

MICHIGAN DEPARTMENT OF ENVIRONMENTAL QUALITY
WATER BUREAU
JUNE 2008

STAFF REPORT

PCB CONCENTRATIONS IN WALLEYE
COLLECTED FROM
TORCH LAKE (HOUGHTON COUNTY) AND LAKE SUPERIOR

INTRODUCTION

Torch Lake, Houghton County, is currently listed as a Great Lakes Area of Concern by the United States Environmental Protection Agency (USEPA), in part because of elevated levels of polychlorinated biphenyls (PCBs) in fish. The PCB concentrations in fish collected from Torch Lake have been consistently higher than in fish found in nearby inland lakes. A fish consumption advisory due to elevated levels of PCBs was first issued for Torch Lake fish by the Michigan Department of Community Health (MDCH) in 1998. The most recent advisory, based on samples collected in 2000, recommends restricting consumption of northern pike, smallmouth bass, and walleye from the lake.

Historically, the Torch Lake region has been an area of copper mining, ore processing, and copper reclamation activities. For over one hundred years, mining and copper processing wastes were released into Torch Lake and surrounding bodies of water. Accidental spills or poor waste disposal methods by area industries may have introduced PCBs to the watershed, and those potential sources have not been thoroughly investigated. Sediment sampling in Torch Lake has detected scattered low-level PCB contamination (USEPA, 2001; Alexander, 2008). A water column PCB concentration study was conducted in 2005 using semi-permeable membrane devices (SPMDs). Results of that study suggested that a source of PCBs does exist in the Torch Lake watershed (Bohr, 2006).

Although the SPMD study and sediment sampling has provided evidence that the Torch Lake watershed contains elevated levels of PCBs, the question remained as to whether the watershed is the cause of elevated concentrations in fish. It has been postulated that the elevated concentrations of PCBs in fish caught in Torch Lake may actually represent exposure to the contaminant in Lake Superior since PCBs are elevated in several species in Lake Superior, and there are no barriers to fish movement between the two water bodies. The elevated PCB concentration in Lake Superior fish is believed to be due primarily to atmospheric deposition.

Prior to this study, no walleye from Lake Superior in the vicinity of Torch Lake had been analyzed for chemical contamination. The goal of this study was to compare concentrations of total PCBs in walleye collected from Torch Lake (Houghton County) with concentrations in walleye collected from Portage Lake and Huron Bay, Lake Superior. The null hypothesis was that PCB concentrations within Torch Lake fish were no different than in fish collected from Portage Lake and nearby waters of Lake Superior.

SUMMARY

1. Walleye were collected from Huron Bay, Lake Superior, in April 2006 and from Torch Lake and Portage Lake in April 2007.
2. The length ranges of walleye collected from all three locations were equivalent.
3. Total PCB and lipid-normalized total PCB concentrations in Torch Lake walleye collected in 2007 were equivalent to the concentrations in walleye collected in 2000.
4. Total PCB and lipid-normalized total PCB concentrations in walleye collected from Torch Lake were higher than concentrations in walleye collected from Huron Bay, and the data suggest that walleye from the two areas represent distinct groups.
5. Total PCB concentrations in Portage Lake walleye appear similar to the concentrations in walleye collected from Huron Bay, but the comparisons are weak due to a small Portage Lake sample.
6. The MDCH fish consumption advisories for Torch Lake and Portage Lake walleye are unlikely to be relaxed based on the total PCB concentrations measured in the 2007 samples.

METHODS

Torch Lake supports a diverse population of fish, including northern pike, smallmouth bass, and walleye. Walleye were selected as the target for PCB concentration comparisons because, of the three species, they were the most likely to be collected in Lake Superior. In addition, walleye are a popular commercial and sport fish.

Walleye were collected in April 2007 from Torch Lake and Portage Lake by the Michigan Department of Natural Resources (MDNR), Fisheries Division, during scheduled sampling work, and in April 2006 from Huron Bay, Lake Superior, by the Keweenaw Bay Indian Community (Figure 1). A total of 16 walleye ranging in length from 17 to 20 inches were collected from Huron Bay in 2006. Twenty walleye ranging in length from 15 to 25 inches were collected from Torch Lake in 2007.

Walleye samples were also collected from Torch Lake in 1988 and 2000. Based on those samples, the MDCH issued fish consumption advisories for walleye due to elevated concentrations of PCBs and mercury.

The Michigan Department of Environmental Quality (MDEQ), Water Bureau (WB) processed the fish in accordance with the Great Lakes and Environmental Assessment Section (GLEAS) Procedure 31 (available upon request). Each fish was measured (total length), weighed, and examined to determine sex; any gross internal or external tumors or abnormalities were noted. Walleye tissue samples were prepared as skin-on, untrimmed fillets, individually wrapped in aluminum foil, labeled appropriately, and frozen until analyzed.

All samples were analyzed by MDCH, Analytical Chemistry Laboratory (ACL), which has a quality assurance program and uses peer-reviewed methods of digestion, extraction, and quantification.

The MDCH, ACL, analyzed the fish tissue samples for mercury, percent lipids, 25 organic chemicals (Table 1), and PCB congeners (Table 2). Total PCB concentration was estimated by summing the concentrations of PCB congeners. Individual congeners below the detection level were assigned a concentration equal to 0 for the purpose of calculating a total PCB

concentration. Also, congener analyses that did not meet retention time criteria or were subject to analytical interference were assigned a concentration equal to 0 for the purpose of calculating a total PCB concentration. If the results of an individual congener analysis did not meet all of the quantification requirements, then the congener was assigned a concentration equal to the estimated concentration for the purpose of calculating a total PCB concentration. If all of the congeners were below the detection level, then the total PCB concentration was reported as less than the detection level of the individual congeners.

Analytical results were reviewed and entered in the MDEQ, WB, Fish Contaminant Monitoring Program (FCMP) database. Results are presented in the attached appendix, and are also available electronically by request or through the FCMP Web site (*The link provided was broken and has been removed*).

PCB concentrations have been shown to differ significantly between the male and female walleye (Madenjian et al., 1998) as well as other species (Rypel et al., 2007). Such differences may be due to gender-related physiological differences and life-history characteristics (e.g., habitat preferences, diet). Most of the walleye collected for this study were male; to eliminate the risk that results could be affected by gender differences, only males were used for the between site comparisons.

Concentrations of bioaccumulative contaminants in fish are generally positively correlated with fish length; in order to make appropriate comparisons between populations it is critical that the size ranges of fish being compared are similar. Analysis of variance indicated that there was no significant difference in the mean length of walleye collected from the three sites, although the overall power of this comparison may be low due to the small Portage Lake sample size. A summary of the lengths of the male walleye collected from Torch Lake, Portage Lake, and Huron Bay is presented in Table 3.

PCBs are highly lipophilic, concentrating in lipids (fat) in fish tissue. Fish with less fat content tend to have lower concentrations of PCBs. Since fat content in fish can vary between individual fish and between fish populations it is sometimes appropriate to normalize the data by dividing the PCB concentrations by the lipid content for each fish sample. For this study, PCB concentrations between sampling sites were compared using both actual (wet weight) concentrations and lipid-normalized concentrations.

Analysis of variance and regression techniques, to be valid, assume data sets have certain characteristics (e.g., normality of residuals and homogeneity of variance). In order to meet the requirements for those tests, data were transformed by taking the natural log of the concentration. Statistical tests were considered significant at $\alpha=0.05$.

RESULTS AND DISCUSSION

Temporal Comparison

Total PCB and lipid-normalized total PCB concentrations in Torch Lake walleye collected in 2007 were equivalent to the concentrations measured in the Torch Lake walleye samples collected in 2000 (Figures 2 and 3). No fish larger than 22 inches were collected in 2000, so statistical comparisons of the two years were made only for fish between 15 and 22 inches. The median total PCB concentrations in walleye between 15 and 22 inches were 40 parts per billion (ppb) and 30 ppb in 2000 and 2007, respectively. The median lipid-normalized total PCB concentrations in those fish were 19 and 21 ppb in 2000 and 2007, respectively. Statistical comparisons using the non-parametric Mann-Whitney test on both the total PCB and lipid-normalized total PCB data sets indicated that the two Torch Lake samples were not significantly different.

Walleye were collected from Portage Lake in 1988 and 1998, but comparisons with the samples collected in 2007 are not informative. Total PCB concentrations prior to 2000 were based on the analysis of Aroclors (manufactured mixtures), and the quantification limit (QL) for those analyses was 25 ppb (the QL for congener analysis is 1 ppb). Total PCB concentrations in the 1988 and 1998 Portage Lake walleye samples were nearly all reported as below the QL, thus a meaningful comparison with the 2007 samples is not possible.

Inter-Site Comparisons

Total PCB concentrations in walleye collected from Torch Lake in 2007 were higher than in walleye collected from Huron Bay in 2006. Linear regression analysis of total PCB concentration versus length and lipid-normalized total PCB concentration versus length yielded similar results. The regression analysis of the Huron Bay samples indicated that there was no significant relationship between size of fish and total PCB concentration, while analysis of the Torch Lake samples indicated that there was a significant positive relationship between fish length and total PCB concentration. This relationship is visually apparent in Figures 4 and 5, and suggests that the Torch Lake samples represent a group of fish separate from the Huron Bay fish. While regression analysis of the Portage Lake samples indicated a significant positive relationship between length and total PCB concentration, that relationship is driven by only one relatively large fish.

The median total PCB concentrations were 20 ppb, 22 ppb, and 100 ppb in Huron Bay, Portage Lake, and Torch Lake walleye, respectively. The median lipid-normalized total PCB concentrations were 15 ppb, 10 ppb, and 63 ppb in Huron Bay, Portage Lake, and Torch Lake walleye, respectively. Analysis of variance indicates that total PCB concentrations in Torch Lake walleye were higher than walleye from both Portage Lake and Huron Bay. However, we cannot differentiate the Portage Lake sample from the others with good confidence since the sample size was small (8 male fish) and large walleye were under-represented.

The general pattern of congener composition in walleye from Torch Lake was similar to that observed in the Huron Bay samples (Figure 6). The congener concentrations were strongly correlated ($r = 0.92$), but there were differences. A total of 50 PCB congeners were quantified in the Torch Lake samples while only 40 were quantified in the Huron Bay walleye. All of the congeners quantified in the Huron Bay samples were also quantified in the Torch Lake samples.

The higher total PCB concentrations and different congener composition in the Torch Lake walleye as compared to the Huron Bay walleye are consistent with the sediment and SPMD studies indicating that there is a source of PCBs in the Torch Lake watershed. It seems likely that the walleye collected in Torch Lake are in the lake for extended periods of time and that the elevated concentrations of PCBs measured in those fish are a result of sources within the Torch Lake watershed over and above atmospheric inputs.

Impact on Fish Consumption Advisory

The current MDCH Fish Consumption Advisory recommends that the general population limit consumption of Torch Lake walleye greater than 22 inches to 1 meal per week, and that children under the age of 15 and women of childbearing age eat no more than 1 meal per week of walleye less than 22 inches and no more than 1 meal per month of walleye larger than 22 inches.

The current Torch Lake walleye advisory recommendations are due to elevated concentrations of mercury and PCBs, and are based on samples collected in 1988 and 2000. The walleye consumption recommendation for the general population is driven by the Statewide Mercury Fish Consumption Advisory, which recommends that the general population eat no more than 1 meal per week of walleye of any size from inland lakes. Mercury concentrations in the 16 walleye collected in 1988 and 2000 were all below the 0.5 parts per million (ppm) “restrict consumption” trigger level, but the fish were all less than 22 inches. Based on those results, the MDCH concluded that the general population did not need to limit consumption of walleye less than 22 inches; restrictive advice remained for larger walleye since no data were available for fish larger than 22 inches. The advice for women and children is driven by both mercury and PCBs. If PCBs were eliminated from the walleye, the restriction on consumption of fish less than 22 inches would be lifted, but the advice to restrict consumption on fish larger than 22 inches would remain until it was known that the mercury concentration in those fish was below 0.5 ppm.

A total of 30 legal size walleye (at least 15 inches) were collected from Torch Lake since 2000. The median total PCB concentration in walleye less than 22 inches was 40 ppb, and the median concentration in walleye greater than 22 inches was 210 ppb. The median concentration in the large walleye exceeds the 200 ppb MDCH women and children “1 meal per month” trigger level, therefore, the MDEQ, WB, will recommend that the walleye advisory remain unchanged. Total mercury results were not available for this report. It is possible that the mercury results may indicate that more restrictive advice is warranted.

The current MDCH Fish Consumption Advisory recommends that the general population limit consumption of Portage Lake walleye greater than 22 inches to 1 meal per week, and that children under the age of 15 and women of childbearing age eat no more than 1 meal per month of walleye larger than 22 inches. There are no restrictions on consumption of Portage Lake walleye less than 22 inches.

A total of 20 legal size walleye were collected from Portage Lake since 1988. The median total PCB concentration in walleye less than 22 inches was 25 ppb, and the median concentration in walleye greater than 22 inches was 76 ppb. Since the latter concentration is less than the 200 ppb MDCH women and children “1 meal per month” trigger level, we could consider recommending that the advice for women and children be relaxed to 1 meal per week for walleye greater than 22 inches. However, since the more contaminated Torch Lake walleye

may easily move into Portage Lake, the MDEQ, WB, will recommend that the advisory remain unchanged until we can confidently determine that PCB concentrations have declined.

Until recently, the MDCH did not issue an advisory for Lake Superior walleye since no data were available. Based on the samples collected from Huron Bay in 2006, the 2008 MDCH Fish Consumption Advisory (currently in draft) recommends restricted consumption of Lake Superior walleye greater than 22 inches due to elevated concentrations of mercury; PCBs in Lake Superior walleye are not elevated to the extent that they need to be listed as a contaminant causing the advisory.

ACKNOWLEDGEMENTS

The MDEQ, WB, would like to thank the MDNR, Fisheries Division staff for collecting the Torch Lake fish, and the Keweenaw Bay Indian Community for providing the walleye collected from Huron Bay.

Report By: Joe Bohr, Aquatic Biologist
Surface Water Assessment Section
Water Bureau

LITERATURE CITED

- Alexander, M. 2008. A Sediment Chemistry Survey of Torch Lake, Houghton County, Michigan, August 7, 8, and 9, 2007. Michigan Dept of Environmental Quality, Water Bureau Staff Report MI/DEQ/WB-08/011.
- Bohr, J. 2006. PCB Concentrations in Torch Lake using Semi-Permeable Membrane Devices, Houghton County, Michigan, October 20-November 18, 2005. Michigan Department of Environmental Quality, Water Bureau Staff Report MI/DEQ/WB-06/032.
- Madenjian, C. P., G. E. Noguchi, R. C. Haas, and K. Schrouder. 1998. Sexual Difference in Polychlorinated Biphenyl Accumulation Rates of Walleye (*Stizostedion vitreum*). Can. J. Fish. Aquat. Sci. 55:1085-1092.
- Rypel, A. L., R. H. Findlay, J. B. Mitchell, D. R. Bayne. 2007. Variations in PCB Concentrations between Genders of Six Warmwater Fish Species in Lake Logan Martin, Alabama, USA. Chemosphere 68:1707-1715.
- USEPA, 2001. Baseline Study Report, Torch Lake Superfund Site, Houghton County, Michigan. USEPA Region 5, Chicago, Illinois, (August 2001).

Table 1. Halogenated organic chemicals and mercury assayed in edible portion and whole fish tissue samples.

<u>Standard Analyses</u>	<u>Level of Quantification</u>
Hexachlorobenzene	0.001 ppm
<i>gamma</i> -BHC (Lindane)	0.001 ppm
Aldrin	0.001 ppm
Dieldrin	0.001 ppm
4,4'-DDE	0.001 ppm
4,4'-DDD	0.001 ppm
4,4'-DDT	0.001 ppm
2,4'-DDE	0.001 ppm
2,4'-DDD	0.001 ppm
2,4'-DDT	0.001 ppm
Heptachlor Epoxide	0.001 ppm
Mercury	0.010 ppm
Oxychlordane	0.001 ppm
<i>gamma</i> -Chlordane	0.001 ppm
<i>trans</i> -Nonachlor	0.001 ppm
<i>alpha</i> -Chlordane	0.001 ppm
<i>cis</i> -Nonachlor	0.001 ppm
Octachlorostyrene	0.001 ppm
Hexachlorostyrene	0.001 ppm
Heptachlorostyrene	0.001 ppm
Pentachlorostyrene	0.001 ppm
Heptachlor	0.001 ppm
Terphenyl	0.250 ppm
Toxaphene	0.050 ppm
Mirex	0.001 ppm
PBB (FF-1, BP-6)	0.001 ppm

Table 2. PCB structure and corresponding identification number of congeners assayed in Michigan FCMP fish tissue samples.

BZ#	Structure	BZ#	Structure
	TRICHLOROBIPHENYLS		HEXACHLOROBIPHENYLS
17	2,2',4	128	2,2',3,3',4,4'
18	2,2',5	130	2,2',3,3',4,5'
22	2,3,4'	132	2,2',3,3',4,6'
25	2,3',4	135	2,2',3,3',5,6'
26	2,3',5	136	2,2',3,3',6,6'
28	2,4,4'	137	2,2',3,4,4',5
31	2,4',5	138	2,2',3,4,4',5'
32	2,4',6	141	2,2',3,4,5,5'
33	2',3,4	144	2,2',3,4,5',6
37	3,4,4'	146	2,2',3,4',5,5'
	TETRACHLOROBIPHENYLS	149	2,2',3,4',5',6
40	2,2',3,3'	151	2,2',3,5,5',6
42	2,2',3,4'	153	2,2',4,4',5,5'
44	2,2',3,5'	156	2,3,3',4,4',5
45	2,2',3,6	157	2,3,3',4,4',5'
47	2,2',4,4'	158	2,3,3',4,4',6
49	2,2',4,5'	163	2,3,3',4',5,6
52	2,2',5,5'	167	2,3',4,4',5,5'
56	2,3,3',4'		HEPTACHLOROBIPHENYLS
60	2,3,4,4'	170	2,2',3,3',4,4',5
63	2,3',4',5	171	2,2',3,3',4,4',6
64	2,3,4',6	172	2,2',3,3',4,5,5'
66	2,3',4,4'	174	2,2',3,3',4,5,6'
70	2,3',4',5	175	2,2',3,3',4,5',6
71	2,3',4',6	177	2,2',3,3',4',5,6
74	2,4,4',5	178	2,2',3,3',5,5',6
77	3,3',4,4'	179	2,2',3,3',5,6,6'
	PENTACHLOROBIPHENYLS	180	2,2',3,4,4',5,5'
82	2,2',3,3',4	182	2,2',3,4,4',5,6'
84	2,2',3,3',6	183	2,2',3,4,4',5',6
87	2,2',3,4,5'	185	2,2',3,4,5,5',6
90	2,2',3,4',5	187	2,2',3,4',5,5',6
91	2,2',3,4',6	190	2,3,3',4,4',5,6
92	2,2',3,5,5'	193	2,3,3',4',5,5',6
95	2,2',3,5',6		OCTACHLOROBIPHENYLS
97	2,2',3',4,5	194	2,2',3,3',4,4',5,5'
99	2,2',4,4',5	195	2,2',3,3',4,4',5,6
100	2,2',4,4',6	196	2,2',3,3',4,4',5,6'
101	2,2',4,5,5'	198	2,2',3,3',4,5,5',6
105	2,3,3',4,4'	199	2,2',3,3',4,5,6,6'
110	2,3,3',4',6	201	2,2',3,3',4,5,5',6'
118	2,3',4,4',5	203	2,2',3,4,4',5,5',6
126	3,3',4,4',5	205	2,3,3',4,4',5,5',6
			NONACHLOROBIPHENYLS
		206	2,2',3,3',4,4',5,5',6

BZ# = identification numbers adopted by the International Union of Pure and Applied Chemists.

Table 3. Lengths of male walleye collected from Huron Bay, Torch Lake, and Portage Lake in 2006 and 2007.

Site	Sample Size	Length (Inches)		
		Minimum	Median	Maximum
Huron Bay	14	17.4	20.6	27.2
Torch Lake	14	15.4	20.2	24.3
Portage Lake	8	16.3	18.2	23.6

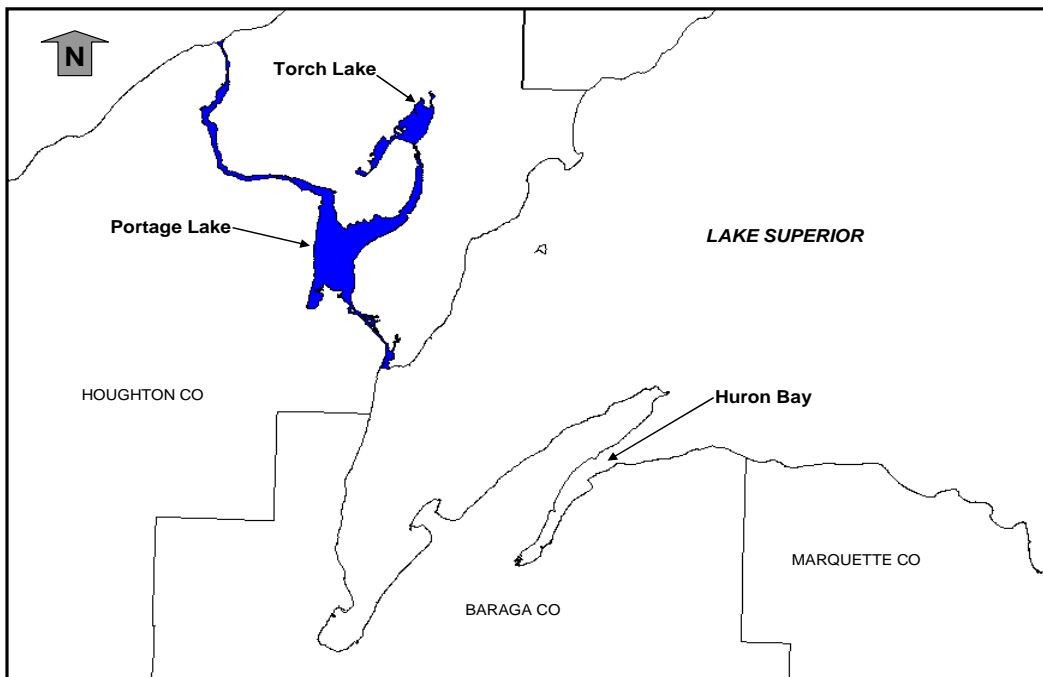


Figure 1. Fish collection locations in 2006 and 2007.

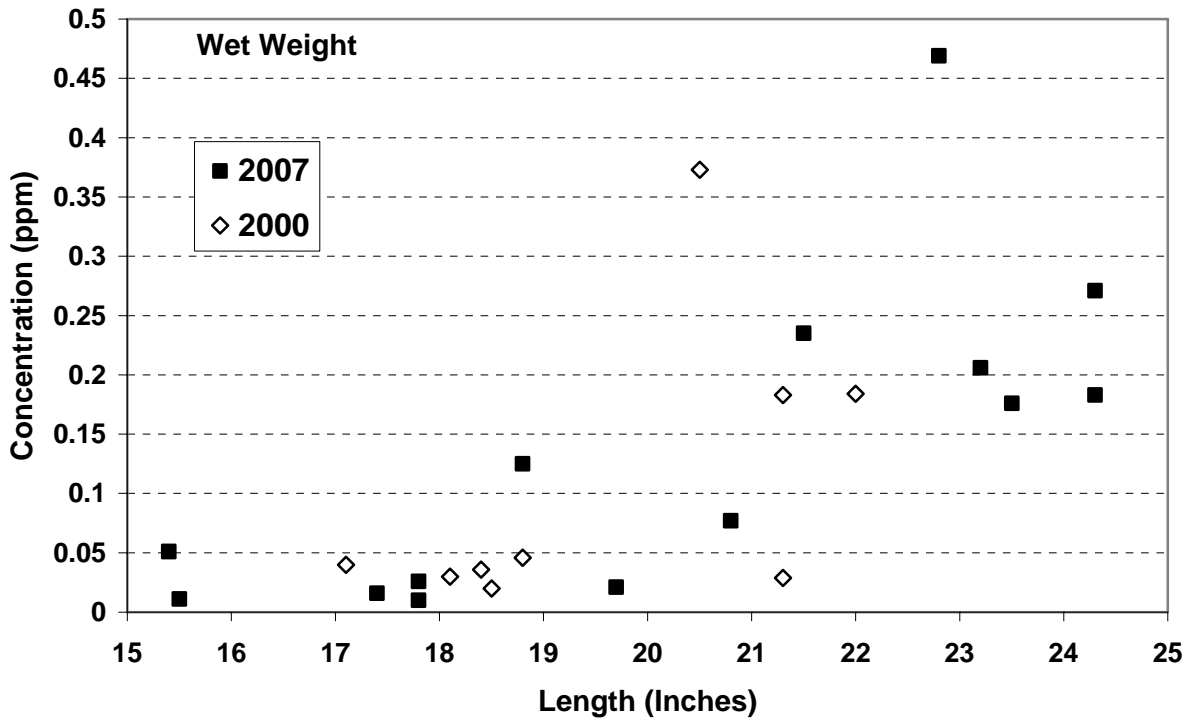


Figure 2. Total length versus total PCB concentration in male walleye collected from Torch Lake, Houghton County, in 2000 and 2006.

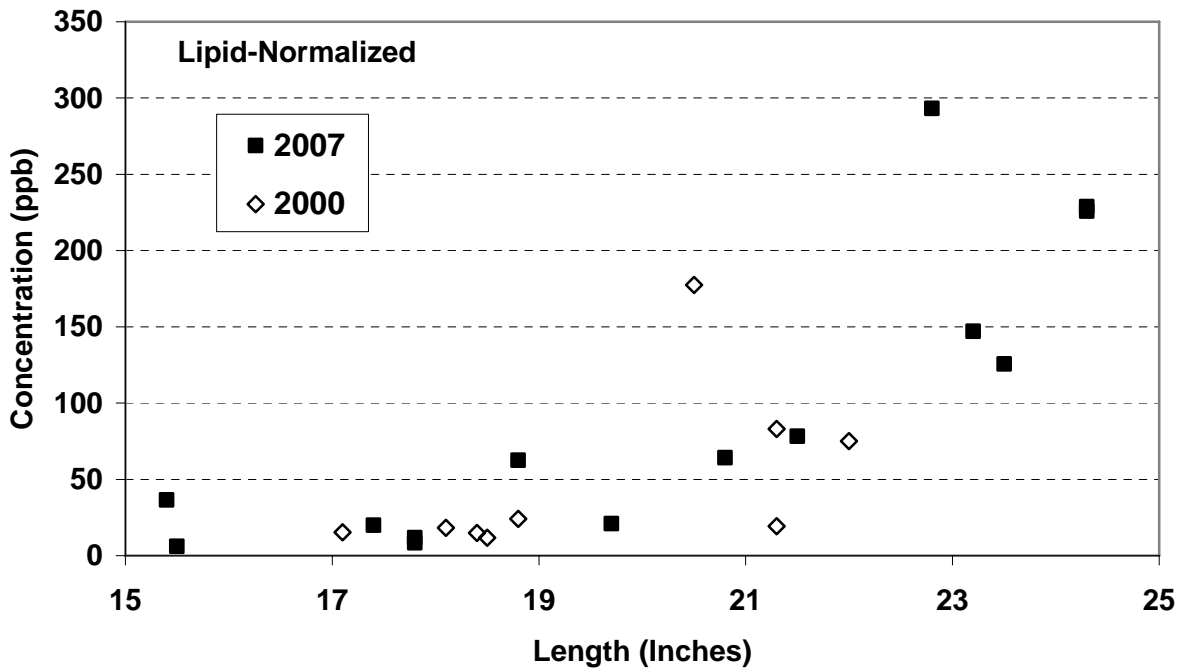


Figure 3. Total length versus lipid-normalized total PCB concentration in male walleye collected from Torch Lake, Houghton County, in 2000 and 2006.

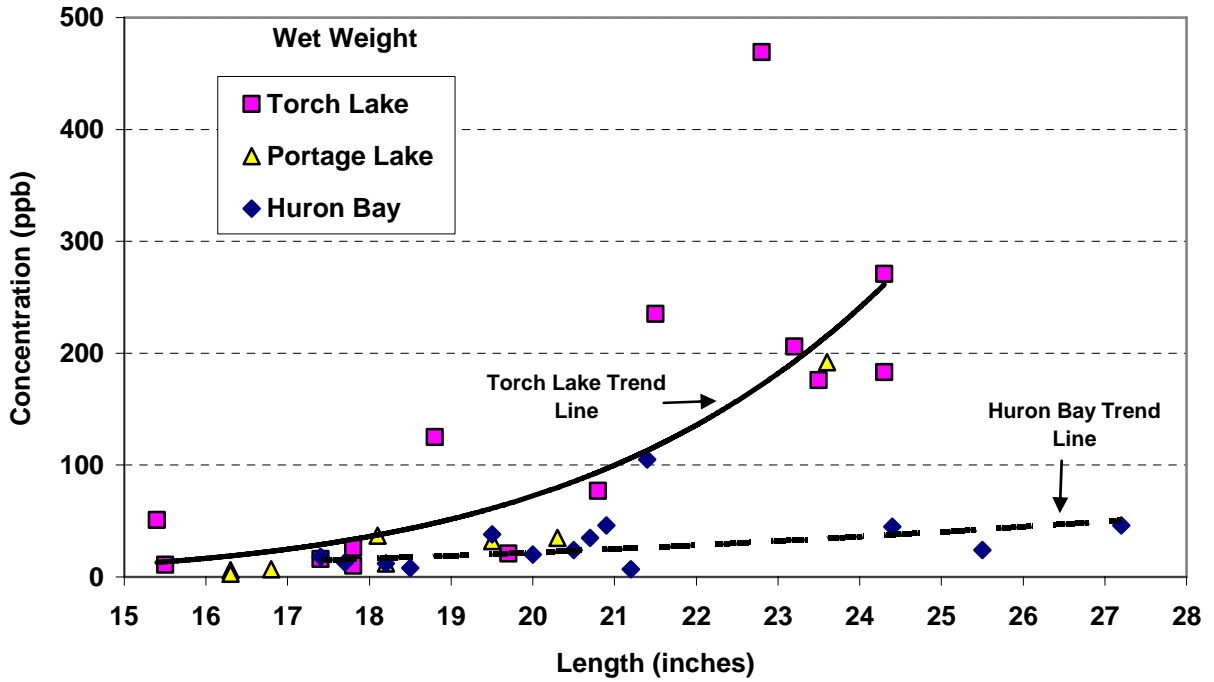


Figure 4. Total length versus total PCB concentration in male walleye collected from Huron Bay in 2006, and Portage and Torch Lakes, Houghton County, in 2007.

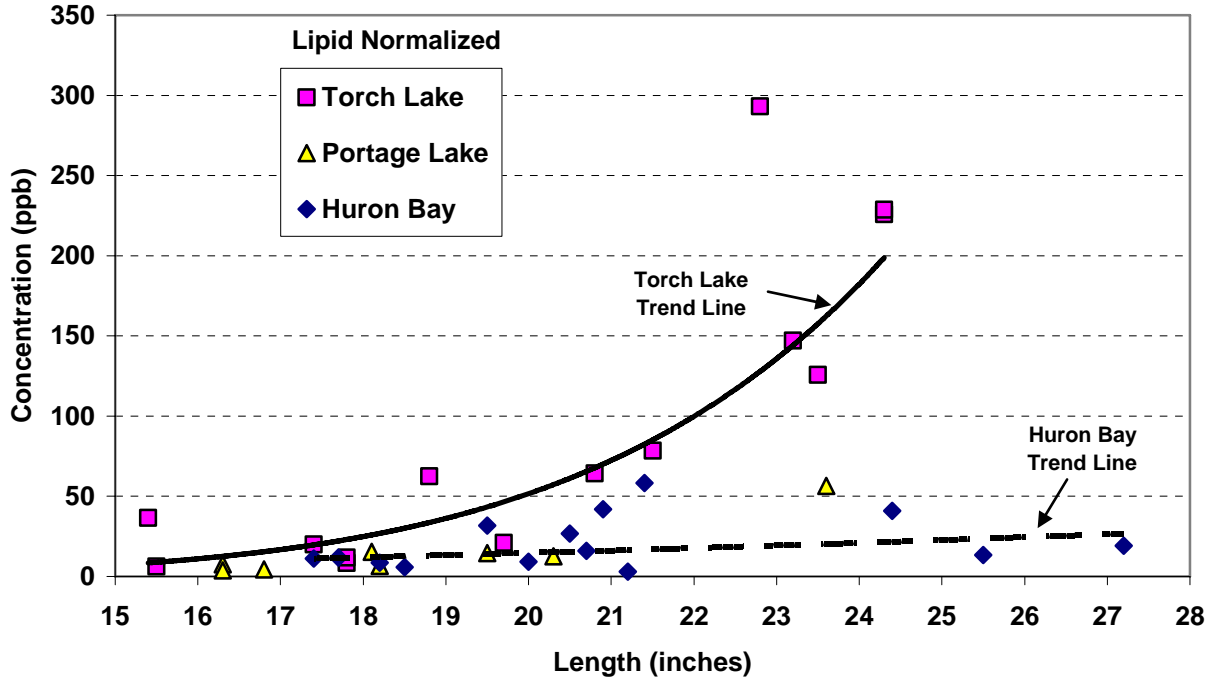


Figure 5. Total length versus lipid normalized total PCB concentration in male walleye collected from Huron Bay in 2006, and Portage and Torch Lakes, Houghton County, in 2007.

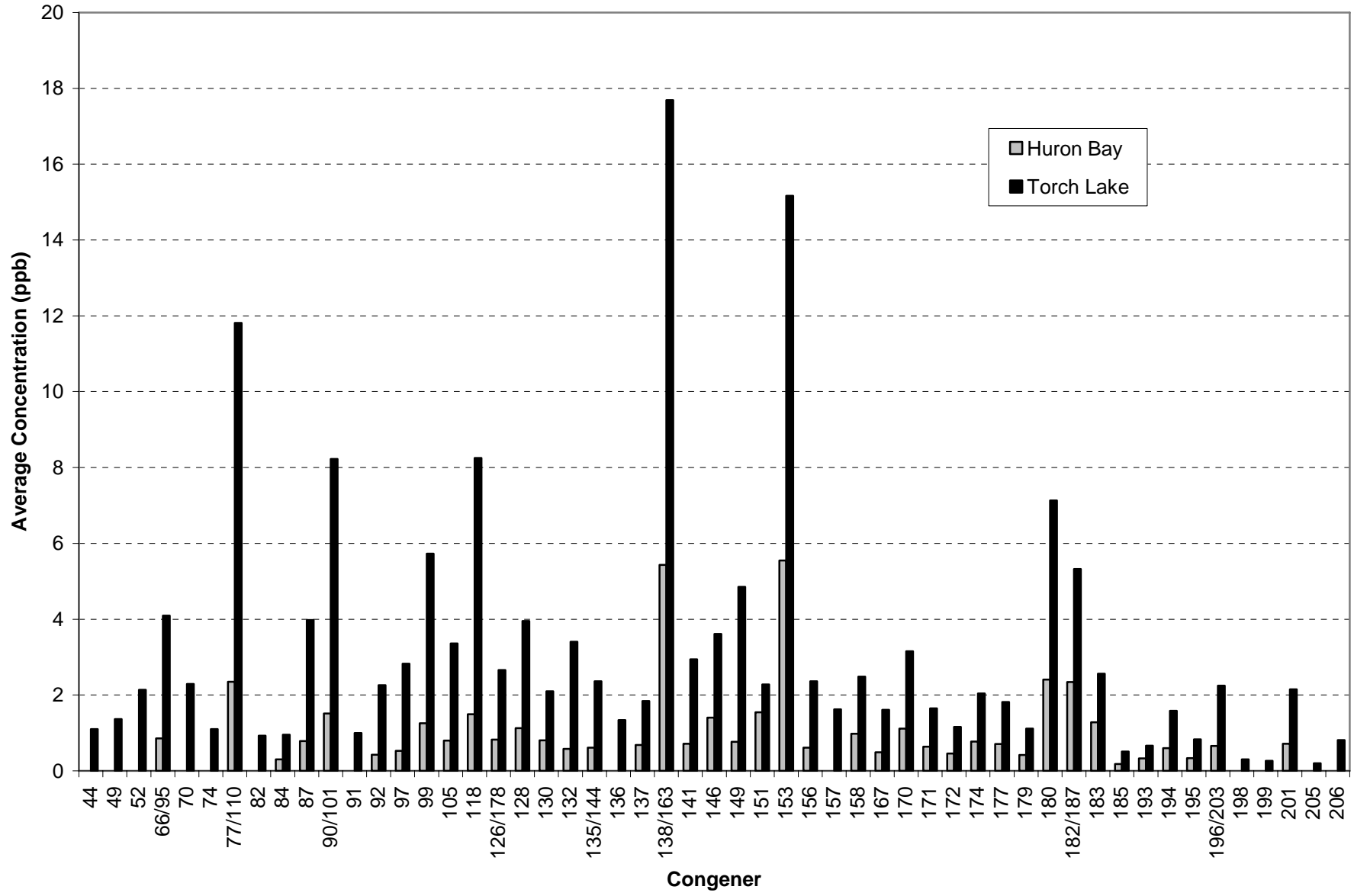


Figure 6. PCB congener composition in walleye collected from Torch Lake and Huron Bay in 2006 and 2007.

APPENDIX Individual fish data and total PCB concentrations for walleye collected from Torch Lake (Houghton County) and from Huron Bay, Lake Superior, from 1988 through 2007, for the Michigan FCMP.

Waterbody Name	Location	Visit ID	Collection Date	Fish ID#	Species	Sex	Length (cm)	Weight (g)	Sample Type	fat (%)	Total PCB - Aroclor (ppm)	Aroclor Code	Total PCB - Cong (ppm)	Cong code
Lake Superior	Huron Bay	2006111	4/20/2006	2006111-F001	Walleye	M	44.3	1900	F	1.6			0.018	
Lake Superior	Huron Bay	2006111	4/20/2006	2006111-F002	Walleye	M	45	1800	F	1.1			0.013	
Lake Superior	Huron Bay	2006111	4/20/2006	2006111-F003	Walleye	M	46.3	2120	F	1.4			0.012	
Lake Superior	Huron Bay	2006111	4/20/2006	2006111-F004	Walleye	F	48.5	2320	F	1.4			0.005	
Lake Superior	Huron Bay	2006111	4/20/2006	2006111-F005	Walleye	M	47.1	2460	F	1.4			0.008	
Lake Superior	Huron Bay	2006111	4/20/2006	2006111-F006	Walleye	F	51	2900	F	2.2			0.011	
Lake Superior	Huron Bay	2006111	4/20/2006	2006111-F007	Walleye	M	49.5	2500	F	1.2			0.038	
Lake Superior	Huron Bay	2006111	4/20/2006	2006111-F008	Walleye	M	50.9	2700	F	2.2			0.02	
Lake Superior	Huron Bay	2006111	4/20/2006	2006111-F009	Walleye	M	52.6	3160	F	2.2			0.035	
Lake Superior	Huron Bay	2006111	4/20/2006	2006111-F010	Walleye	M	52	3100	F	0.9			0.024	
Lake Superior	Huron Bay	2006111	4/20/2006	2006111-F011	Walleye	M	53.9	3840	F	2.3			0.007	
Lake Superior	Huron Bay	2006111	4/20/2006	2006111-F012	Walleye	M	53.2	3580	F	1.1			0.046	
Lake Superior	Huron Bay	2006111	4/20/2006	2006111-F013	Walleye	M	54.4	3820	F	1.8			0.105	
Lake Superior	Huron Bay	2006111	4/20/2006	2006111-F014	Walleye	M	61.9	4920	F	1.1			0.045	
Lake Superior	Huron Bay	2006111	4/20/2006	2006111-F015	Walleye	M	64.8	6780	F	1.8			0.024	
Lake Superior	Huron Bay	2006111	4/20/2006	2006111-F016	Walleye	M	69.2	8080	F	2.4			0.046	
Portage Lake	Houghton County	88016	8/4/1988	88016-F011	Walleye	U	76.2	4651.2	F	3.9	0.1			
Portage Lake	Houghton County	88016	8/4/1988	88016-F012	Walleye	U	54.356	1413.6	F	1.5	0.025	K		
Portage Lake	Houghton County	88016	8/4/1988	88016-F013	Walleye	U	62.23	1824	F	0.7	0.18			
Portage Lake	Houghton County	88016	8/4/1988	88016-F014	Walleye	U	55.88	1459.2	F	1.9	0.025	K		
Portage Lake	Houghton County	88016	8/4/1988	88016-F015	Walleye	U	51.816	1459.2	F	2.1	0.025	K		
Portage Lake	Houghton County	88016	8/4/1988	88016-F016	Walleye	U	46.99	1094.4	F	2	0.026			
Portage Lake	Houghton County	88016	8/4/1988	88016-F017	Walleye	U	45.974	1048.8	F	0.8	0.025	K		
Portage Lake	Houghton County	88016	8/4/1988	88016-F018	Walleye	U	40.64	638.4	F	1.4	0.025	K		
Portage Lake	Houghton County	88016	8/4/1988	88016-F019	Walleye	U	38.862	592.8	F	1.1	0.025	K		
Portage Lake	Houghton County	88016	8/4/1988	88016-F020	Walleye	U	38.1	547.2	F	1.2	0.025	K		
Portage Lake	Houghton County	1998151	9/15/1998	1998151-F001	Walleye	M	36.3	420	F	0.7	0.025	K		
Portage Lake	Houghton County	1998151	9/15/1998	1998151-F002	Walleye	U	36.3	440	F	0.65	0.025	K		
Portage Lake	Houghton County	1998151	9/15/1998	1998151-F003	Walleye	M	36.8	470	F	1.25	0.025	K		
Portage Lake	Houghton County	1998151	9/15/1998	1998151-F004	Walleye	M	39.4	630	F	0.85	0.025	K		
Portage Lake	Houghton County	1998151	9/15/1998	1998151-F005	Walleye	M	40.9	600	F	0.75	0.025	K		

APPENDIX Individual fish data and total PCB concentrations for walleye collected from Torch Lake (Houghton County) and from Huron Bay, Lake Superior, from 1988 through 2007, for the Michigan FCMP.

Waterbody Name	Location	Visit ID	Collection Date	Fish ID#	Species	Sex	Length (cm)	Weight (g)	Sample Type	fat (%)	Total PCB - Aroclor (ppm)	Aroclor Code	Total PCB - Cong (ppm)	Cong code
Portage Lake	Houghton County	2007247	4/19/2007	2007247-F001	Walleye	M	41.402	640	F	0.8			0.006	
Portage Lake	Houghton County	2007247	4/19/2007	2007247-F002	Walleye	M	41.402	610	F	0.8			0.003	
Portage Lake	Houghton County	2007247	4/19/2007	2007247-F003	Walleye	M	42.672	610	F	1.6			0.007	
Portage Lake	Houghton County	2007247	4/19/2007	2007247-F004	Walleye	M	45.974	850	F	2.4			0.037	
Portage Lake	Houghton County	2007247	4/19/2007	2007247-F005	Walleye	M	46.228	840	F	1.8			0.012	
Portage Lake	Houghton County	2007247	4/19/2007	2007247-F006	Walleye	M	49.53	1280	F	2.2			0.032	
Portage Lake	Houghton County	2007247	4/19/2007	2007247-F007	Walleye	M	51.562	1300	F	2.8			0.035	
Portage Lake	Houghton County	2007247	4/19/2007	2007247-F008	Walleye	F	59.69	2350	F	3.6			0.052	
Portage Lake	Houghton County	2007247	4/19/2007	2007247-F009	Walleye	M	59.944	1970	F	3.4			0.192	
Portage Lake	Houghton County	2007247	4/19/2007	2007247-F010	Walleye	F	69.85	3230	F	1.2			0.034	
Torch Lake	Houghton County	88015	8/23/1988	88015-F025	Walleye	U	46.736	957.6	F	1	0.033			
Torch Lake	Houghton County	88015	8/23/1988	88015-F026	Walleye	U	42.926	729.6	F	1.4	0.043			
Torch Lake	Houghton County	88015	8/23/1988	88015-F027	Walleye	U	43.688	729.6	F	0.85	0.045			
Torch Lake	Houghton County	88015	8/23/1988	88015-F028	Walleye	U	37.338	456	F	1.1	0.025			
Torch Lake	Houghton County	88015	8/23/1988	88015-F029	Walleye	U	33.782	319.2	F	0.55	0.025	K		
Torch Lake	Houghton County	88015	8/23/1988	88015-F030	Walleye	U	49.53	1003.2	F	2.3	0.081			
Torch Lake	Houghton County	2000096	5/3/2000	2000096-F010	Walleye	M	43.4	760	F	2.6			0.04	
Torch Lake	Houghton County	2000096	5/3/2000	2000096-F011	Walleye	M	46	1000	F	1.65			0.03	
Torch Lake	Houghton County	2000096	5/3/2000	2000096-F012	Walleye	M	46.7	900	F	2.4			0.036	
Torch Lake	Houghton County	2000096	5/3/2000	2000096-F013	Walleye	M	47	940	F	1.7			0.02	
Torch Lake	Houghton County	2000096	5/3/2000	2000096-F014	Walleye	M	47.8	980	F	1.9			0.046	
Torch Lake	Houghton County	2000096	5/3/2000	2000096-F015	Walleye	M	52.1	1180	F	2.1			0.373	
Torch Lake	Houghton County	2000096	5/3/2000	2000096-F016	Walleye	M	54.1	1480	F	2.2			0.183	
Torch Lake	Houghton County	2000096	5/3/2000	2000096-F017	Walleye	M	55.9	1640	F	2.45			0.184	
Torch Lake	Houghton County	2000096	5/3/2000	2000096-F018	Walleye	F	55.4	1930	F	1.85			0.039	
Torch Lake	Houghton County	2000096	5/3/2000	2000096-F019	Walleye	M	54.1	1620	F	1.5			0.029	
Torch Lake	Houghton County	2007257	4/25/2007	2007257-F021	Walleye	M	39.37	520	F	1.8			0.011	
Torch Lake	Houghton County	2007257	4/25/2007	2007257-F022	Walleye	M	39.116	620	F	1.4			0.051	
Torch Lake	Houghton County	2007257	4/25/2007	2007257-F023	Walleye	M	44.196	680	F	0.8			0.016	
Torch Lake	Houghton County	2007257	4/25/2007	2007257-F024	Walleye	M	45.212	860	F	1.2			0.01	
Torch Lake	Houghton County	2007257	4/25/2007	2007257-F025	Walleye	M	45.212	710	F	2.2			0.026	

APPENDIX Individual fish data and total PCB concentrations for walleye collected from Torch Lake (Houghton County) and from Huron Bay, Lake Superior, from 1988 through 2007, for the Michigan FCMP.

Waterbody	Location	Visit ID	Collection Date	Fish ID#	Species	Sex	Length (cm)	Weight (g)	Sample Type	fat (%)	Total PCB - Aroclor (ppm)	Aroclor Code	Total PCB - Cong (ppm)	Cong code
T	Houghton County	2007257	4/25/2007	2007257-F026	Walleye	M	47.752	1060	F	2			0.125	
T	Houghton County	2007257	4/25/2007	2007257-F027	Walleye	M	50.038	900	F	1			0.021	
T	Houghton County	2007257	4/25/2007	2007257-F028	Walleye	M	52.832	1350	F	1.2			0.077	
T	Houghton County	2007257	4/25/2007	2007257-F029	Walleye	F	53.086	1180	F	1.2			0.052	
T	Houghton County	2007257	4/25/2007	2007257-F030	Walleye	M	54.61	1760	F	3			0.235	
T	Houghton County	2007257	4/25/2007	2007257-F031	Walleye	F	54.61	1710	F	1.4			0.039	
T	Houghton County	2007257	4/25/2007	2007257-F032	Walleye	M	57.912	1770	F	1.6			0.469	
T	Houghton County	2007257	4/25/2007	2007257-F033	Walleye	U	54.864	1550	F	2.2			0.212	
T	Houghton County	2007257	4/25/2007	2007257-F034	Walleye	M	58.928	1980	F	1.4			0.206	
T	Houghton County	2007257	4/25/2007	2007257-F035	Walleye	M	59.69	1920	F	1.4			0.176	
T	Houghton County	2007257	4/25/2007	2007257-F036	Walleye	U	60.198	1840	F	1.2			0.161	
T	Houghton County	2007257	4/25/2007	2007257-F037	Walleye	M	61.722	2180	F	1.2			0.271	
T	Houghton County	2007257	4/25/2007	2007257-F038	Walleye	M	61.722	2180	F	0.8			0.183	
T	Houghton County	2007257	4/25/2007	2007257-F039	Walleye	U	63.246	2100	F	1			0.346	
T	Houghton County	2007257	4/25/2007	2007257-F040	Walleye	U	63.246	2570	F	0.6			0.206	