on behalf of Central Hudson Gas & Electric Corporation (LMS, 1974). Their study found that the dominant food item consumed by the 49 white perch obtained from Roseton and Danskammer Point during the spring were amphipods, representing 93% of the total identified food volume. During fall sampling, amphipods (*Gammarus* spp. and *Leptochierus plumulosus*) were the dominant food item consumed by the 36 white perch captured. Copepods were found to be a dominant prey item for smaller white perch, but were infrequently found in larger white perch. During the 1974 sampling season, the largest size range of white perch (>17 cm) consumed amphipods and isopods, supplemented by chronomid larvae during the spring and summer, and the decapods *R. harrissi* and *C. septemspinosa* during the fall and winter. The data on gut contents indicate that white perch feed primarily on benthic invertebrates and select arthropods such as amphipods and chironomid insect larvae (based on personal knowledge of benthic invertebrates in the lower Hudson). This fish species probably makes use of all depths in the river for foraging based on collections made using bottom trawls and bottom gill nets in the lower Hudson River (personal observations.)

A small subset of the white perch samples taken as part of the TAMS/Gradient Phase 2 activities were analyzed for gut contents. A large number of chironomid were found and identified to evaluate the relative contribution of sediment and water sources to the diet of white perch resident in the Hudson River. Table A-4 shows the results of these analyses. Spaces in the table were left blank when the habitat and association of a prey item were unknown.

Table A-4 shows that white perch in the Hudson River generally consume chironomid equally associated with both the water column and sediment. Particular individual fish (i.e., Fish No. 5) appear to feed exclusively on water column sources, while others (Fish No. 1) show a greater sediment influence. Chironomid represent a significant proportion of the available benthos in the Hudson River. Based on the table shown above, it appears that this collection of white perch consumed organisms that live on plants and the surfaces of sediments as well as those that burrow into sediment.

Another group of 40 white perch from the NYS DEC 1996 sampling effort were also evaluated by Menzie-Cura for gut contents. These fish were collected in the river at Troy and at Catskill Creek in the Spring of 1997. Chironomid insect larvae were the most common food item in the diet (75% of fish) and amphipods were the next most common dietary item (35% of fish). These observations are similar to those made on the fish collected during the TAMS/Gradient Phase 2 sampling.

The data on feeding behavior for white perch indicate that this species eats invertebrates. The species can make use of near-shore areas as well as the main river bottom for foraging. Feeding is elective for arthropods such as chironomid insect larvae and amphipods. In nearshore areas where rooted aquatic plants are present, the species probably feeds on arthropods associated with both sediments and plants. In areas along the main river bottom, the species probably feeds primarily on benthic invertebrates. Benthic invertebrates include species that vary in the degree of surface water, pore water, and sediment exposure. Oligochaete worms form a small part of the white perch diet which suggests that this species does consume organisms that are closely associated with sediment. This is also suggested by the presence of chironomid insect larvae such as *Tanytarsus, Procadius, Chironomus* and *Cryptochironomus* in their digestive system that are also reported to burrow into sediments rather live on surfaces of plants and substrates (Simpson and Bode, 1980, personal observations). However, white perch also eat benthic organisms that may be more strongly influenced by surface water exposure. These include chironomid insect larvae such as *Polypedilum illinoense grp.* and *Dicrotendipes neomodestus* that tend to live on the surface of substrates. The amphipod *Gammarus* is also likely to be influenced strongly by water exposures because it lives on or near surface sediments and also swims into the water column.

Based on available information we estimate that the diet of white perch contains 75% invertebrates that are influenced primarily by sediments and 25% of invertebrates that are influenced by water. This estimate is uncertain. If we assume that benthic species are more likely to be exposed to sediment than to water, we estimate that the 50 to 100% of the white perch diet consists of invertebrates that are primarily influenced by sediment exposure.

1.3.2 Range, Movement and Habitat within the Hudson River

White perch prefer shallow areas and tributaries, generally staying close to rooted vegetation. The position of this fish relative to the water surface varies somewhat based on size (Selzer-Hamilton, 1991). White perch are bottom oriented fish that accumulate in areas with dissolved oxygen of at least 6 mgL^{-1} (Selzer-Hamilton, 1991). Gladden et al., (1988) compared the spatial segregation of a number of fish species in the Hudson River estuary and found the majority of white perch over the course of three years to prefer the main channel bottom

Because white perch make spawning migrations, they are considered semianadromous. Spawning occurs in the upper reaches of the Lower Hudson River. Eggs, larvae, and juveniles gradually disperse downstream throughout the summer. Young-of-the-year white perch often congregate in the Tappan Zee and Croton-Haverstraw regions, with a smaller peak from Saugerties to Catskill (Lawler, Matusky & Skelly Engineers, 1992).

During the summer, white perch move randomly within the local area. Adult white perch tend to accumulate at 4.6-6 meters depth during the day and move back to the surface during the night (Selzer-Hamilton, 1991). White perch spend the winter in depths of 12-18 meters, but occasionally can be found at depths as low as 42 meters. Hudson River white perch are acclimated at 27.8°C and avoid temperatures that are below 9.5°C or above 34.5°C.

White perch prefer shallow and wetland areas to other habitats, but undertake extensive migrations within the estuary (Carlson, 1986). White perch were most often found in tributaries, vegetated backwaters, and shore areas in the Lower Hudson River. Carlson observed the greatest increase in summertime abundance between River Mile 102 and 131. By winter, the majority of white perch move downriver, although some overwinter in the upper estuary in areas over 32 feet deep (Texas Instruments, 1980).

In the Upper Hudson River, white perch were taken in the lower two lock pools (MPI, 1984). They were taken primarily in shallow and wetland habitats (see Table A-3).

All ages of white perch are adversely affected by high levels of suspended solids. Adult white perch can be found in water with pH ranges between 6.0 and 9.0 and avoid areas with moderate turbidity at 45 NTU, although they can be found in either clear or highly turbid areas (Selzer-Hamilton, 1991).

1.3.3 Reproduction

Spawning is episodic, usually occurring in a two week period from mid-May to early June when the water temperatures are between 16° and 20°C. Hudson River white perch tend to spawn beginning in April when the water temperature reaches 10° to 12°C, and continue spawning through June. In years when the water temperature increases gradually, the peak spawning period lasts from four to six weeks (Klauda et al., 1988).

White perch prefer to spawn in shallow water, such as flats or embankments, and tidal creeks. They generally spawn over any bottom type (Scott and Crossman, 1973). Spawning is greatest in the fresh water regions around Albany, and between River Mile 86 and 124 (McFadden et al., 1978; Texas Instruments, 1980).

Fecundity of Hudson River white perch age 2 to 7, the maximum age of white perch in the river, ranges from less than 15,000 to more than 160,000 eggs per female (Bath and O'Connor, 1981). Mean fecundity in that study was 50,678 eggs per female and was dependent upon size.

1.4 Yellow Perch

Yellow perch, *Perca flavescens*, are gregarious fish that travel in schools of 50-200. They feed omnivorously on organisms from the sediment and in the water column. Yellow perch are an important freshwater sport fish.

1.4.1 Foraging

Yellow perch feed actively early in the morning or late in the evening, with less feeding taking place later in the day. At night the fish are inactive and rest on the bottom (Scott and Crossman, 1973).

Young fish feed primarily upon cladocerans, ostracods, and chironomid larvae (Smith, 1985). As they grow, they shift to insects. Chabot and Maly (1986) found that fish that were one to one and a half years old preferred large zooplankton species. Larger fish eat crayfish, small fish, and odonate nymphs (Smith, 1985). Piavis (1991 Yellow perch habitat requirements for) found that approximately 25 percent of the diet of yearling yellow perch was made up of other perch. From May through August, chironomids generally comprise between 30 percent and 60 percent of the diet. Piavis noted that adult yellow perch forage on midge larvae, anchovies, killifish, silversides, scuds, and caddsisfly larvae. Adults also forage on pumpkinseed.

Information on feeding behavior of yellow perch in the Hudson is available from the work conducted by Exponent (1998a, 1998b) and fish collected by NYSDEC in Spring 1997 and analyzed by Menzie-Cura. The Exponent data set consists of fish that are in the range of 6.1 to 14.6 cm . The fish analyzed by Menzie-Cura were larger (median = 21.5 cm, maximum = 31.8 cm). Both data sets indicate that yellow perch feed primarily on invertebrates. Based on the literature fish may be eaten by larger yellow perch. The diet of yellow perch indicates they eat a wide variety of invertebrates from the water column, from plants, and from sediments Table A-1 and Table A-2). Amphipods (especially *Gammarus*), isopods (*Caecidotea*), cyclopoid copepods, and most of the cladoceran species were predominant in yellow perch stomachs. Analyses performed by Menzie-Cura indicated that larger yellow perch also eat small clams and snails as well as oligochaete worms; all of these are common benthic species. Predominant insect larvae in the guts of yellow perch (6 – 14 cm length) included species that are readily available on the surfaces of plants and on sediments as well as diptera pupa which tend to be planktonic.

Our qualitative assessment of the Exponent (1998a, 1998b) data for yellow perch in the 6-14 cm size range suggests that benthic invertebrates could comprise as much as 70% of the diet. However, we estimate that up to 56% of the diet could consist of invertebrates that live primarily in the water (e.g., zooplankton and on plants). Some of the benthic invertebrates associated with the sediments could also be strongly influenced by surface water (e.g., *Gammarus* spp.) Therefore, the component of the invertebrate diet that is exposed to surface water could be even greater than that indicated from a simple division of benthic and non-benthic. We estimate that this component could be as much as 65% (and might be even higher).

Oligochaete worms were observed in the gut contents of a number of larger yellow perch (11 to 32 cm) indicating that these fish forage directly in the sediments. Larger yellow perch also probably eat fish although none were observed in the gut contents examined by Menzie-Cura. We estimate that fish are probably a small part of the diet of large yellow perch (i.e., less than 10%).

1.4.2 Range, Movement and Habitat within the Hudson River

Yellow perch are most abundant in waters that are clear and have moderate vegetation and sand, gravel or mucky bottoms. Abundance decreases with increases in turbidity or with decreases in abundance of vegetation. Adult perch prefer slow moving waters near the shore areas where there is moderate cover.

Yellow perch studied in the freshwater Cedar Lake in Illinois stayed within a 5 to 20 kilometer home range (Fish and Savitz, 1983). The fish preferred heavy and light weeded as well as sandy areas, and were virtually never seen in open water (see Table A-5).

Yellow perch are found throughout the Upper Hudson River (MPI, 1984), particularly near River Mile 153 (Federal Dam) and again up near the Thompson' Island Pool area (see Table A-5).

Yellow perch prefer wetlands, embayments and shallow areas to other habitats, but can be found in all types of habitats to some degree. They primarily inhabit the freshwater portion of the estuary with an apparently even distribution of early life stage abundance from river mile 77 through 153 (Texas Instruments, 1976; Carlson, 1986).

Yellow perch require a minimum dissolved oxygen concentration for all life stages of 5 mg/L-1. Seasonal lethal dissolved oxygen is 0.2 mg/L-1 in winter and 1.5 mg/L-1 in summer. Yellow perch are poikilothermic, requiring less oxygen in winter. Suboptimal dissolved oxygen may have acute implications, in that if a preferred habitat contains less dissolved oxygen than necessary, then fish may leave the area, subjecting them to predation, or they may experience retarded growth, impacting survivability (Piavis, 1991).

1.4.3 Reproduction

Yellow perch are among the earliest spring spawners, with spawning occurring near vegetated areas and in upstream, tidal tributaries (Carlson, 1986). In the Chesapeake River, adult yellow perch migrate from downstream stretches of tidal waters to spawning areas in less saline upper reaches in mid February through March (Piavis, 1991). Spawning occurs when water temperatures reach 45-52°F in April and May in New York waters (Smith, 1985). Males arrive at the spawning ground first. Spawning occurs in 5 to 10 feet of water over sand, rubble, or vegetation. Eggs are often draped over logs or vegetation.

1.5 Brown Bullhead

The brown bullhead, *Ictalurus nebulosus*, is a demersal omnivorous species occurring near or on the bottom in shallow, warmwater situations with abundant aquatic vegetation and sand to mud bottoms. Brown bullhead are sometimes found as deep as 40 feet, and are very tolerant of conditions of temperature, oxygen, and pollution (Scott and Crossman, 1973).

1.5.1 Foraging

The brown bullhead feeds on or near the bottom, mainly at night. Adult brown bullhead are truly omnivorous, consuming offal, waste, molluscs, immature insects, terrestrial insects, leeches, crustaceans including crayfish and plankton, worms, algae, plant material, fishes, and fish eggs. Raney and Webster (1940) found that young bullheads in Cayuga Lake near Ithaca, New York fed upon crustaceans, primarily ostracods and cladocerans, and dipterans, mostly chironomids. For brown bullhead in the Ottawa River, algae have also been noted as a significant food source (Gunn et al., 1977).

Information on the diet of brown bullhead in the Hudson River is available for the river north of Newburgh (LMS, 1975). This work indicated that brown bullhead displayed a varied and seemingly opportunistic feeding behavior. Smaller bullheads (size interval I) ate primarily chironomid insect larvae, amphipods., odonata, and oligochaete worms. Larger bullheads displayed a similar feeding behavior but also ate young-of-the-year fish. Observations made on gut contents of brown bullheads collected in the Kingston area indicated that oligochaete worms were a major part of the diet.

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Additional information on feeding habits of Hudson River fish is available from Exponent (1998a, 1998b) and for fish collected in Spring 1997 and analyzed by Menzie-Cura.. The available data from these studies indicates that the diet reflects a large benthic invertebrate component. Only one fish was observed in a gut of one bullhead. Our analysis of the Exponent data indicate that predominant prey items for bullheads included small clams, amphipods (*Gammarus*), isopods (*Caecidotea*), a few of the cladoceran species, and chironomid insect larvae that are typically considered to burrow into sediments (e.g., *Procladius*). Menzie-Cura also observed that the diet of brown bullhead frequently contain oligochaete setae (worms are usually quickly digested or unidentifiable).

A qualitative assessment of the Exponent data suggests that 71 to 83% of the invertebrates are associated with sediments and 17 to 29% are associated with water. Because oligochaete worms may be a major food item, the benthic percentage is probably even higher and we estimate that it may be as high as 95%. Data for the lower Hudson reported by LMS (1975) also support a high component of the diet as benthic in nature in that are large component was comprised of oligochaete worms. These organisms are digested more quickly that insects and crustaceans and are probably underrepresented in the Exponent and Menzie-Cura analyses. Fish are considered to be a minor component of the diet (less than 5%).

1.5.2 Range, Movement and Habitat within the Hudson River

Brown bullhead, a freshwater demersal fish, resides in water conditions that are shallow, calm and warm. In the summer, bullheads can be found in coves with ooze bottoms and lush vegetation, especially water clover, spatterdock and several species of pond weed (Raney, 1967 Some catfish of New York). Carlson (1986) found that the vegetated backwaters and offshore areas are the most common habitats for brown bullheads. McBride (1985) found bullhead abundant in river canal pools (see Table A-5).

Brown bullhead were most frequently taken in wetland and embayment habitats (MPI, 1984) (see Table A-5). Brown bullhead prefer wetlands, embayments, and shallow habitats. Carlson (1986) found bullheads most frequently in backwaters, but also in other, deeper areas such as the channel border. This species prefers silty bottoms, slow currents, and deeper waters.

1.5.3 Reproduction

Brown bullhead reach maturity at two years and spawn for two weeks in the late spring and early summer. Smith (1985) noted that in New York, brown bullhead spawn when water temperatures reach 27°C in May and June.

They prefer to spawn among roots of aquatic vegetation, usually near the protection of a stump, rock or tree, near shores or creek mouths. Males, sometimes aided by females, build nests under overhangs or obstructions (Smith, 1985). Eggs are guarded.

1.6 Pumpkinseed

The pumpkinseed, *Lepomis gibbosus*, is the most abundant and widespread fish in New York State (Smith, 1985). In the Hudson River, they feed exclusively upon epiphytic water column organisms. Pumpkinseed are important forage for predatory fishes.

1.6.1 Foraging

Pumpkinseed are diurnal feeders in areas with low light intensity and migrating to cooler, deeper water at night. They do not feed in winter and only begin to feed when the water temperature rises above 8.5° C. Pumpkinseed forage on hard shelled gastropods and are able to exploit food sources not available to other fish, particularly mollusks (Sadzikowski and Wallace, 1976 A comparison of food habits of). Food is mainly a variety of insects and, secondarily, other invertebrates. Small fish or other vertebrates, e.g., larval salamanders, can also contribute significantly to the pumpkinseed diet (Scott and Crossman, 1973).

Early juvenile pumpkinseed prefer chironomid larvae, amphipods, cladocerans, and, to a lesser extent, copepods as food items (Sadzikowski and Wallace, 1976). Juvenile pumpkinseed in the Connecticut River feed primarily upon benthic organisms (Domermuth and Reed, 1980). A study conducted in the St. Lawrence River near Massena found that juvenile pumpkinseed between 77 and 113 mm in length consumed 94 percent chironomids (Johnson, 1983). Feldman (1992) found that juvenile pumpkinseed taken from Thompson Island Pool in the Hudson River consumed zooplankton such as cladocerans, copepods, ostracods, chironomids and talitrids. Adults consumed mostly gastropods on plants. No sediment source of food was noted.

Adult pumpkinseed primarily prefer insects and secondarily prefer other invertebrates. As the fish age and increase in size, other fish and invertebrates other than insects constitute a larger portion of the diet, up to 50 percent of the diet.

A small subset of the pumpkinseed samples taken as part of the TAMS/Gradient Phase 2 activities were analyzed for gut contents. A large number of chironomid were found and identified to evaluate the relative contribution of sediment and water sources to the diet of pumpkinseed resident in the Hudson River. Table A-6 shows the results of these analyses. Spaces in the table were left blank when information on habitat and association were unknown. These gut content analyses demonstrate that pumpkinseed in the Hudson River appear to feed largely upon species associated with plants or other surface substrates.

Additional data on the diet of pumpkinseed sunfish is available from the collections of yearling fish made by Exponent (1998a, 1998b). These data indicated that the diet of the fish was comprised invertebrate commonly associated with benthic environments. Predominant prey items included small clams, snails, amphipods, isopods, and insect larvae. However, most of the invertebrate prey items live at or on the surface of substrates rather than deep within the sediments. Gastropod snails were a predominant item in the diet similar to the observations of Feldman who observed that these were an important part of the diet of adult fish; he presumed they were eating gastropods living on plants. The composition of the chironomid insect larvae in the gut contents of yearling sunfish is also suggestive that yearling fish feed on surface substrates rather than on burrowing animals; *Dicrotendipes spp.* were commonly observed while

Procladius spp. were rarely seen in the gut contents. The amphipod *Gammarus spp.* is also an important item in the diet and is considered epibenthic and meroplanktonic.

The diet of pumpkinseeds changes with size and age as noted above. Young-of-the-year fish may consume a proportionally greater amount of smaller invertebrates associated with the water column while larger juvenile and adult sunfish may consume a proportionally greater amount of benthic invertebrates. These benthic invertebrates largely include species that live on or at the surface of substrates. Gastropods, for example, feed on surface substrates and are likely exposed to water conditions directly above sediments or around stands of plants. The diet of pumpkinseed sunfish consist of invertebrates that may be more influenced by conditions at and above the water/sediment interface than by conditions deeper in the sediments.

1.6.2 Range, Movement and Habitat within the Hudson River

Pumpkinseed are restricted to freshwater and are found in shallow quiet areas with slow moving water. Pumpkinseed are usually found in clear water with submerged vegetation, brush or debris as cover. They rely on the littoral zone as a refuge from predators and for foraging material (Feldman, 1992).

Several investigators have noted the ability of pumpkinseed to return to a home range, even after significant displacement (Hasler and Wisby, 1958; Fish and Savitz, 1983; Shoemaker, 1952; Gerking, 1958).

Pumpkinseed are found throughout the Upper Hudson River above Federal Dam (MPI, 1984) (see Table A-7). They are found primarily in wetland, stream mouth, and embayment habitats (see Table A-7).

1.6.3 Reproduction

Spawning occurs during early spring and summer although it can extend into late summer (Scott and Crossman, 1973). Nests are built in water that is 6 to 12 inches deep, forming colonies close to aquatic vegetation and other pumpkinseed nesting areas. Nesting occurs when the water temperature reaches 60°F and lasts approximately 11 days. Nesting substrates include sand, sandy clay, mud, limestone, shells and gravel. Females lay from 600 to 5,000 eggs (Smith, 1985). Males guard the nest for one week after hatching.

1.7 Spottail Shiner

The spottail shiner, *Notropis hudsonius*, consumes plankton, aquatic insects, and some bottom-dwelling organisms, and is therefore exposed to sediment and water column. The spottail shiner is consumed by virtually all other fish, including larger spottail shiners.

1.7.1 Foraging

Spottail shiners are morphologically suited for bottom foraging in that they have rounded snouts that hang slightly over their mouths. They do not however feed exclusively upon benthic organisms. Spottail shiners are considered omnivorous and opportunistic feeders, feeding upon cladocerans, ostracods, aquatic and terrestrial insects, spiders, mites, fish eggs and larvae, plant fibers, seeds, and algae (Texas Instruments, 1980; Scott and Crossman, 1973; Smith, 1987). Based on work in the lower Hudson River, Gladden et al. (1988) consider zooplankton to be a major part of the spottail shiners diet.

In Lake Nipigon, Ontario (Scott and Crossman, 1973), 40 percent of the diet was made up of *Daphnia* spp. Other cladocerans were also present, and aquatic insect larvae, including chironomids and ephemeropterids, comprised another 40 percent of the spottail shiner diet.

In Lake Michigan, Anderson and Brazo (1978) found that terrestrial dipterians and fish eggs represented the major components of the spottail shiner's diet in the spring and summer. In the fall, chironomid larvae and terrestrial insects represent the major diet components.

Information on the diet of spottail shiners in the Hudson River was obtained by Exponent (1998a, 1998b). We evaluated these data qualitatively and found that the major food items appeared to be organisms with a high association for the water column (algae, cladocera, and copepods) and species that live in close associated with surface substrates (ostracods, amphipods, chironomid larvae and caddisfly larvae). The composition of the predominant chironomid larvae in spottail shiner gut contents are considered surface sprawlers or epiphytic rather than sediment burrowers.

Observations on feeding behavior of spottail shiner suggests they can range from benthic feeders to water column feeders. Many of the benthic invertebrates include surface dwellers that are influenced by surface water conditions. We estimate spottail shiners primarily eat invertebrates that are more directly influenced by surface water conditions than by conditions below the surface of sediments. However, benthic invertebrates could be an important part of the diet based on the literature.

1.7.2 Range, Movement and Habitat within the Hudson River

Spottail shiners prefer clear water and can be found at depths up to 60 feet (Smith, 1987), but tend to congregate in larger numbers in shallow areas (Anderson and Brazo, 1978) (see Table A-7). Spottail shiners in the Upper Hudson River were primarily taken in wet dumpsite habitat areas (MPI, 1984) (see Table A-7).

1.7.3 Reproduction

Spottail shiners spawn in the spring and early summer in habitats with sandy bottoms and algae (Scott and Crossman, 1973). In New York waters, spawning usually occurs at the mouths of streams in June or July. Ovarian egg counts range from 100 to 2,600 eggs per female. depending upon total size (Smith, 1985).

1.8 Striped Bass

The striped bass, *Morone saxatilis*, is an anadromous species that enters the Hudson River to spawn throughout the estuarine portion of the river, but particularly upstream from the saltfront. While most adults return to the sea after spawning, some remain within the estuary for a period. Young of the year gradually move downstream during the summer months and move out of the river during the winter. Historically, striped bass were an important Hudson River fisheries species, but high polychlorinated biphenyl levels closed the fishery in 1976.

1.8.1 Foraging

Striped bass are voracious, carnivorous fish that feed in groups or schools and alternate periods of intense feeding activity with periods of digestion (Raney, 1952). Peak foraging time for juveniles is at twilight. Adults feed throughout the day, but forage most vigorously just after dark and just before dawn. Adults typically gorge themselves in surface waters, then drop down into deeper waters to digest their food. Seasonally, adult feeding intensity lessens in the late spring and summer. Feeding ceases during spawning.

Striped bass feed primarily upon invertebrates when they are young, consuming larger invertebrates and fish as they grow larger. Post yolk-sac larvae feed upon zooplankton. Hjorth (1988), in a study of Hudson River striped bass larvae, found that copepodids and adults of the calanoid copepod *Eurytemora affinis* were the most frequently selected prey item. Hudson River striped bass larvae also fed upon cladocerans, especially *Bosmina* spp. Copepods and cladocerans are the most common zooplankters in the Hudson River during times that striped bass larvae are present (Texas Instruments, 1980).

A study by the Hudson River power authorities (Texas Instruments, 1980) found that striped bass up to 75 mm preferred amphipods *Gammarus* spp., calanoid copepods, and chironomid larvae. Fish from 76-125 mm preferred *Gammarus* and calanoid copepods. Those from 126-200 mm preferred a fish prey, *Microgadus* tomcod.

Fish are generally considered to make up the bulk of the diet of adult striped bass. Researchers commonly find engraulids and clupeids the most the most common prey (summarized in Setzler et al., 1980). Because striped bass feed in schools, schooling species of fish generally comprise a large portion of the diet. Striped bass are known to gorge themselves upon schooling clupeids and engraulids, concentrating their feeding activity upon whatever species is most abundant. Many other species have also been noted in striped bass diets, for example, mummichogs, mullet, white perch and tomcod. Invertebrates also may persist in the diet of adult striped bass. Schaefer (1970) found that in Long Island Sound, fish from 275-399 mm fork length fed primarily (85 percent by volume) upon invertebrates, primarily the amphipods *Gammarus* spp. and *Haustorius canadensis* and the mysid shrimp *Neomysis americana*. Fish from 400-599 mm divided their diet between fish (46 percent) (bay anchovy, Atlantic silverside, and scup) and amphipods. Sixty percent of the diet of fish from 600-940 mm in length was made up of fish, but even these larger animals consumed amphipods, mysids, and lady crabs. Schaefer hypothesized that the continued importance of invertebrates in larger fishes diets may have resulted from turbidity in the surf zone making it difficult to pursue fast-swimming fish.

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1.8.2 Range, Movement and Habitat within the Hudson River

Striped bass are anadromous, spawning in tidal rivers, then migrating to coastal waters to mature. Abundant data on distribution and abundance of early life history stages of striped bass are available, because the Hudson River utilities have conducted annual surveys of the distribution of striped bass in the Hudson River since 1973. Field sampling has been conducted from New York City, the George Washington Bridge at River Mile 12, to the Federal Dam. Since 1981 the sampling programs have been adjusted to emphasize collection of striped bass. Additionally, the utilities have sponsored mark-recapture studies of striped bass (e.g., McLaren et al., 1981). These studies documented movement of the species within and outside the river.

The upstream spring migration of adult striped bass begins in March and April and ranges up to the Federal Dam. As young striped bass grow during the summer, they move downstream. Even at the egg stage, striped bass can be found throughout the Hudson River Estuary, although peak abundances of eggs and larvae are usually found from the Indian Point to Kingston reaches of the river, approximately River Miles 100-150 (Lawler, Matusky & Skelly Engineers, 1992). Downstream movement is partially determined by flow rate.

At approximately 13 mm total length, striped bass form schools and move into shallow waters (Raney, 1952). In the Hudson River, young-of-the-year striped bass begin to appear in catches during early July. They move shoreward as well as downstream throughout the summer and are usually found over sandy or gravel bottoms (Setzler et al., 1980). The utilities' studies typically find peak catches of young-of-the-year fish at River Mile 35, at the southern end of Croton-Haverstraw Bay (Lawler, Matusky & Skelly, 1992).

Some young-of-the year fish leave the estuary during the summer and fall (Dovel, 1992 Movements of immature striped bass). Dovel (1992) summarized movements of young striped bass within the river based upon studies conducted by the utilities and others. He found that young striped bass congregate in the vicinity of the salt front during the winter, although movements in the Lower Hudson River continue throughout the winter. During the spring, some yearling striped bass continue to emigrate from the river, while other move upstream. By their second year, most striped bass have left the river, except for their returns during spawning migrations.

1.8.3 Reproduction

In the Hudson River, striped bass spawn above the salt front and potentially as far upstream as the Federal Dam At River Mile 153. On average, however, they do not spawn as far upstream as white perch. During periods of low freshwater flow, striped bass spawn further upstream than in years of high flow. Age at sexual maturity of striped bass depends upon water temperature (Setzler et al., 1980). Males mature at approximately two years, and females mature later. Spawning is triggered by sudden rises in temperature and occurs at or near the surface. Spawning occurs in brief, explosive episodes. Eggs are broadcast into the water, where a single female may be surrounded by as many as 50 males.

1.9 Shortnose Sturgeon

The shortnose sturgeon, *Acipenser brevirostrum*, is the smaller of two sturgeons that occur in the Hudson River. Both the shortnose and Atlantic sturgeons have been prized for their flesh and their eggs for caviar, but sturgeons were also purposely destroyed when they became entangled in the shad nets that were once common on the Hudson River. The shortnose sturgeon has been listed on the federal endangered species list since 1967. Because it is rare and because historical data often link it with the Atlantic sturgeon, only limited data are available to describe its natural history.

1.9.1 Foraging

No field studies have documented the diets of larval shortnose sturgeon. Buckley and Kynard (1981) observed post yolk-sac larvae that they had hatched in the laboratory to feed upon zooplankton.

Juvenile shortnose sturgeon feed mostly upon benthic crustaceans and insect larvae (summarized in Gilbert, 1989). Juveniles of 20-30 cm fork length have been recorded as feeding extensively upon cladocerans. Adult fish feed indiscriminately upon bottom organisms and off emergent vegetation. Food items of juvenile and adult fish include polychaete worms, molluscs. crustaceans, aquatic insects, and small bottom-dwelling fishes (Gilbert, 1989).

Juveniles and adults generally feed by rooting along the bottom, consuming considerable mud and debris with food items. As much as 85-95 percent of their stomachs may contain mud and other non-food material. Conversely, shortnose sturgeon may also feed upon gastropods that live upon vegetation. Shortnose sturgeon from New Brunswick and South Carolina have been reported as including almost exclusively gastropods with no non-food matter.

Shortnose sturgeon mostly feed at night or when turbidity is high, when they move into shallow water to feed. Adults move into areas as shallow as 1-5 m and forage among the weeds and river banks. Feeding occurs in deeper water during the summer, possibly in response to water temperature. The relatively little feeding occurs during the winter also occurs in deeper waters.

Shortnose sturgeon are not thought to feed in groups or schools. Mark-recapture data (Dovel et al., 1992) suggest, however, that fish tend to move as groups. Fish of the same group would therefore tend to eat in the same general areas.

1.9.2 Range, Movement and Habitat within the Hudson River

Shortnose sturgeon are found throughout the portion of the Hudson River below the Federal Dam. They are considered anadromous because they are sometimes taken by commercial fishermen at sea. However, their movements are more restricted than Atlantic sturgeon, and most of the Hudson River population probably does not leave the river. The fish does not require a marine component to its life cycle: a landlocked population in the Holyoke Pool, part of the Connecticut River system, persisted from 1848 until a fish ladder was constructed in 1955.

Adult shortnose sturgeon winter in Esopus Meadows, approximately at River Mile 90 (Dovel et al., 1992), in the Croton-Haverstraw region, approximately River Mile 35 (Geoghegan et al., 1992), and possibly in other small areas not yet identified.

Adult fish migrate upstream to spawn in the upper reaches of the portion of the Hudson River south of the Federal Dam in spring and then disperse downstream to feed during the summer. They can be taken throughout the fresh waters of the tidal portion of the river during the summer months.

The size of the nursery area for shortnose sturgeon larvae and young is difficult to determine, because few specimens are collected. Based upon the utilities' collections of young of the year in Haverstraw Bay, Dovel et al. (1992) presume that the young fish occupy the same freshwater portion of the estuary as do the adults of the species.

1.9.3 Reproduction

Shortnose sturgeons spawn in the upper reaches of the estuarine portion of the Hudson River, approximately River Miles 130-150. Spawning is limited to the last two weeks in April and the first two weeks in May. Throughout its range, the shortnose sturgeon spawns at water temperatures of 9-14°C (summarized in Crance, 1986). Dovel and his co-workers (1992) found that in 1979 and 1980, spawning in the Hudson River occurred at water temperatures of 10-18°C.

Age and size of the fish at maturity varies by latitude (Gilbert, 1989). In the Hudson River, females first spawn at approximately 9-10 years and males at 11-20 years. Spawning does not occur each year and is most likely controlled by environmental factors rather than by endocrinology.

Shortnose sturgeons produce approximately 40,000-200,000 eggs per spawning in New York waters.

Table A-1
Predominant Food Items in Hudson River Fish
(note: less common items are not listed)

	Largemout h bass	Pumpkinse ed sunfish	Brown bullhead	Yellow perch	Spottail shiner	White perch
PLANT MATTER						
Algae	**				***	
Vegetation						
BRYOZOA						
Bryozoa statoblasts					***	
BIVALVE MOLLUSCS (CLAMS)						
Pisidium		***		X		
Sphaerium		***	***			
GASTROPOD MOLLUSCS (SNAILS)						
Gastropods		***		X		
Planorbidae		***				
Valvata bicarinata		***				
OLIGOCHAETE WORMS						
Oligochaete worms			XX	X		
AMPHIPOD CRUSTACEANS						
Amphipod	**	***	***	***,XXX	****	XX
Gammarus spp.	**	****	****	****		
Hyalella azteca	**			**		
ISOPOD CRUSTACEANS						
Caecidotea	**	**	***	***,XXX		
CLADOCERAN CRUSTACEANS						
Bosmina longirostris	**					
Camptoceerus				***	**	
Chydorus				***	**	
Chydorus sphaericus	***		***	***	****	
Cladocera			**	***	****	
Eurycercus	***		**	****	****	
Pleuoxus denticulatus					***	
Sida				***		
Simocephalus serrulatus	**		**	***		
COPEPOD CRUSTACEANS						
Cyclopoid copepods	**			****	**	
OSTRACOD CRUSTACEANS						
Ostracod					****	

Table A-1
Predominant Food Items in Hudson River Fish
(note: less common items are not listed)

	Largemouth bass	Pumpkinseed sunfish	Brown bullhead	Yellow perch	Spottail shiner	White perch
Podocopa	**			**	**	
AQUATIC INSECTS						
Chaoborida						
Chaoborus			**			
Chironomidae						
Ablabesmyia annulata		**				
Ablabesmyia amallochi				**		
Chironomus spp.	**	**	**	**	****	XX
pupa		***		***	***	
Cryptochironomus						XX
Cricotopus/OrthocaldiusOrtho		**				
Dicrotendipes modestus		***		**	***	XX
Dicrotendipes neomodestus		***			***	XX
Polypedilum		**				XXX
Procaldius bellus			**			
Procaldius			**			XX
Tanytarsus spp.		***				XX
Ephemeroptera						
Caenis				**		
Odonata						
Coenargi				**, X		
Enallagma				**		
Tabanidae						
Tabanidae					**	
Trichoptera						
Oecetis					***	
Orthotrichia					**	
Trichoptera larave unid.					***	
ARACHNIDA						
Fish (unidentified species)	****		observed		***	

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Table A-2 Hudson River Fish Stomach Contents

Fish Species	Length	Weight	Collection Date	Location	Sex	Fish	Cray fish	Chironom id	Amphi pods	Isopods	Snails	Clams	Dragonfly Nymph	Caddisfly Nymph	Damsel Fly Nymph
BB	275	345	5/14/97	Hudson above feeder dam	F	0	0	1	5	17	0	1	0	0	0
BB	311	460	5/14/97	Hudson above feeder dam	F	0	0	0	4	24	2	0	0	0	0
BB	282	300	5/14/97	Hudson above feeder dam	F	0	0	0	0	12	0	0	0	0	0
BB	323	555	5/14/97	Hudson above feeder dam	F	0	0	3	0	8	0	5	1	0	0
BB	306	460	5/14/97	Hudson above feeder dam	M	0	0	0	22	16	0	0	0	0	0
BB	310	435	5/14/97	Hudson above feeder dam	M	0	0	5	0	24	0	3	0	0	0
BB	337	560	5/14/97	Hudson above feeder dam	M	0	0	0	7	0	2	1	0	2	0
BB	340	610	5/14/97	Hudson above feeder dam	M	0	0	10	24	14	1	0	0	0	0
BB	340	640	5/14/97	Hudson above feeder dam	M	0	0	0	29	13	0	0	0	0	0
BB	311	420	5/14/97	Hudson above feeder dam	M	0	0	0	0	21	0	0	0	0	0
BB	325	565	5/14/97	Hudson above feeder dam	M	0	0	1	8	54	0	0	0	0	0
BB	297	390	5/14/97	Hudson above feeder dam	M	0	0	3	3	9	0	0	0	1	0
BB	330	560	5/14/97	Hudson above feeder dam	F	0	0	12	2	23	2	0	0	0	0
BB	349	415	5/14/97	Hudson above feeder dam	M	0	0	0	0	0	0	0	0	0	0
BB	257	260	5/14/97	Hudson above feeder dam	F	0	0	0	0	16	0	0	0	0	0
BB	285	350	5/14/97	Hudson above feeder dam	F	0	4	35	1	0	0	0	0	0	0
BB	298	335	5/14/97	Hudson above feeder dam	F	0	0	0	0	16	0	0	0	0	0
BB	289	320	5/12/97	Hudson stillwater	M	0	0	2	30	0	15	0	3	0	0
BB	305	405	5/12/97	Hudson stillwater	F	0	0	44	1	0	0	0	0	0	0
BB	329	520	5/12/97	Hudson stillwater	M	0	0	6	5	0	10	43	3	0	0
BB	345	690	5/12/97	Hudson stillwater	F	0	0	1	0	0	0	0	0	0	0
BB	285	325	5/12/97	Hudson stillwater	M	0	0	0	0	0	0	0	0	0	0
BB	346	640	5/12/97	Hudson stillwater	M	0	0	0	0	0	0	0	0	0	0
BB	271	280	5/12/97	Hudson stillwater	F	0	0	52	0	0	26	4	0	0	0
BB	334	675	5/12/97	Hudson stillwater	F	0	0	0	7	15	15	46	0	0	14
BB	290	410	5/12/97	Hudson stillwater	F	0	0	16	1	17	0	0	1	0	0
BB	302	470	5/12/97	Hudson stillwater	F	0	0	0	0	0	0	13	0	0	0
BB	345	650	5/12/97	Hudson stillwater	M	0	0	0	1	1	0	0	0	0	0
BB	310	460	5/12/97	Hudson stillwater	U	0	0	2	1	1	8	0	1	0	0
BB	338	485	5/12/97	Hudson stillwater	F	0	0	3	0	0	9	6	0	0	0
BB	355	765	5/12/97	Hudson stillwater	F	0	0	1	2	1	1	0	0	0	5
BB	280	330	5/12/97	Hudson stillwater	F	0	0	15	5	9	18	17	0	0	0

Table A-2 Hudson River Fish Stomach Contents

Fish Species	Length	Weight	Collection Date	Location	Sex	Mosquito Larvae	Caddisfly Larvae	Horse Fly Nymph	Adult Insect	Pupa	Diatoms	Oligochaete Setae	Daphnidae
BB	275	345	5/14/97	Hudson above feeder dam	F	0	0	0	0	0	yes	yes	0
BB	311	460	5/14/97	Hudson above feeder dam	F	0	0	0	0	0	yes	0	0
BB	282	300	5/14/97	Hudson above feeder dam	F	0	0	0	0	0	0	yes	0
BB	323	555	5/14/97	Hudson above feeder dam	F	0	0	0	0	0	yes	yes	0
BB	306	460	5/14/97	Hudson above feeder dam	M	0	0	0	0	0	0	0	0
BB	310	435	5/14/97	Hudson above feeder dam	M	0	0	0	0	0	yes	0	0
BB	337	560	5/14/97	Hudson above feeder dam	M	0	0	0	0	0	0	yes	0
BB	340	610	5/14/97	Hudson above feeder dam	M	0	1	0	0	0	0	yes	0
BB	340	640	5/14/97	Hudson above feeder dam	M	0	0	0	0	0	yes	yes	0
BB	311	420	5/14/97	Hudson above feeder dam	M	0	0	0	0	0	0	0	0
BB	325	565	5/14/97	Hudson above feeder dam	M	0	0	0	0	0	yes	yes	0
BB	297	390	5/14/97	Hudson above feeder dam	M	0	0	0	0	0	0	yes	0
BB	330	560	5/14/97	Hudson above feeder dam	F	0	0	0	0	0	yes	yes	0
BB	349	415	5/14/97	Hudson above feeder dam	M	0	0	0	0	0	0	0	0
BB	257	260	5/14/97	Hudson above feeder dam	F	0	0	0	0	0	0	yes	0
BB	285	350	5/14/97	Hudson above feeder dam	F	0	0	0	0	0	yes	yes	0
BB	298	335	5/14/97	Hudson above feeder dam	F	0	0	0	0	0	0	0	0
BB	**289**	**320**	5/12/97	Hudson stillwater	M	0	0	0	0	0	yes	0	0
BB	**305**	**405**	5/12/97	Hudson stillwater	F	0	0	0	0	0	yes	0	0
BB	**329**	**520**	5/12/97	Hudson stillwater	M	0	0	0	0	0	yes	yes	0
BB	**345**	**690**	5/12/97	Hudson stillwater	F	0	0	0	0	0	yes	0	0
BB	**285**	**325**	5/12/97	Hudson stillwater	M	0	0	0	0	0	0	0	0
BB	**346**	**640**	5/12/97	Hudson stillwater	M	0	0	0	0	0	yes	0	0
BB	**271**	**280**	5/12/97	Hudson stillwater	F	0	0	0	0	0	0	0	0
BB	**334**	**675**	5/12/97	Hudson stillwater	F	0	0	0	0	0	yes	yes	0
BB	**290**	**410**	5/12/97	Hudson stillwater	F	0	0	0	0	0	yes	0	0
BB	**302**	**470**	5/12/97	Hudson stillwater	F	0	0	0	0	0	yes	yes	0
BB	**345**	**650**	5/12/97	Hudson stillwater	M	0	0	0	0	0	yes	yes	0
BB	**310**	**460**	5/12/97	Hudson stillwater	U	0	0	0	0	0	yes	0	0
BB	**338**	**485**	5/12/97	Hudson stillwater	F	0	0	0	0	0	0	0	0
BB	**355**	**765**	5/12/97	Hudson stillwater	F	0	0	0	0	0	yes	yes	0
BB	**280**	**330**	5/12/97	Hudson stillwater	F	0	0	0	0	0	yes	yes	0

Table A-2 Hudson River Fish Stomach Contents

Fish Species	Length	Weight	Collection Date	Location	Sex	Fish	Cray fish	Chironomid	Amphipods	Isopods	Snails	Clams	Dragonfly Nymph	Caddisfly Nymph	Damsel Fly Nymph
BB	**264**	**275**	5/12/97	Hudson stillwater	F	0	0	15	6	11	0	0	3	0	1
BB	**352**	**725**	5/12/97	Hudson stillwater	M	0	0	3	10	10	0	1	0	0	0
BB	**321**	**550**	5/12/97	Hudson stillwater	F	0	0	32	0	0	0	0	0	0	0
BB	**292**	**355**	5/12/97	Hudson stillwater	F	0	0	0	40	9	24	5	0	0	0
BB	**288**	**335**	5/12/97	Hudson stillwater	M	0	0	7	2	6	0	0	0	0	0
BB	324	470	5/13/97	Hudson @ Griffin Island	M	0	0	4	0	5	0	0	0	0	0
BB	336	490	5/13/97	Hudson @ Griffin Island	M	0	0	0	0	0	0	0	0	0	0
BB	258	270	5/13/97	Hudson @ Griffin Island	F	0	0	2	0	12	0	1	0	0	0
BB	231	170	5/13/97	Hudson @ Griffin Island	M	0	0	4	0	0	0	0	0	0	0
BB	235	205	5/13/97	Hudson @ Griffin Island	M	0	0	10	0	6	0	0	0	0	0
BB	280	320	5/13/97	Hudson @ Griffin Island	F	0	0	5	1	6	0	0	0	0	0
BB	296	450	5/13/97	Hudson @ Griffin Island	F	0	0	2	0	15	0	3	0	0	0
BB	269	330	5/13/97	Hudson @ Griffin Island	F	0	0	24	0	15	0	0	4	0	0
BB	269	290	5/13/97	Hudson @ Griffin Island	M	0	0	6	0	7	0	0	1	0	0
BB	253	260	5/13/97	Hudson @ Griffin Island	M	0	0	5	2	5	0	0	2	0	0
BB	297	410	5/13/97	Hudson @ Griffin Island	F	0	0	3	2	1	0	0	2	0	0
BB	330	665	5/13/97	Hudson @ Griffin Island	F	0	0	6	0	15	1	0	1	0	0
BB	264	310	5/13/97	Hudson @ Griffin Island	M	0	0	5	0	1	0	12	0	0	0
BB	251	240	5/13/97	Hudson @ Griffin Island	F	0	0	3	0	6	1	10	0	0	0
BB	227	175	5/13/97	Hudson @ Griffin Island	M	0	0	2	2	0	0	0	0	0	0
BB	240	195	5/13/97	Hudson @ Griffin Island	M	0	0	4	1	1	0	1	0	0	0
BB	205	120	5/13/97	Hudson @ Griffin Island	M	0	0	10	2	0	0	0	0	0	0
BB	230	165	5/13/97	Hudson @ Griffin Island	M	0	0	14	0	1	2	6	0	0	0
BB	206	110	5/13/97	Hudson @ Griffin Island	M	0	0	4	1	0	0	0	0	0	0
BB	200	100	5/13/97	Hudson @ Griffin Island	M	0	0	0	0	0	0	0	0	0	0
BB Totals						**0**	**0**	**382**	**227**	**443**	**137**	**178**	**22**	**3**	**20**

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Table A-2 Hudson River Fish Stomach Contents

Fish Species	Length	Weight	Collection Date	Location	Sex	Mosquito Larvae	Caddisfly Larvae	Horse Fly Nymph	Adult Insect	Pupa	Diatoms	Oligochaete Setae	Daphnidae
BB	**264**	**275**	5/12/97	Hudson stillwater	F	0	0	0	0	0	yes	yes	0
BB	**352**	**725**	5/12/97	Hudson stillwater	M	0	0	0	0	0	yes	yes	0
BB	**321**	**550**	5/12/97	Hudson stillwater	F	0	0	0	0	0	yes	yes	0
BB	**292**	**355**	5/12/97	Hudson stillwater	F	0	0	0	0	0	yes	yes	0
BB	**288**	**335**	5/12/97	Hudson stillwater	M	0	0	0	0	0	yes	yes	0
BB	324	470	5/13/97	Hudson @ Griffin Island	M	0	0	0	0	0	yes	0	0
BB	336	490	5/13/97	Hudson @ Griffin Island	M	0	0	0	0	0	0	0	0
BB	258	270	5/13/97	Hudson @ Griffin Island	F	0	0	0	0	0	yes	yes	0
BB	231	170	5/13/97	Hudson @ Griffin Island	M	0	0	0	0	0	0	0	0
BB	235	205	5/13/97	Hudson @ Griffin Island	M	0	0	0	0	0	0	yes	0
BB	280	320	5/13/97	Hudson @ Griffin Island	F	0	1	0	0	0	yes	yes	0
BB	296	450	5/13/97	Hudson @ Griffin Island	F	1	0	1	0	0	0	0	0
BB	269	330	5/13/97	Hudson @ Griffin Island	F	0	0	0	0	0	yes	yes	0
BB	269	290	5/13/97	Hudson @ Griffin Island	M	0	0	0	0	0	yes	yes	0
BB	253	260	5/13/97	Hudson @ Griffin Island	M	0	0	0	0	0	yes	yes	0
BB	297	410	5/13/97	Hudson @ Griffin Island	F	0	0	0	0	0	yes	yes	0
BB	330	665	5/13/97	Hudson @ Griffin Island	F	0	0	0	0	0	0	0	0
BB	264	310	5/13/97	Hudson @ Griffin Island	M	1	0	2	0	0	yes	0	0
BB	251	240	5/13/97	Hudson @ Griffin Island	F	0	0	0	0	0	yes	0	0
BB	227	175	5/13/97	Hudson @ Griffin Island	M	0	0	0	0	0	yes	yes	0
BB	240	195	5/13/97	Hudson @ Griffin Island	M	0	0	0	0	0	yes	0	0
BB	205	120	5/13/97	Hudson @ Griffin Island	M	0	0	0	0	3	yes	yes	0
BB	230	165	5/13/97	Hudson @ Griffin Island	M	0	0	0	0	0	yes	yes	0
BB	206	110	5/13/97	Hudson @ Griffin Island	M	0	0	0	0	0	yes		0
BB	200	100	5/13/97	Hudson @ Griffin Island	M	0	0	0	0	0	0	0	0
BB Totals						**2**	**2**	**3**	**0**	**3**	**34**	**34**	**0**

Table A-2 Hudson River Fish Stomach Contents

Fish Species	Length	Weight	Collection Date	Location	Sex	Fish	Cray fish	Chironom id	Amphi pods	Isopods	Snails	Clams	Dragonfly Nymph	Caddisfly Nymph	Damsel Fly Nymph
LMB	472	1860	5/22/97	Catskill Creek	F	0	0	0	0	0	0	0	0	0	0
LMB	411	1070	5/22/97	Catskill Creek	M	0	1	0	0	0	0	0	0	0	0
LMB	409	1130	5/22/97	Catskill Creek	M	1	0	0	0	0	0	0	0	0	0
LMB	347	630	5/22/97	Catskill Creek	M	0	0	0	0	0	0	0	0	0	0
LMB	389	920	5/22/97	Catskill Creek	F	0	0	0	0	0	0	0	0	0	0
LMB	364	860	5/22/97	Catskill Creek	M	1	1	0	0	0	0	0	0	0	0
LMB	370	660	5/22/97	Catskill Creek	M	0	1	0	0	0	0	0	0	0	0
LMB	361	890	5/22/97	Catskill Creek	F	4	1	0	0	0	0	0	0	0	0
LMB	339	580	5/22/97	Catskill Creek	F	0	0	0	0	0	0	0	0	0	0
LMB	352	730	5/22/97	Catskill Creek	F	0	1	0	0	0	0	0	0	0	0
LMB	416	1290	5/22/97	Catskill Creek	F	1	0	0	0	0	0	0	0	0	0
LMB	353	700	5/22/97	Catskill Creek	M	1	0	0	0	0	0	0	0	0	0
LMB	336	460	5/22/97	Catskill Creek	F	1	0	0	0	0	0	0	0	0	0
LMB	333	540	5/22/97	Catskill Creek	M	0	0	0	0	0	0	0	0	0	0
LMB	307	420	5/22/97	Catskill Creek	F	0	0	0	0	0	0	0	0	0	0
LMB	360	570	5/22/97	Catskill Creek	F	0	0	0	0	0	0	0	0	0	0
LMB	462	1740	5/22/97	Catskill Creek	F	0	0	0	0	0	0	0	0	0	0
LMB	345	680	5/22/97	Catskill Creek	F	1	0	0	0	0	0	0	0	0	0
LMB	419	1170	5/22/97	Catskill Creek	F	0	1	0	0	0	0	0	0	0	0
LMB	342	700	5/22/97	Catskill Creek	F	1	0	0	0	0	0	0	0	0	0
LMB	396	1040	5/28/97	Hudson @ Troy	F	1	0	0	0	0	0	0	0	0	0
LMB	404	1030	5/28/97	Hudson @ Troy	M	1	0	0	0	0	0	0	0	0	0
LMB	345	530	5/28/97	Hudson @ Troy	M	0	0	0	0	0	0	0	0	0	0
LMB	314	470	5/28/97	Hudson @ Troy	M	1	0	0	0	0	0	0	0	0	0
LMB	398	750	6/12/97	Hudson @ Troy	F	0	0	0	0	0	0	0	0	0	0
LMB	435	1280	6/12/97	Hudson @ Troy	F	1	0	0	0	0	0	0	0	0	0
LMB	295	410	6/12/97	Hudson @ Troy	F	1	0	0	0	0	0	0	0	0	0
LMB	317	480	6/12/97	Hudson @ Troy	M	1	0	0	0	0	0	0	0	0	0
LMB	364	640	6/12/97	Hudson @ Troy	M	0	0	0	0	0	0	0	0	0	0
LMB	315	440	6/12/97	Hudson @ Troy	F	0	0	0	0	0	0	0	0	0	0
LMB	429	1230	6/12/97	Hudson @ Troy	F	0	0	0	0	0	0	0	0	0	0
LMB	419	930	5/12/97	Hudson stillwater	F	1	0	0	0	0	0	0	0	0	0

304034

Table A-2 Hudson River Fish Stomach Contents

Fish Species	Length	Weight	Collection Date	Location	Sex	Mosquito Larvae	Caddisfly Larvae	Horse Fly Nymph	Adult Insect	Pupa	Diatoms	Oligochaete Setae	Daphnidae
LMB	472	1860	5/22/97	Catskill Creek	F	0	0	0	0	0	0	0	0
LMB	411	1070	5/22/97	Catskill Creek	M	0	0	0	0	0	0	0	0
LMB	409	1130	5/22/97	Catskill Creek	M	0	0	0	0	0	0	0	0
LMB	347	630	5/22/97	Catskill Creek	M	0	0	0	0	0	0	0	0
LMB	389	920	5/22/97	Catskill Creek	F	0	0	0	0	0	0	0	0
LMB	364	860	5/22/97	Catskill Creek	M	0	0	0	0	0	0	0	0
LMB	370	660	5/22/97	Catskill Creek	M	0	0	0	0	0	0	0	0
LMB	361	890	5/22/97	Catskill Creek	F	0	0	0	0	0	0	0	0
LMB	339	580	5/22/97	Catskill Creek	F	0	0	0	0	0	0	0	0
LMB	352	730	5/22/97	Catskill Creek	F	0	0	0	0	0	0	0	0
LMB	416	1290	5/22/97	Catskill Creek	F	0	0	0	0	0	0	0	0
LMB	353	700	5/22/97	Catskill Creek	M	0	0	0	0	0	0	0	0
LMB	336	460	5/22/97	Catskill Creek	F	0	0	0	0	0	0	0	0
LMB	333	540	5/22/97	Catskill Creek	M	0	0	0	0	0	0	0	0
LMB	307	420	5/22/97	Catskill Creek	F	0	0	0	0	0	0	0	0
LMB	360	570	5/22/97	Catskill Creek	F	0	0	0	0	0	0	0	0
LMB	462	1740	5/22/97	Catskill Creek	F	0	0	0	0	0	0	0	0
LMB	345	680	5/22/97	Catskill Creek	F	0	0	0	0	0	0	0	0
LMB	419	1170	5/22/97	Catskill Creek	F	0	0	0	0	0	0	0	0
LMB	342	700	5/22/97	Catskill Creek	F	0	0	0	0	0	0	0	0
LMB	396	1040	5/28/97	Hudson @ Troy	F	0	0	0	0	0	0	0	0
LMB	404	1030	5/28/97	Hudson @ Troy	M	0	0	0	0	0	0	0	0
LMB	345	530	5/28/97	Hudson @ Troy	M	0	0	0	0	0	0	0	0
LMB	314	470	5/28/97	Hudson @ Troy	M	0	0	0	0	0	0	0	0
LMB	398	750	6/12/97	Hudson @ Troy	F	0	0	0	0	0	0	0	0
LMB	435	1280	6/12/97	Hudson @ Troy	F	0	0	0	0	0	0	0	0
LMB	295	410	6/12/97	Hudson @ Troy	F	0	0	0	0	0	0	0	0
LMB	317	480	6/12/97	Hudson @ Troy	M	0	0	0	0	0	0	0	0
LMB	364	640	6/12/97	Hudson @ Troy	M	0	0	0	0	0	0	0	0
LMB	315	440	6/12/97	Hudson @ Troy	F	0	0	0	0	0	0	0	0
LMB	429	1230	6/12/97	Hudson @ Troy	F	0	0	0	0	0	0	0	0
LMB	419	930	5/12/97	Hudson stillwater	F	0	0	0	0	0	0	0	0

Table A-2 Hudson River Fish Stomach Contents

Fish Species	Length	Weight	Collection Date	Location	Sex	Fish	Cray fish	Chironom id	Amphi pods	Isopods	Snails	Clams	Dragonfly Nymph	Caddisfly Nymph	Damsel Fly Nymph
LMB	**425**	**920**	5/12/97	Hudson stillwater	F	0	0	0	0	0	0	0	0	0	0
LMB	**402**	**850**	5/12/97	Hudson stillwater	F	0	0	0	0	0	0	0	0	0	0
LMB	**402**	**910**	5/12/97	Hudson stillwater	M	0	0	0	0	0	0	0	0	0	0
LMB	**394**	**940**	5/12/97	Hudson stillwater	F	1	0	0	0	0	0	0	0	0	0
LMB	**367**	**740**	5/12/97	Hudson stillwater	F	1	0	0	0	0	0	0	0	0	0
LMB	**358**	**680**	5/12/97	Hudson stillwater	F	1	0	0	0	0	0	0	1	0	0
LMB	**386**	**950**	5/12/97	Hudson stillwater	F	1	0	0	0	0	0	0	0	0	0
LMB	**385**	**960**	5/12/97	Hudson stillwater	F	0	0	0	0	0	0	0	0	0	0
LMB	**529**	**2300**	5/12/97	Hudson River	F	1	0	0	0	0	0	0	0	0	0
LMB	**481**	**1990**	5/12/97	Hudson River	F	2	0	0	0	0	0	0	0	0	0
LMB	**413**	**1010**	5/12/97	Hudson River	F	0	0	0	0	0	0	0	0	0	0
LMB	**250**	**185**	5/12/97	Hudson stillwater	F	0	0	0	0	0	0	0	0	0	0
LMB	**289**	**350**	5/12/97	Hudson stillwater	F	1	0	0	0	0	0	0	0	0	0
LMB	**295**	**415**	5/12/97	Hudson stillwater	F	0	1	0	0	0	0	0	0	0	0
LMB	**325**	**545**	5/12/97	Hudson stillwater	F	1	0	0	0	0	0	0	0	0	0
LMB	**318**	**480**	5/12/97	Hudson stillwater	M	0	0	0	0	0	0	0	0	0	0
LMB	**288**	**395**	5/12/97	Hudson stillwater	M	0	0	0	0	0	0	0	0	0	0
LMB	**252**	**225**	5/12/97	Hudson stillwater	F	0	0	0	0	0	0	0	0	0	0
LMB	**235**	**180**	5/12/97	Hudson stillwater	F	0	0	0	0	0	0	0	0	0	0
LMB	409	1030	5/12/97	Hudson @ Griffin Island	M	1	1	0	0	0	0	0	0	0	0
LMB	433	1400	5/13/97	Hudson @ Griffin Island	F	1	0	0	0	0	0	0	0	0	0
LMB	447	1560	5/13/97	Hudson @ Griffin Island	M	1	0	0	0	0	0	0	0	0	0
LMB	388	860	5/13/97	Hudson @ Griffin Island	M	0	0	0	0	0	0	0	0	0	0
LMB	296	350	5/13/97	Hudson @ Griffin Island	M	0	0	0	0	0	0	0	0	0	0
LMB	300	435	5/13/97	Hudson @ Griffin Island	M	1	0	0	0	0	0	0	0	0	0
LMB	273	335	5/13/97	Hudson @ Griffin Island	F	1	0	0	0	0	0	0	0	0	0
LMB	260	255	5/13/97	Hudson @ Griffin Island	F	0	0	0	0	0	0	0	0	0	0
LMB	303	460	5/13/97	Hudson @ Griffin Island	M	1	1	0	0	0	0	0	0	0	0
LMB	266	250	5/13/97	Hudson @ Griffin Island	F	1	0	0	0	0	0	0	0	0	0
LMB	270	260	5/13/97	Hudson @ Griffin Island	M	1	0	0	0	0	0	0	0	0	0
LMB	235	165	5/13/97	Hudson @ Griffin Island	M	0	0	0	0	0	0	0	0	0	0
LMB	232	180	5/13/97	Hudson @ Griffin Island	M	0	0	0	0	0	0	0	0	0	0

Table A-2 Hudson River Fish Stomach Contents

Fish Species	Length	Weight	Collection Date	Location	Sex	Mosquito Larvae	Caddisfly Larvae	Horse Fly Nymph	Adult Insect	Pupa	Diatoms	Oligochaete Setae	Daphnidae
LMB	425	920	5/12/97	Hudson stillwater	F	0	0	0	0	0	0	0	0
LMB	402	850	5/12/97	Hudson stillwater	F	0	0	0	0	0	0	0	0
LMB	402	910	5/12/97	Hudson stillwater	M	0	0	0	0	0	0	0	0
LMB	394	940	5/12/97	Hudson stillwater	F	0	0	0	0	0	0	0	0
LMB	367	740	5/12/97	Hudson stillwater	F	0	0	0	0	0	0	0	0
LMB	358	680	5/12/97	Hudson stillwater	F	0	0	0	0	0	0	0	0
LMB	386	950	5/12/97	Hudson stillwater	F	0	0	0	0	0	0	0	0
LMB	385	960	5/12/97	Hudson stillwater	F	0	0	0	0	0	0	0	0
LMB	529	2300	5/12/97	Hudson River	F	0	0	0	0	0	0	0	0
LMB	481	1990	5/12/97	Hudson River	F	0	0	0		0	0	0	0
LMB	413	1010	5/12/97	Hudson River	F	0	0	0	0	0	0	0	0
LMB	250	185	5/12/97	Hudson stillwater	F	0	0	0	0	0	0	0	0
LMB	289	350	5/12/97	Hudson stillwater	F	0	0	0	0	0	0	0	0
LMB	295	415	5/12/97	Hudson stillwater	F	0	0	0	0	0	0	0	0
LMB	325	545	5/12/97	Hudson stillwater	F	0	0	0	0	0	0	0	0
LMB	318	480	5/12/97	Hudson stillwater	M	0	0	0	0	0	0	0	0
LMB	288	395	5/12/97	Hudson stillwater	M	0	0	0	1	0	0	0	0
LMB	252	225	5/12/97	Hudson stillwater	F	0	0	0	0	0	0	0	0
LMB	235	180	5/12/97	Hudson stillwater	F	0	0	0	2	0	0	0	0
LMB	409	1030	5/12/97	Hudson @ Griffin Island	M	0	0	0	0	0	0	0	0
LMB	433	1400	5/13/97	Hudson @ Griffin Island	F	0	0	0	0	0	0	0	0
LMB	447	1560	5/13/97	Hudson @ Griffin Island	M	0	0	0	0	0	0	0	0
LMB	388	860	5/13/97	Hudson @ Griffin Island	M	0	0	0	0	0	0	0	0
LMB	296	350	5/13/97	Hudson @ Griffin Island	M	0	0	0	0	0	0	0	0
LMB	300	435	5/13/97	Hudson @ Griffin Island	M	0	0	0	0	0	0	0	0
LMB	273	335	5/13/97	Hudson @ Griffin Island	F	0	0	0	0	0	0	0	0
LMB	260	255	5/13/97	Hudson @ Griffin Island	F	0	0	0	0	0	0	0	0
LMB	303	460	5/13/97	Hudson @ Griffin Island	M	0	0	0	0	0	0	0	0
LMB	266	250	5/13/97	Hudson @ Griffin Island	F	0	0	0	0	0	0	0	0
LMB	270	260	5/13/97	Hudson @ Griffin Island	M	0	0	0	0	0	0	0	0
LMB	235	165	5/13/97	Hudson @ Griffin Island	M	0	0	0	0	0	0	0	0
LMB	232	180	5/13/97	Hudson @ Griffin Island	M	0	0	0	0	0	0	0	0

304037

Table A-2 Hudson River Fish Stomach Contents

Fish Species	Length	Weight	Collection Date	Location	Sex	Fish	Cray fish	Chironom id	Amphi pods	Isopods	Snails	Clams	Dragonfly Nymph	Caddisfly Nymph	Damsel Fly Nymph
LMB	265	260	5/13/97	Hudson @ Griffin Island	M	0	0	0	0	0	0	0	12	0	0
LMB	242	170	5/13/97	Hudson @ Griffin Island	M	0	0	0	0	0	0	0	0	0	0
LMB	231	165	5/13/97	Hudson @ Griffin Island	M	0	0	0	10	26	0	0	0	0	0
LMB	192	90	5/13/97	Hudson @ Griffin Island	M	0	0	0	0	0	0	0	0	0	0
LMB	191	90	5/13/97	Hudson @ Griffin Island	M	0	0	0	2	2	0	0	1	0	0
LMB	172	60	5/13/97	Hudson @ Griffin Island	M	0	0	0	0	0	0	0	0	0	0
LMB	185	75	5/13/97	Hudson @ Griffin Island	M	0	0	0	0	0	0	0	0	0	6
LMB	182	80	5/13/97	Hudson @ Griffin Island	M	0	0	0	1	19	0	6	0	0	0
LMB	**280**	**315**	5/14/97	Hudson above feeder dam	M	0	0	0	0	0	0	0	0	0	0
LMB	**289**	**375**	5/14/97	Hudson @ Troy	M	0	0	0	0	0	0	0	0	0	0
LMB Totals						**24**	**3**	**0**	**13**	**47**	**0**	**6**	**14**	**0**	**6**

304038

Table A-2 Hudson River Fish Stomach Contents

Fish Species	Length	Weight	Collection Date	Location	Sex	Mosquito Larvae	Caddisfly Larvae	Horse Fly Nymph	Adult Insect	Pupa	Diatoms	Oligochaete Setae	Daphnidae
LMB	265	260	5/13/97	Hudson @ Griffin Island	M	0	0	0	0	0	0	0	0
LMB	242	170	5/13/97	Hudson @ Griffin Island	M	0	0	0	0	0	0	0	0
LMB	231	165	5/13/97	Hudson @ Griffin Island	M	0	0	0	0	0	0	0	0
LMB	192	90	5/13/97	Hudson @ Griffin Island	M	0	0	0	0	0	0	0	0
LMB	191	90	5/13/97	Hudson @ Griffin Island	M	0	0	0	0	0	0	0	0
LMB	172	60	5/13/97	Hudson @ Griffin Island	M	0	0	0	0	0	0	0	0
LMB	185	75	5/13/97	Hudson @ Griffin Island	M	0	0	0	0	0	0	0	0
LMB	182	80	5/13/97	Hudson @ Griffin Island	M	0	0	0	0	0	0	0	0
LMB	**280**	**315**	5/14/97	Hudson above feeder dam	M	0	0	0	0	0	0	0	0
LMB	**289**	**375**	5/14/97	Hudson @ Troy	M	0	0	0	0	0	0	0	0
LMB Totals						**0**	**0**	**0**	**3**	**0**	**0**	**0**	**0**

304039

Table A-2 Hudson River Fish Stomach Contents

Fish Species	Length	Weight	Collection Date	Location	Sex	Fish	Cray fish	Chironom id	Amphi pods	Isopods	Snails	Clams	Dragonfly Nymph	Caddisfly Nymph	Damsel Fly Nymph
WP	178	80	5/22/97	Catskill Creek	F	0	0	0	0	0	0	0	0	0	0
WP	174	70	5/22/97	Catskill Creek	F	0	0	10	0	0	0	0	0	0	0
WP	177	75	5/22/97	Catskill Creek	F	0	0	8	0	0	0	0	0	0	0
WP	176	65	5/22/97	Catskill Creek	F	0	0	3	0	0	0	0	0	0	0
WP	167	70	5/22/97	Catskill Creek	F	0	0	11	3	0	0	0	0	0	0
WP	166	60	5/22/97	Catskill Creek	M	0	0	1	7	0	0	0	0	0	0
WP	159	55	5/22/97	Catskill Creek	F	0	0	4	0	0	0	0	0	0	0
WP	182	80	5/22/97	Catskill Creek	F	0	0	9	0	0	0	0	0	0	0
WP	167	65	5/22/97	Catskill Creek	F	0	0	6	1	0	0	0	0	0	0
WP	211	135	5/22/97	Catskill Creek	F	0	0	1	2	0	0	0	0	0	0
WP	182	80	5/22/97	Catskill Creek	F	0	0	20	0	0	0	0	0	0	0
WP	167	65	5/22/97	Catskill Creek	F	0	0	35	1	0	0	0	0	0	0
WP	177	70	5/22/97	Catskill Creek	F	0	0	29	0	0	0	0	0	0	0
WP	160	55	5/22/97	Catskill Creek	F	0	0	2	0	0	0	0	0	0	0
WP	171	60	5/22/97	Catskill Creek	F	0	0	15	1	0	0	0	0	0	0
WP	160	50	5/22/97	Catskill Creek	F	0	0	24	0	0	0	0	0	0	0
WP	156	45	5/22/97	Catskill Creek	M	0	0	12	1	0	0	0	0	0	0
WP	160	50	5/22/97	Catskill Creek	M	0	0	0	0	0	0	0	0	0	0
WP	152	50	5/22/97	Catskill Creek	F	0	0	10	4	0	0	0	0	0	0
WP	146	40	5/22/97	Catskill Creek	F	0	0	17	1	0	0	0	0	0	0
WP	196	105	5/28/97	Hudson @ Troy	F	0	0	2	0	0	0	0	0	0	0
WP	220	170	5/28/97	Hudson @ Troy	F	0	0	0	0	0	0	0	0	0	0
WP	204	110	5/28/97	Hudson @ Troy	F	0	0	0	0	0	0	0	0	0	0
WP	206	130	5/28/97	Hudson @ Troy	F	0	0	2	0	0	0	0	0	0	0
WP	185	85	5/28/97	Hudson @ Troy	F	0	0	10	1	0	0	0	0	0	0
WP	163	60	5/28/97	Hudson @ Troy	M	0	0	5	1	0	0	0	0	0	0
WP	183	90	5/28/97	Hudson @ Troy	F	0	0	7	0	0	0	0	0	0	0
WP	176	75	5/28/97	Hudson @ Troy	M	0	0	3	0	0	0	0	0	0	0
WP	174	70	5/28/97	Hudson @ Troy	F	0	0	6	0	0	0	0	0	0	0
WP	163	65	5/28/97	Hudson @ Troy	M	0	0	0	0	0	0	0	0	0	0
WP	181	75	5/28/97	Hudson @ Troy	M	0	0	0	0	0	0	0	0	0	0
WP	170	65	5/28/97	Hudson @ Troy	M	0	0	4	1	0	0	0	0	0	0

304040

Table A-2 Hudson River Fish Stomach Contents

Fish Species	Length	Weight	Collection Date	Location	Sex	Mosquito Larvae	Caddisfly Larvae	Horse Fly Nymph	Adult Insect	Pupa	Diatoms	Oligochaete Setae	Daphnidae
WP	178	80	5/22/97	Catskill Creek	F	0	1	0	0	0	0	0	0
WP	174	70	5/22/97	Catskill Creek	F	0	0	0	0	0	0	0	0
WP	177	75	5/22/97	Catskill Creek	F	0	0	0	0	0	0	0	0
WP	176	65	5/22/97	Catskill Creek	F	0	0	0	0	0	0	0	0
WP	167	70	5/22/97	Catskill Creek	F	0	0	0	0	0	0	0	0
WP	166	60	5/22/97	Catskill Creek	M	0	0	0	0	0	0	0	0
WP	159	55	5/22/97	Catskill Creek	F	0	0	0	1	0	0	0	0
WP	182	80	5/22/97	Catskill Creek	F	0	0	0	0	0	0	0	0
WP	167	65	5/22/97	Catskill Creek	F	0	0	0	0	0	0	0	0
WP	211	135	5/22/97	Catskill Creek	F	0	0	0	0	2	0	0	0
WP	182	80	5/22/97	Catskill Creek	F	0	0	0	0	0	0	0	0
WP	167	65	5/22/97	Catskill Creek	F	0	0	0	0	0	0	0	0
WP	177	70	5/22/97	Catskill Creek	F	0	0	0	0	0	0	0	0
WP	160	55	5/22/97	Catskill Creek	F	0	0	0	0	0	0	0	0
WP	171	60	5/22/97	Catskill Creek	F	0	0	0	0	0	0	0	0
WP	160	50	5/22/97	Catskill Creek	F	0	0	0	0	0	0	0	0
WP	156	45	5/22/97	Catskill Creek	M	0	0	0	0	0	0	0	0
WP	160	50	5/22/97	Catskill Creek	M	0	0	0	0	0	0	0	0
WP	152	50	5/22/97	Catskill Creek	F	0	0	0	0	0	0	0	0
WP	146	40	5/22/97	Catskill Creek	F	0	0	0	0	0	0	yes	0
WP	196	105	5/28/97	Hudson @ Troy	F	0	0	0	0	0	0	0	0
WP	220	170	5/28/97	Hudson @ Troy	F	0	0	0	0	0	0	0	0
WP	204	110	5/28/97	Hudson @ Troy	F	0	0	0	0	0	yes	0	0
WP	206	130	5/28/97	Hudson @ Troy	F	0	0	0	0	0	0	0	0
WP	185	85	5/28/97	Hudson @ Troy	F	0	0	0	0	0	yes	0	0
WP	163	60	5/28/97	Hudson @ Troy	M	0	0	0	0	0	yes	0	0
WP	183	90	5/28/97	Hudson @ Troy	F	0	0	0	1	1	0	0	0
WP	176	75	5/28/97	Hudson @ Troy	M	0	0	0	0	0	0	0	0
WP	174	70	5/28/97	Hudson @ Troy	F	0	0	0	0	0	yes	0	0
WP	163	65	5/28/97	Hudson @ Troy	M	0	0	0	0	0	0	0	0
WP	181	75	5/28/97	Hudson @ Troy	M	0	0	0	0	0	0	0	0
WP	170	65	5/28/97	Hudson @ Troy	M	0	0	0	0	0	yes	0	0

304041

Table A-2 Hudson River Fish Stomach Contents

Fish Species	Length	Weight	Collection Date	Location	Sex	Fish	Cray fish	Chironom id	Amphi pods	Isopods	Snails	Clams	Dragonfly Nymph	Caddisfly Nymph	Damsel Fly Nymph
WP	157	55	5/28/97	Hudson @ Troy	M	0	0	2	0	0	0	0	0	0	0
WP	166	60	5/28/97	Hudson @ Troy	M	0	0	1	0	0	0	0	0	0	0
WP	161	60	5/28/97	Hudson @ Troy	M	0	0	1	0	0	0	0	0	0	0
WP	194	100	5/28/97	Hudson @ Troy	M	0	0	0	0	0	0	0	0	0	0
WP	160	60	5/28/97	Hudson @ Troy	F	0	0	0	2	0	0	0	0	0	0
WP	168	60	5/28/97	Hudson @ Troy	M	0	0	0	0	0	0	0	0	0	0
WP	150	45	5/28/97	Hudson @ Troy	M	0	0	0	2	0	0	0	0	0	0
WP	163	60	5/28/97	Hudson @ Troy	M	0	0	1	0	0	0	0	0	0	0
WP Totals						**0**	**0**	**261**	**28**	**0**	**0**	**0**	**0**	**0**	**0**

304042

Table A-2 Hudson River Fish Stomach Contents

Fish Species	Length	Weight	Collection Date	Location	Sex	Mosquito Larvae	Caddisfly Larvae	Horse Fly Nymph	Adult Insect	Pupa	Diatoms	Oligochaete Setae	Daphnidae
WP	157	55	5/28/97	Hudson @ Troy	M	0	0	0	0	0	yes	0	0
WP	166	60	5/28/97	Hudson @ Troy	M	0	0	0	0	0	0	0	0
WP	161	60	5/28/97	Hudson @ Troy	M	0	0	0	0	0	0	0	0
WP	194	100	5/28/97	Hudson @ Troy	M	0	0	0	0	0	0	yes	0
WP	160	60	5/28/97	Hudson @ Troy	F	0	0	0	0	0	0	0	0
WP	168	60	5/28/97	Hudson @ Troy	M	0	0	0	0	0	0	0	0
WP	150	45	5/28/97	Hudson @ Troy	M	0	0	0	0	1	0	0	0
WP	163	60	5/28/97	Hudson @ Troy	M	0	0	0	0	0	0	0	0
WP Totals						**0**	**1**	**0**	**2**	**4**	**6**	**1**	**0**

Table A-2 Hudson River Fish Stomach Contents

Fish Species	Length	Weight	Collection Date	Location	Sex	Fish	Cray fish	Chironom id	Amphi pods	Isopods	Snails	Clams	Dragonfly Nymph	Caddisfly Nymph	Damsel Fly Nymph
YP	292	408	5/18/98	TIP	M	0	0	0	0	1	4	52	0	0	0
YP	195	102	5/18/98	TIP	M	0	0	0	1	0	0	0	0	0	10
YP	267	290	5/18/98	TIP	M	0	0	0	0	0	0	0	6	0	0
YP	154	220	5/18/98	TIP	M	0	0	3	0	0	0	0	0	0	1
YP	290	370	5/18/98	TIP	M	0	0	0	0	0	0	2	0	0	0
YP	280	296	5/18/98	TIP	F	0	0	0	1	0	0	23	0	0	0
YP	318	418	5/18/98	TIP	F	0	0	0	0	0	0	0	1	0	0
YP	188	241	5/18/98	TIP	M	0	0	1	0	0	0	22	0	0	0
YP	288	366	5/18/98	TIP	M	0	0	0	0	6	1	13	0	0	0
YP	235	184	5/18/98	TIP	M	0	0	0	0	0	0	0	0	1	0
YP	266	281	5/18/98	TIP	M	0	0	0	3	3	0	1	2	0	0
YP	196	102	5/18/98	TIP	M	0	0	0	0	0	2	0	0	0	14
YP	291	362	5/18/98	TIP	M	0	0	0	0	0	0	26	0	0	0
YP	215	136	5/18/98	TIP	F	0	0	0	0	7	0	27	0	0	1
YP	240	188	5/18/98	TIP	M	0	0	0	0	0	0	0	0	0	0
YP	226	150	5/14/97	Hudson above feeder dam	M	0	0	2	10	0	0	0	0	0	0
YP	185	75	5/14/97	Hudson above feeder dam	M	0	0	2	7	25	0	0	0	0	0
YP	193	90	5/14/97	Hudson above feeder dam	M	0	0	0	5	1	0	0	0	0	0
YP	169	60	5/14/97	Hudson above feeder dam	M	0	0	0	1	3	0	0	0	0	0
YP	175	75	5/14/97	Hudson above feeder dam	M	0	0	0	5	10	0	0	0	0	0
YP	171	65	5/14/97	Hudson above feeder dam	M	0	0	5	4	1	0	0	0	0	0
YP	169	65	5/14/97	Hudson above feeder dam	M	0	0	0	3	2	0	0	0	0	0
YP	166	55	5/14/97	Hudson above feeder dam	M	0	0	0	0	0	0	0	0	0	0
YP	161	55	5/14/97	Hudson above feeder dam	M	0	0	0	6	6	0	0	0	0	0
YP	163	50	5/14/97	Hudson above feeder dam	M	0	0	2	0	12	1	0	0	0	0
YP	169	60	5/14/97	Hudson above feeder dam	M	0	0	1	6	0	0	0	0	0	0
YP	272	270	5/14/97	Hudson above feeder dam	M	0	0	1	6	0	0	0	1	0	0
YP	276	275	5/14/97	Hudson above feeder dam	M	0	0	0	5	5	0	0	0	0	0
YP	270	245	5/14/97	Hudson above feeder dam	M	0	0	0	2	5	1	0	0	0	0
YP	266	215	5/14/97	Hudson above feeder dam	M	0	0	4	7	10	18	0	0	0	0
YP	264	225	5/14/97	Hudson above feeder dam	M	0	0	1	4	9	0	0	1	0	0
YP	263	200	5/14/97	Hudson above feeder dam	M	0	0	3	5	0	0	0	0	0	0

Table A-2 Hudson River Fish Stomach Contents

Fish Species	Length	Weight	Collection Date	Location	Sex	Mosquito Larvae	Caddisfly Larvae	Horse Fly Nymph	Adult Insect	Pupa	Diatoms	Oligochaete Setae	Daphnidae
YP	292	408	5/18/98	TIP	M	0	0	0	0	0	0	0	0
YP	195	102	5/18/98	TIP	M	0	0	0	0	0	0	0	0
YP	267	290	5/18/98	TIP	M	0	0	0	0	0	yes	0	0
YP	154	220	5/18/98	TIP	M	0	2	0	0	0	0	0	0
YP	290	370	5/18/98	TIP	M	0	0	0	0	0	0	0	0
YP	280	296	5/18/98	TIP	F	0	1	0	0	0	0	yes	0
YP	318	418	5/18/98	TIP	F	0	0	0	0	0	0	0	0
YP	188	241	5/18/98	TIP	M	1	1	0	0	0	yes	0	0
YP	288	366	5/18/98	TIP	M	0	3	0	0	0	0	yes	0
YP	235	184	5/18/98	TIP	M	0	0	0	0	0	0	0	0
YP	266	281	5/18/98	TIP	M	0	0	0	0	0	0	0	0
YP	196	102	5/18/98	TIP	M	0	0	0	0	0	yes	0	0
YP	291	362	5/18/98	TIP	M	0	0	0	0	0	0	yes	0
YP	215	136	5/18/98	TIP	F	0	0	0	0	0	yes	0	0
YP	240	188	5/18/98	TIP	M	0	6	0	0	0	0	0	0
YP	**226**	**150**	5/14/97	Hudson above feeder dam	M	0	0	0	0	0	0	0	0
YP	**185**	**75**	5/14/97	Hudson above feeder dam	M	0	0	0	0	0	0	0	0
YP	**193**	**90**	5/14/97	Hudson above feeder dam	M	0	0	0	0	0	0	0	0
YP	**169**	**60**	5/14/97	Hudson above feeder dam	M	0	0	0	0	0	0	0	0
YP	**175**	**75**	5/14/97	Hudson above feeder dam	M	0	0	0	0	0	0	0	0
YP	**171**	**65**	5/14/97	Hudson above feeder dam	M	0	0	0	0	0	0	0	0
YP	**169**	**65**	5/14/97	Hudson above feeder dam	M	0	0	0	0	0	0	0	0
YP	**166**	**55**	5/14/97	Hudson above feeder dam	M	1	0	0	0	0	0	0	0
YP	**161**	**55**	5/14/97	Hudson above feeder dam	M	0	0	0	0	0	0	0	0
YP	**163**	**50**	5/14/97	Hudson above feeder dam	M	0	0	0	0	0	0	0	0
YP	**169**	**60**	5/14/97	Hudson above feeder dam	M	150	0	0	0	0	0	0	0
YP	**272**	**270**	5/14/97	Hudson above feeder dam	M	0	0	0	0	0	0	0	0
YP	**276**	**275**	5/14/97	Hudson above feeder dam	M	0	0	0	0	0	0	0	0
YP	**270**	**245**	5/14/97	Hudson above feeder dam	M	0	0	0	0	0	0	0	0
YP	**266**	**215**	5/14/97	Hudson above feeder dam	M	0	0	0	0	0	0	0	0
YP	**264**	**225**	5/14/97	Hudson above feeder dam	M	0	0	0	0	0	0	0	0
YP	**263**	**200**	5/14/97	Hudson above feeder dam	M	0	0	0	0	0	0	0	0

304045

Table A-2 Hudson River Fish Stomach Contents

Fish Species	Length	Weight	Collection Date	Location	Sex	Fish	Cray fish	Chironom id	Amphi pods	Isopods	Snails	Clams	Dragonfly Nymph	Caddisfly Nymph	Damsel Fly Nymph
YP	252	210	5/14/97	Hudson above feeder dam	M	0	0	1	2	3	0	0	1	0	0
YP	213	130	5/28/97	Hudson @ Troy	M	0	0	0	52	0	0	0	0	9	0
YP	252	185	5/12/97	Hudson stillwater	M	0	0	0	0	0	0	0	1	0	0
YP	242	160	5/12/97	Hudson stillwater	M	0	0	0	0	0	0	0	1	0	0
YP	208	120	5/12/97	Hudson stillwater	M	0	0	0	0	4	3	0	2	0	0
YP	185	85	5/12/97	Hudson stillwater	M	0	0	1	4	2	1	15	4	0	0
YP	185	70	5/12/97	Hudson stillwater	M	0	0	1	0	0	0	0	5	0	0
YP	153	40	5/12/97	Hudson stillwater	M	0	0	1	0	0	0	0	3	0	0
YP	156	40	5/12/97	Hudson stillwater	M	0	0	0	0	0	0	0	3	0	0
YP	143	25	5/12/97	Hudson stillwater	M	0	0	8	0	0	0	0	2	0	0
YP	273	270	5/14/97	Hudson above feeder dam	M	0	0	0	2	30	0	0	0	0	0
YP	246	210	5/14/97	Hudson above feeder dam	M	0	0	2	20	12	9	0	0	0	0
YP	285	330	5/14/97	Hudson above feeder dam	M	0	0	0	0	0	0	0	0	0	0
YP	268	290	5/18/98	TIP	M	0	0	0	0	2	0	35	0	0	0
YP	216	147	5/18/98	TIP	M	0	0	1	0	27	1	0	0	0	0
YP	219	135	5/18/98	TIP	M	0	0	0	0	0	0	0	0	2	0
YP	175	72	5/18/98	TIP	M	0	0	0	0	0	0	1	0	0	0
YP	268	259	5/18/98	TIP	M	0	0	0	2	1	0	0	0	0	0
YP	305	393	6/17/98	Feeder Dam Pool	M	0	0	0	2	1	0	0	4	0	0
YP	260	247	6/17/98	Feeder Dam Pool	M	0	0	0	1	2	0	0	7	0	0
YP	235	177	6/17/98	Feeder Dam Pool	F	0	0	0	2	5	0	0	0	0	0
YP	233	179	6/17/98	Feeder Dam Pool	M	0	0	0	2	200	2	0	0	0	0
YP	203	115	6/17/98	Feeder Dam Pool	M	0	0	0	21	42	0	0	1	0	0
YP	210	131	6/17/98	Feeder Dam Pool	F	0	0	2	3	140	1	0	2	0	0
YP	196	116	6/17/98	Feeder Dam Pool	F	0	0	0	12	47	1	0	0	0	0
YP	216	134	6/17/98	Feeder Dam Pool	M	0	0	0	22	42	0	1	4	0	0
YP	209	132	6/17/98	Feeder Dam Pool	M	0	0	0	6	33	0	0	0	0	0
YP	220	188	6/17/98	Feeder Dam Pool	F	0	0	0	22	11	0	0	0	0	0
YP	226	139	6/17/98	Feeder Dam Pool	M	0	0	0	0	0	0	0	0	0	0
YP	243	212	6/17/98	Feeder Dam Pool	M	0	0	2	5	9	18	0	0	0	0
YP	295	336	6/17/98	Feeder Dam Pool	F	0	0	0	87	67	1	0	0	0	0
YP	180	72	6/17/98	Feeder Dam Pool	M	0	0	2	1	1	1	0	1	0	0

304046

Table A-2 Hudson River Fish Stomach Contents

Fish Species	Length	Weight	Collection Date	Location	Sex	Mosquito Larvae	Caddisfly Larvae	Horse Fly Nymph	Adult Insect	Pupa	Diatoms	Oligochaete Setae	Daphnidae
YP	**252**	**210**	5/14/97	Hudson above feeder dam	M	0	0	0	0	0	0	0	0
YP	213	130	5/28/97	Hudson @ Troy	M	0	0	0	0	0	0	0	0
YP	**252**	**185**	5/12/97	Hudson stillwater	M	0	0	0	0	0	0	0	0
YP	**242**	**160**	5/12/97	Hudson stillwater	M	0	0	0	0	0	0	0	0
YP	**208**	**120**	5/12/97	Hudson stillwater	M	0	0	0	0	0	0	0	0
YP	**185**	**85**	5/12/97	Hudson stillwater	M	0	0	0	0	0	0	0	0
YP	**185**	**70**	5/12/97	Hudson stillwater	M	0	0	0	0	0	0	0	0
YP	**153**	**40**	5/12/97	Hudson stillwater	M	0	0	0	0	0	0	0	0
YP	**156**	**40**	5/12/97	Hudson stillwater	M	0	0	0	0	0	0	0	0
YP	**143**	**25**	5/12/97	Hudson stillwater	M	0	0	0	0	0	0	0	0
YP	**273**	**270**	5/14/97	Hudson above feeder dam	M	0	0	0	0	0	0	0	0
YP	**246**	**210**	5/14/97	Hudson above feeder dam	M	0	0	0	0	0	0	0	0
YP	**285**	**330**	5/14/97	Hudson above feeder dam	M	0	0	0	0	0	0	0	0
YP	268	290	5/18/98	TIP	M	0	0	0	0	0	0	0	0
YP	216	147	5/18/98	TIP	M	0	0	0	0	0	yes	0	1
YP	219	135	5/18/98	TIP	M	0	0	0	0	0	0	0	0
YP	175	72	5/18/98	TIP	M	0	0	0	0	0	0	yes	75
YP	268	259	5/18/98	TIP	M	0	6	0	0	0	0	0	0
YP	305	393	6/17/98	Feeder Dam Pool	M	0	0	0	0	0	yes	0	0
YP	260	247	6/17/98	Feeder Dam Pool	M	0	0	0	0	0	0	0	0
YP	235	177	6/17/98	Feeder Dam Pool	F	0	0	0	0	0	0	0	0
YP	233	179	6/17/98	Feeder Dam Pool	M	0	0	0	0	0	0	0	0
YP	203	115	6/17/98	Feeder Dam Pool	M	0	0	0	0	0	yes	yes	0
YP	210	131	6/17/98	Feeder Dam Pool	F	0	0	0	0	0	0	0	1
YP	196	116	6/17/98	Feeder Dam Pool	F	0	0	0	0	0	0	0	0
YP	216	134	6/17/98	Feeder Dam Pool	M	0	0	0	0	0	0	0	0
YP	209	132	6/17/98	Feeder Dam Pool	M	4	0	0	0	0	0	0	0
YP	220	188	6/17/98	Feeder Dam Pool	F	0	0	0	0	0	yes	0	3
YP	226	139	6/17/98	Feeder Dam Pool	M	0	0	0	0	0	0	0	0
YP	243	212	6/17/98	Feeder Dam Pool	M	0	0	0	0	0	yes	0	0
YP	295	336	6/17/98	Feeder Dam Pool	F	1	0	0	0	0	0	yes	0
YP	180	72	6/17/98	Feeder Dam Pool	M	0	0	0	0	0	0	yes	0

304047

Table A-2 Hudson River Fish Stomach Contents

Fish Species	Length	Weight	Collection Date	Location	Sex	Fish	Cray fish	Chironom id	Amphi pods	Isopods	Snails	Clams	Dragonfly Nymph	Caddisfly Nymph	Damsel Fly Nymph
YP	224	129	6/17/98	Feeder Dam Pool	F	0	0	0	0	0	0	0	0	0	0
YP	220	153	6/17/98	Feeder Dam Pool	F	0	0	2	4	32	0	1	0	0	0
YP	195	99	6/17/98	Feeder Dam Pool	F	0	0	0	1	0	0	0	0	0	0
YP	260	213	6/17/98	Feeder Dam Pool	F	0	0	0	35	10	1	0	0	0	1
YP	249	212	6/17/98	Feeder Dam Pool	M	0	0	0	8	4	5	0	3	0	0
YP	258	245	6/17/98	Feeder Dam Pool	F	0	0	0	0	0	0	0	0	0	0
YP	156	41.4	5/21/98	Coveville Marina	F	0	0	0	1	4	0	0	0	0	0
YP	155	50.9	5/21/98	Coveville Marina	M	0	0	0	0	0	0	0	20	0	0
YP	125	20.3	5/21/98	Coveville Marina	M	0	0	0	15		0	0	0	0	0
YP	110	14.2	5/21/98	Coveville Marina	M	0	0	0	2	2	0	0	0	0	0
YP	116	17.8	5/21/98	Coveville Marina	F	0	0	0	1	0	0	0	0	0	0
YP	296	324	5/21/98	Coveville Marina	F	0	0	0	0	0	0	0	0	0	0
YP	150	44.3	5/21/98	Coveville Marina	M	0	0	0	0	0	0	0	0	0	0
YP	199	80.6	5/21/98	Coveville Marina	M	0	0	1	2	4	2	1	0	0	0
YP	212	174.1	5/21/98	Coveville Marina	F	0	0	0	1	0	2	2	1	1	0
YP	153	43.2	5/21/98	Coveville Marina	F	0	0	0	0	0	0	1	0	0	0
YP	147	43.7	5/21/98	Coveville Marina	F	0	0	1	1	2	0	0	0	0	0
YP	199	100.3	5/21/98	Coveville Marina	M	0	0	80	3	0	0	0	0	0	0
YP	149	43.3	5/21/98	Coveville Marina	F	0	0	0	16	7	0	0	1	0	0
YP	147	32.8	5/21/98	Coveville Marina	M	0	0	0	8	0	2	0	10	0	0
YP	143	33.6	5/21/98	Coveville Marina	F	0	0	0	10	11	0	0	0	0	0
YP Totals						**0**	**0**	**130**	**457**	**867**	**77**	**223**	**87**	**13**	**27**

304048

Table A-2 Hudson River Fish Stomach Contents

Fish Species	Length	Weight	Collection Date	Location	Sex	Mosquito Larvae	Caddisfly Larvae	Horse Fly Nymph	Adult Insect	Pupa	Diatoms	Oligochaete Setae	Daphnidae
YP	224	129	6/17/98	Feeder Dam Pool	F	0	0	0	0	0	yes	yes	0
YP	220	153	6/17/98	Feeder Dam Pool	F	0	0	0	0	0	yes	0	0
YP	195	99	6/17/98	Feeder Dam Pool	F	0	0	0	0	0	0	yes	0
YP	260	213	6/17/98	Feeder Dam Pool	F	1	0	0	0	0	0	0	0
YP	249	212	6/17/98	Feeder Dam Pool	M	0	0	0	0	0	yes	0	0
YP	258	245	6/17/98	Feeder Dam Pool	F	0	0	0	0	0	0	0	0
YP	156	41.4	5/21/98	Coveville Marina	F	0	0	0	0	0	yes	0	0
YP	155	50.9	5/21/98	Coveville Marina	M	0	0	0	0	0	0	0	0
YP	125	20.3	5/21/98	Coveville Marina	M	0	0	0	0	0	yes	yes	0
YP	110	14.2	5/21/98	Coveville Marina	M	0	0	0	0	0	0	yes	12
YP	116	17.8	5/21/98	Coveville Marina	F	0	0	0	0	0	0	0	2
YP	296	324	5/21/98	Coveville Marina	F	0	0	0	0	0	0	0	0
YP	150	44.3	5/21/98	Coveville Marina	M	0	0	0	0	0	0	yes	18
YP	199	80.6	5/21/98	Coveville Marina	M	0	0	0	0	0	0	yes	0
YP	212	174.1	5/21/98	Coveville Marina	F	0	0	0	0	0	0	yes	0
YP	153	43.2	5/21/98	Coveville Marina	F	0	0	0	0	0	0	0	500
YP	147	43.7	5/21/98	Coveville Marina	F	0	0	0	0	0	yes	0	500
YP	199	100.3	5/21/98	Coveville Marina	M	0	0	0	0	0	yes	0	0
YP	149	43.3	5/21/98	Coveville Marina	F	0	0	0	0	0	0	0	0
YP	147	32.8	5/21/98	Coveville Marina	M	0	0	0	0	0	0	yes	0
YP	143	33.6	5/21/98	Coveville Marina	F	0	0	0	0	0	yes	yes	27
YP Totals						**158**	**19**	**0**	**0**	**0**	**17**	**16**	**1139**

304049

Table A-3 Distribution and Preferential Habitats of Largemouth Bass and White Perch

Distribution of Largemouth Bass by Lock Pool in the Upper Hudson (MPI, 1984)

Dam to Lock 1	Lock 1 to Lock 2	Lock 2 to Lock 3	Lock 3 to Lock 4	Lock 4 to Lock 5 downstream	Lock 4 to Lock 5 middle	Lock 4 to Lock 5 upstream	Lock 5 to Lock 6	Lock 6 to Lock 7
17	5	24	3	41	11	15	15	4

Preferential Habitats for Largemouth Bass in the Upper Hudson River (MPI, 1984)

Artificial Cut	Shallow	Wetland	Stream Mouth	Wet Dumpsite	Alt. Channel	Embayme nt
12	14	34	28	13	4	37

Distribution of White Perch by Lock Pool in the Upper Hudson (MPI, 1984)

Dam to Lock 1	Lock 1 to Lock 2	Lock 2 to Lock 3	Lock 3 to Lock 4	Lock 4 to Lock 5 downstream	Lock 4 to Lock 5 middle	Lock 4 to Lock 5 upstream	Lock 5 to Lock 6	Lock 6 to Lock 7
44	17	0	0	0	0	0	0	1

Preferential Habitats for White Perch in the Upper Hudson River (MPI, 1984)

Artificial Cut	Shallow	Wetland	Stream Mouth	Wet Dumpsite	Alt. Channel	Rapids
6	24	13	8	4	6	2

Table A-4
White Perch Chironomid Identification for the Hudson River

Taxon	Number	Habitat	Association
Fish No. 1			
Ablabesmyia simpsoni	4	sprawler	epiphytic
Coelotanypus	1	burrower	sediment
Procladius (Holotanypus)	9	burrower	sediment
Cryptochironomus	1	sprawler & burrower	both
Cryptotendipes	86	burrower	sediment
Paralauterborniella	1	clinger	epiphytic
Polypedilum illinoense grp.	1	clinger	epiphytic
Tanytarsus	11	burrower	sediment
Fish No. 2			
Polypedilum illinoense grp.	13	sprawler	epiphytic
Dicrotendipes neomodestus	9	sprawler	epiphytic
Fish No. 3			
Ablabesmyia simpsoni	8	sprawler	epiphytic
Procladius (H.) sp.	5	burrower	sediment
Procladius (Ps.) bellus	1	burrower	sediment
Chironomus	5	burrower	sediment
Cryptochironomus	1	sprawler & burrower	both
Cryptotendipes	48	burrower	sediment
Harnishchia	2	clinger	epiphytic
Polypedilum halterale grp.	1	sprawler	epiphytic
Polypedilum illinoense grp.	1	sprawler	epiphytic
Paralauterborniella	4	clinger	epiphytic
Tanytarsus	2	burrower	sediment
Pupa	2		
Copepoda			
Fish No. 4			
Meropelopia	1		
Dicrotendipes neomodestus	4	sprawler	epiphytic
Glyptotendipes	1	clinger	epiphytic
Polypedilum illinoense grp.	6	sprawler	epiphytic
Fish No. 5			
Cricotopus bicinctus grp.	1	clinger	epiphytic
Dicrotendipes neomodestus	15	sprawler	epiphytic
Polypedilum illinoense grp.	37	sprawler	epiphytic
P. scalaenum	1	clinger	epiphytic

Table A-5 Distribution and Preferential Habitats of Yellow Perch and Brown Bullhead

Distribution of Yellow Perch by Lock Pool in the Upper Hudson (MPI, 1984)

Dam to Lock 1	Lock 1 to Lock 2	Lock 2 to Lock 3	Lock 3 to Lock 4	Lock 4 to Lock 5 downstream	Lock 4 to Lock 5 middle	Lock 4 to Lock 5 upstream	Lock 5 to Lock 6	Lock 6 to Lock 7
23	1	12	12	6	8	20	36	24

Preferential Habitats for Yellow Perch in the Upper Hudson River (MPI, 1984)

Artificial Cut	Shallow	Wetland	Stream Mouth	Wet Dumpsite	Alt. Channel	Embayment
15	20	46	17	13	14	37

Distribution of Brown Bullhead by Lock Pool in the Upper Hudson (MPI, 1984)

Dam to Lock 1	Lock 1 to Lock 2	Lock 2 to Lock 3	Lock 3 to Lock 4	Lock 4 to Lock 5 downstream	Lock 4 to Lock 5 middle	Lock 4 to Lock 5 upstream	Lock 5 to Lock 6	Lock 6 to Lock 7
6	1	24	14	27	8	6	3	8

Preferential Habitats for Brown Bullhead in the Upper Hudson River (MPI, 1984)

Artificial Cut	Shallow	Wetland	Stream Mouth	Wet Dumpsite	Alt. Channel	Embayment
0	5	43	10	5	13	30

Table A-6
Pumpkinseed Chironomid Identification for the Hudson River

Taxon	Number	Habitat	Association
Fish No. 1			
Cricotopus bicinctus grp.	1		
Cricotopus sylvestris grp.	1	sprawler & burrower	both
Psectrocladius	3		
Synorthocladius	1		
Dicrotendipes neomodestus	3	sprawler	epiphytic
Polypedilum convictum grp.	3	sprawler	epiphytic
Polypedilum illinoense grp.	8	sprawler	epiphytic
Rheotanytarsus	3	spawler	epiphytic
Fish No. 2			
Cricotopus sylvestris grp.	1	sprawler & burrower	both
Psectrocladius	1	sprawler	epiphytic
Polypedilum convictum grp.	1	sprawler	epiphytic
Polypedilum illinoense grp.	9	sprawler	epiphytic
Paratanytarsus	1	sprawler	epiphytic
Rheotanytarsus	2	sprawler	epiphytic
Chrioonomidae pupae	1		
Lepidoptera larvae	1		
Fish No. 3			
Ablabesmyia simpsoni	1	sprawler	epiphytic
Cricotopus sylvestris grp.	7	sprawler & burrower	both
Psectrocladius	1	sprawler	epiphytic
Thienemanniella	1	clinger	epiphytic
Polypedilum convictum grp.	3	sprawler	epiphytic
Polypedilum illinoense grp.	25	sprawler	epiphytic
Rheotanytarsus	1	clinger	epiphytic

Table A-7 Distribution and Preferential Habitats of Pumpkinseed and Spottail Shiner

Distribution of Pumpkinseed by Lock Pool in the Upper Hudson (MPI, 1984)

Dam to Lock 1	Lock 1 to Lock 2	Lock 2 to Lock 3	Lock 3 to Lock 4	Lock 4 to Lock 5 downstream	Lock 4 to Lock 5 middle	Lock 4 to Lock 5 upstream	Lock 5 to Lock 6	Lock 6 to Lock 7
98	12	123	67	164	33	46	157	96

Preferential Habitats for Pumpkinseed in the Upper Hudson River (MPI, 1984)

Artificial Cut	Shallow	Wetland	Stream Mouth	Wet Dumpsite	Alt. Channel	Embayme nt
35	82	234	210	50	35	182

Distribution of Spottail Shiner by Lock Pool in the Upper Hudson (MPI, 1984)

Dam to Lock 1	Lock 1 to Lock 2	Lock 2 to Lock 3	Lock 3 to Lock 4	Lock 4 to Lock 5 downstream	Lock 4 to Lock 5 middle	Lock 4 to Lock 5 upstream	Lock 5 to Lock 6	Lock 6 to Lock 7
26	3	27	1	13	22	7	36	36

Preferential Habitats for Spottail Shiner in the Upper Hudson River (MPI, 1984)

Artificial Cut	Shallow	Wetland	Stream Mouth	Wet Dumpsite	Alt. Channel	Embayme nt
3	9	32	2	68	35	4

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APPENDIX B

FISHRAND Exposure Concentrations for Risk Assessments

1. Introduction

The HUDTOX fate and transport model and the FISHRAND bioaccumulation model were developed and refined over a period of years. Concurrent with these modeling efforts, EPA conducted the risk assessments for the Reassessment. Accordingly, in the risk assessments, EPA used modeled concentrations of PCBs in sediment, water and fish from the most updated versions of HUDTOX and FISHRAND that were available at the time. The FISHRAND results for the Upper Hudson River that were used in the risk assessments are presented below. The HUDTOX results that were used in the risk assessments are presented in Appendix A of Book 2.

2. FISHRAND Results Used in the August 1999 Ecological Risk Assessment for the Hudson River (USEPA, 1999)[1]

For the August 1999 Ecological Risk Assessment for the Hudson River, EPA evaluated current and future risks to ecological receptors in the Upper Hudson River for the time period 1993 through 2018. EPA used the calibration and forecast results for total PCBs in fish for 1993-2018, as presented in the May 1999 Baseline Modeling Report (BMR). These were computed from FISHRAND based on HUDTOX results using initial conditions in sediment specified from the 1991 GE composite data set and a PCB concentration of 10 ng/L in the water column at the upstream boundary.

The FISHRAND forecasts for PCBs in fish at River Miles 189, 168, and 154 from the May 1999 BMR that were used in the August 1999 Ecological Risk Assessment (1998 to 2018) are compared to the results for this RBMR (as presented in Chapter 7) in Figures B-1 through B-3, respectively.

3. FISHRAND Results Used in the August 1999 Human Health Risk Assessment for the Upper Hudson River (USEPA, 1999)[2]

For the August 1999 Human Health Risk Assessment for the Upper Hudson River, EPA estimated concentrations of PCBs in fish, up to 40 years for the point estimate

[1] U.S. Environmental Protection Agency (US EPA). Phase 2 Report – Review Copy. Further Site Characterization and Analysis. Volume 2E – Baseline Ecological Risk Assessment, Hudson River PCBs Reassessment RI/FS. Prepared for US EPA by TAMS Consultants, Inc. and Menzie-Cura & Associates, Inc., US EPA, Region II, New York, New York, August 1999.

[2] U.S. Environmental Protection Agency (US EPA). Phase 2 Report – Review Copy. Further Site Characterization and Analysis. Volume 2F - Human Health Risk Assessment for the Upper Hudson River, Hudson River PCBs Reassessment RI/FS. Prepared for US EPA by TAMS Consultants, Inc. and Gradient Corporation. US EPA, Region II, New York, New York, August 1999.

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Figure B-1: May 1999 and January 2000 Wet Weight Forecast Results for River Mile 189

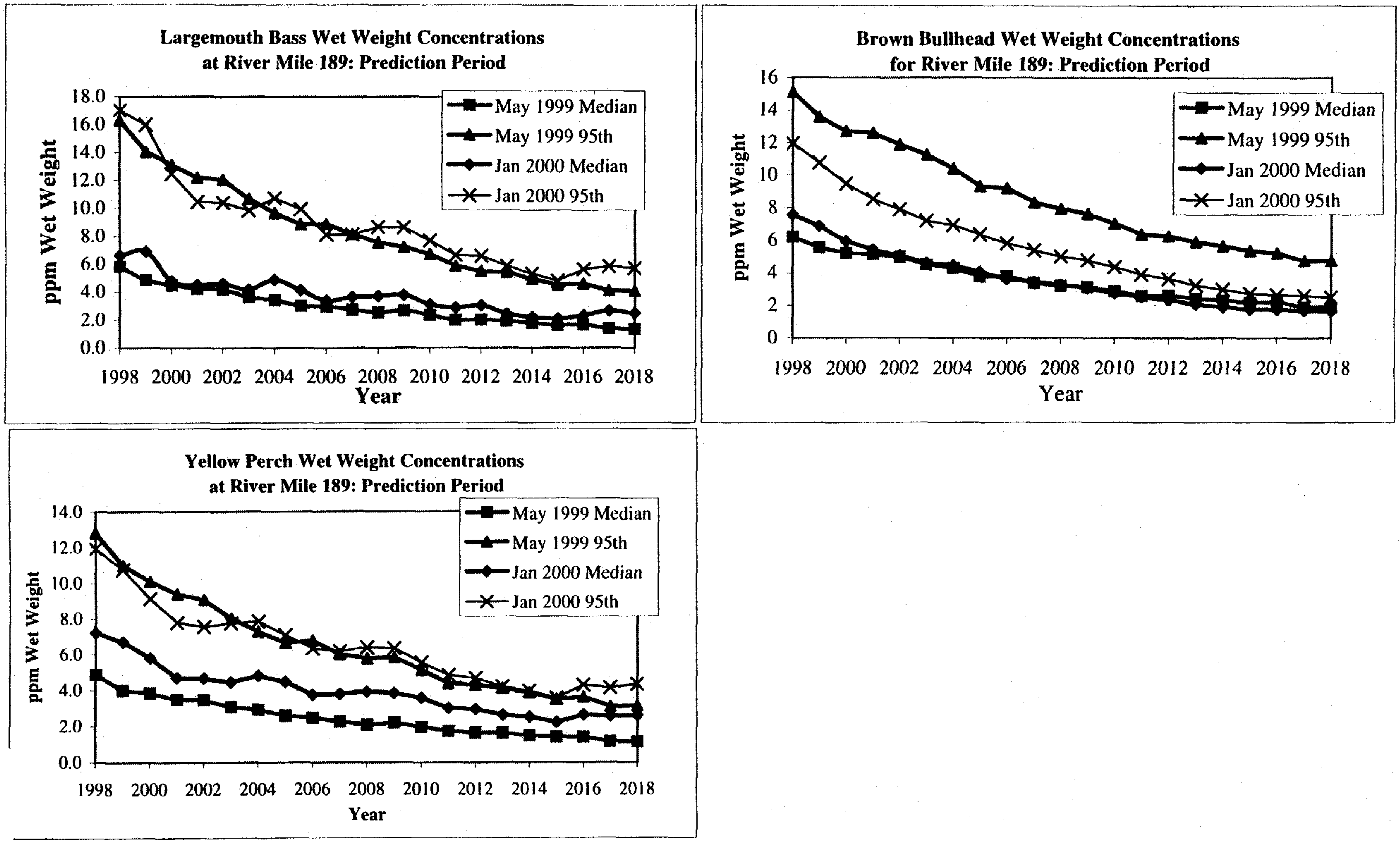

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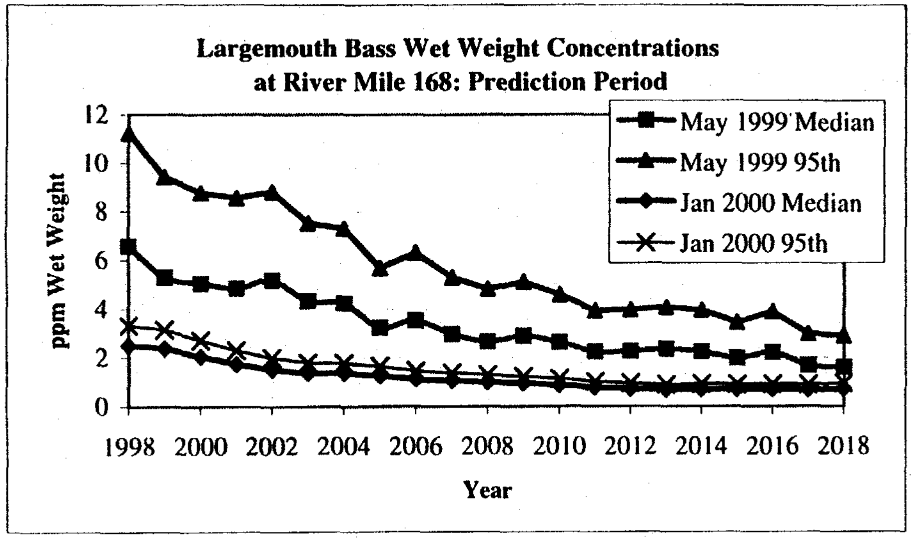
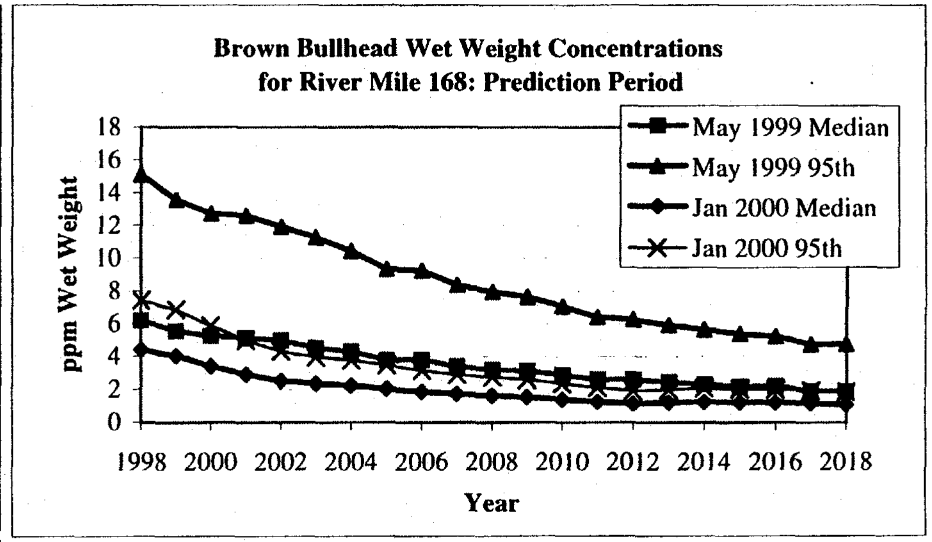
Figure B-2: May 1999 and January 2000 Wet Weight Forecast Results for River Mile 168





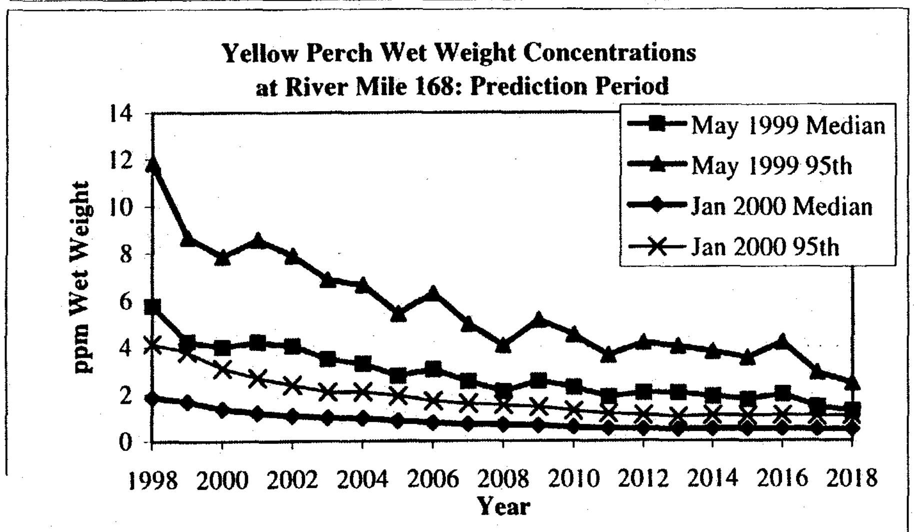


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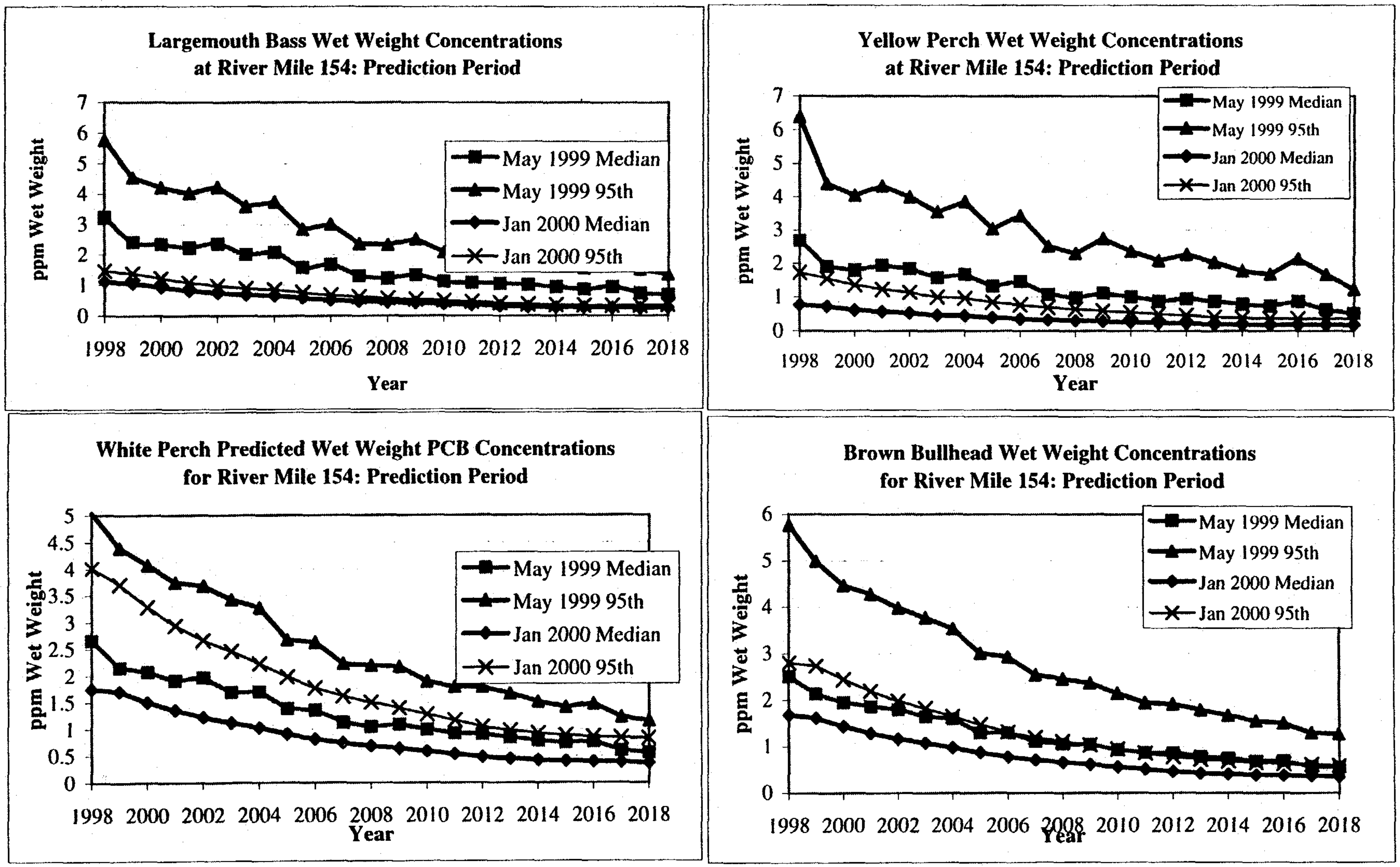
Figure B-3: May 1999 and January 2000 Wet Weight Forecast Results for River Mile 154



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